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Motorcyclists

A literature review and exploratory analysis of fatalities and serious injury collisions in relation to motorcyclists: Implications for education, engineering and enforcement initiatives

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In the UK, a motorcyclist is more likely to be killed or seriously injured than any other type of road user; in 2008, the fatality rate for motorcyclists was 40 times that of car drivers. Research indicates there may be differences in collisions between larger (over 125cc) and smaller bikes (up to 125cc). Cornwall and national statistics demonstrate whilst motorcycle KSI collisions are steadily reducing, fatal collisions remain fairly stable, and that riders themselves are responsible for the majority of fatal collisions. This report explores collision and rider factors associated with bikes over 125cc and up to 125cc separately, for both serious injury and fatal collisions. It examines evidence for education, engineering and enforcement initiatives aimed at riders, and considers recommendations for the future.

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Executive Summary

The aim of this research is to identify whether there are any differences between serious and fatal road traffic collisions involving motorcyclists and examine ways of increasing safety and reducing casualty involvement through education, engineering and enforcement initiatives.

Examination of collision data suggests different collision factors are related to bikes over 125cc and bikes up to 125cc.

Bikes over 125cc:

- Collisions are most likely to occur during the afternoon, at weekends and during the summer months.
- Collisions are most likely to occur on rural, A class, single carriageway roads when the weather is fine and the road surface is dry.
- The most common collisions were those which occurred at junctions and on bends. Collisions at junctions tend to be the fault of the other motorist turning and pulling out in front of a motorcycle. T-junctions are featured most commonly nationally and private driveways are also common in Cornwall. Collisions on bends tend to be the fault of the rider losing control due to excess speed.
- In a high proportion of fatal collisions a motorcycle hit an object; this was most common on rural roads.
- 21% of Cornwall's fatal collisions occurred when the motorcyclists were riding in convoy.

Bikes up to 125cc:

- Collisions are most likely to occur from 15.01-18.00 than any other time of the day, these collisions are quite evenly spread across day of the week and month of the year.
- Collisions are most common on urban A and unclassified roads, than any other road type, when the weather is fine and dry.
- The most common types of collision were those that occurred at a junction and when the motorcyclist was going ahead.
- The most common contributory factor to these collisions was inexperience of the rider.
- A high proportion of fatal collisions involved the motorcycle hitting an object.

The differences between fatal and serious injury collisions were:

- A higher proportion of fatal collisions occurred on rural roads than serious injury collisions.
- More fatal collisions hit an object than serious injury collisions.
- More fatal collisions occurred on bikes over 125cc than bikes up to 125cc.

A number of recommendations can be made from the evidence on motorcyclist's initiatives:

Bikes over 125cc:

- Initiatives aimed at riders of bikes over 125cc could be targeted at times and places identified as high risk. Statistics show collisions most commonly occur during the afternoon at weekends, and during the summer months, on rural A class single carriageways, at junctions and on bends.
- Initiatives could target convoy riding; 21% of all Cornwall's fatal collisions involving motorcyclists occurred when the motorcyclists were riding in convoy, all but 1 were riding sports bikes over 500cc. Due to this high percentage in Cornwall, it may be beneficial to collect data on convoy riding nationally.
- Initiatives could target speeding; loss of control due to speed was the most common cause of collisions.

Bikes up to 125cc:

- Initiatives aimed at riders of bikes up to 125cc could be targeted at times and places identified as high risk. Statistics show collisions most commonly occur during rush hour times, at junctions on urban A class and unclassified roads.

- Research suggests more collisions are in the remit of the other motorist for bikes under 125cc, compared to collisions involving larger bikes. The most common contributory factor to collisions involving bikes under 125cc was inexperience, suggesting initiatives could target increasing the defensive riding skills of riders of smaller bikes.

Education, training and publicity

- Statistics show males aged 30-49 who ride for leisure purposes are most at risk of collisions on bikes over 125cc, and young males (under 25 years) who ride for commuting purposes are most at risk of collisions on bikes up to 125cc. It was found bikes of different sizes also have different types of collisions. Different initiatives could be developed for different bike sizes and therefore different collision types. Cornwall Wheels to Work and Learn provides mopeds to young people (16+) who have difficulties getting to work or education. Projects such as these may provide a target audience for initiatives aimed at riders of small bikes.
- Research into motivations suggests 'look-at-me enthusiasts', 'car aspirants' and those motivated by performance ('performance hobbyist' and performance disciples') are most at risk of collisions. Initiatives could target these groups of riders.
- Research into the motivations of riders on small bikes suggests safety is not a prominent factor for young riders. Initiatives could focus on raising the awareness of the benefits of safety features when riding.
- Research has found getting participants to elaborate on the persuasive messages given in an intervention increases the interventions effectiveness; therefore rider education initiatives could pair persuasive messages with elaboration techniques.
- Risky riding behaviour, for example speeding, is considered an enjoyable activity for some riders, and these riders often tend to overestimate their abilities. Therefore, education and publicity initiatives should give consideration to rider intentions, motivation and attitudes towards riding.
- Training tends to focus on control skills and ignore higher order cognitive skills and psycho-social factors. Training initiatives could take into consideration cognitive skills such as hazard perception, and rider's motivations, attitudes and personality.
- Research has found skills training can have negative effects on collision risk, this implies caution should be taken when developing skill based training courses for young riders.
- Evaluations could be carried out on existing and future motorcycle training in order to establish which are most effective at increasing rider's safety so an evidence base can be built in this area. Evaluations should include before and after questionnaires, with questions that relate to the aims of the course, and follow up data should be collected relating to traffic offenses and collisions.

Engineering

- Crash barriers have been found to increase the risk of a fatal collision for motorcyclists. There have been mixed findings for the success of using secondary rail systems, which may increase the risk for car drivers. Impact attenuators have been found to increase motorcyclists safety during a collision, the shape of the support posts is also important with SIGMA posts causing less damage to the motorcyclist than traditional shape posts. It may be beneficial to consider the shape of support posts and impact attenuators on crash barriers where motorcycle collision rates are high.
- Research suggests road-side furniture and vegetation may obscure motorist's views of motorcyclists, and furniture positioned on the outside of bends may increase the severity of a collision if the motorcyclist collides with this furniture. A high proportion of Cornwall's fatal collisions involved the motorcycle hitting an object. Initiatives could target removing or repositioning vegetation and roadside furniture in collision hot spots.

Enforcement

- Research has shown collision involvement is related to previous riding convictions. Enforcement initiatives could target individuals with previous drink-riding and speeding convictions and recorded suspensions.

- Research suggests the more intense the enforcement the more effective it is in reducing speeding. Speeding could be targeted through increased on-road stopping and police presence.

1. Introduction

While motorcycles account for less than 4% of all registered vehicles nationally, they account for almost 10% of all road traffic casualties and 20% of all fatalities.[1] In the UK, a motorcyclist is more likely to be killed or seriously injured than any other type of road user;[2] in 2008, the fatality rate for motorcyclists was 40 times that of car drivers.[3] Table 1 shows the relative risk of car drivers, pedestrian's, cyclists and motorcyclists for being killed or seriously injured in a road traffic collision.

Casualty rate per billion KM travelled

	Killed	Killed or seriously injured
Car driver	2	20
Pedestrian	31	358
Pedal cyclist	24	546
Motorcyclist	93	1,131

Table 1 Reported road casualties: relative risk of different forms of transport, Great Britain, 2008[2]

Cornwall's statistics show a similar risk for motorcyclists with 25% of all fatal collisions involving a motorcycle.

Since motorcyclists are over represented in road traffic collisions the aim of this report is to identify initiatives that may increase their safety by examining factors involved in motorcycle collisions and the evidence regarding whether initiatives increase motorcyclist safety on the roads.

Since 2002, motorcycle KSI (killed and seriously injured) collisions in Cornwall have steadily decreased whilst fatal collisions remain fairly stable. This report examines factors that may be behind this trend by considering fatal and serious injury collisions separately. Data for Cornwall's serious injury collisions and national fatal and serious injury collisions were taken from STATs19; an established police recording format with specific definitions and details for contributory factors, location, vehicles, and injuries. Cornwall's fatal data was obtained from Cornwall's fatal database, which includes information recorded in STATs19 and extra information from coroner's inquests and engineering details. It is important to note that Cornwall's fatal figures are small in absolute numbers; therefore, national data has been included where appropriate.

Nationally, motorcycling has undergone a number of trends over time; the peak year for motorcycling was 1960 when there were almost 1.5 million bikes on the roads. By 1995 numbers had reduced to just under 0.6 million but since then the numbers have risen.[8] This is mirrored in the number of motorcycle fatalities, which has shown an increase since 1996, after a reduction prior to this. Figure 1 shows the number of motorcyclists killed in the UK from 1979-2007.

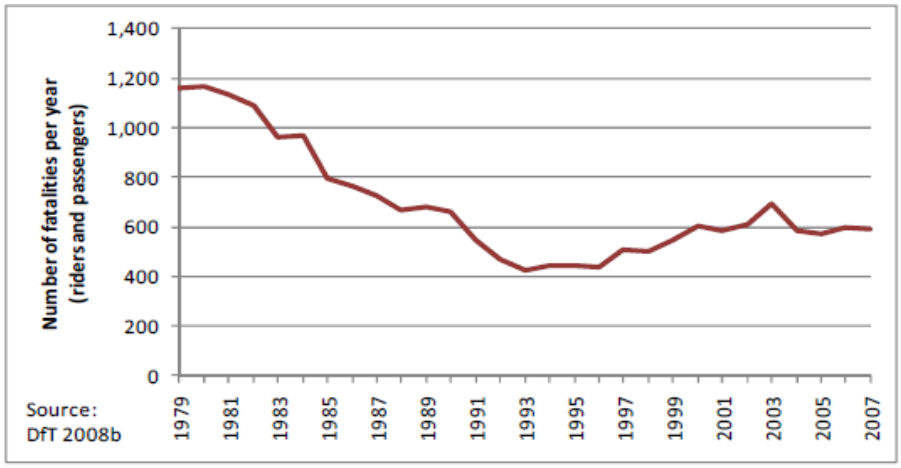

Figure 1 Numbers of motorcycle fatalities over time in the UK[8]

There have also been changes in the age of riders and engine size of motorcycles involved in collisions. In the UK the number of motorcycle casualties in the 20-24 age group has been falling, but those in the 25-59 age group has increased steadily from 1992 onwards.[4] Since 1996, the proportion of registered lower engine sized motorcycles in the UK has also steadily decreased, whilst larger engine sizes have become increasingly popular.[2] In 2008, the most common engine size was between 501-700cubic capacities (cc).[5]

Research in the UK has shown that motorcycle collisions involving more powerful bikes (over 125cc) are generally more severe than those involving lighter bikes (up to 125cc) [6] (Figure 2).

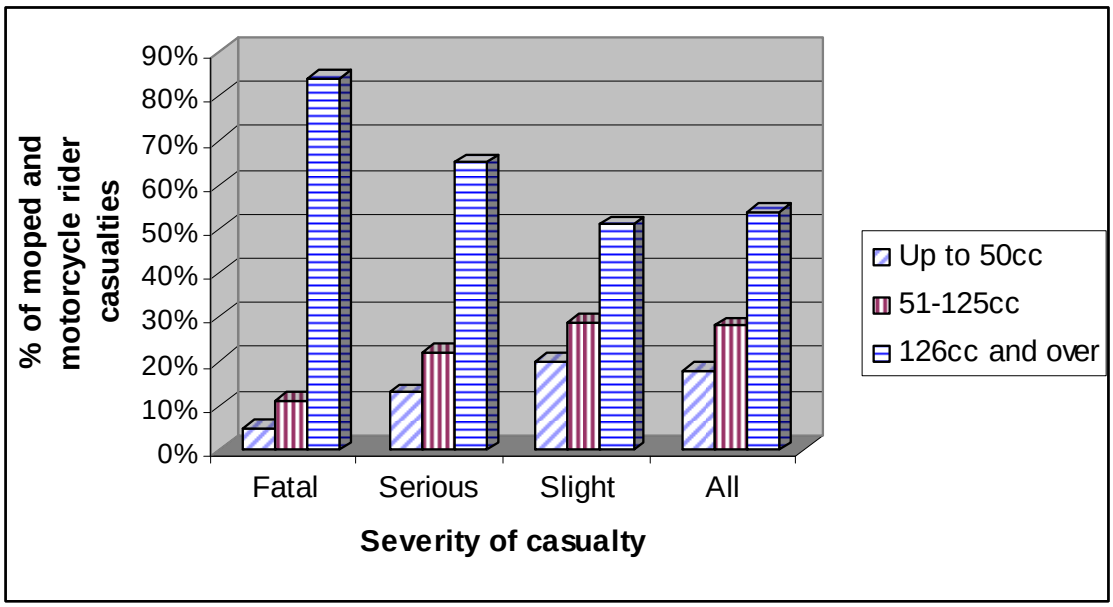

Figure 2 Moped and motorcycle rider and passenger casualties – percentage distribution by engine size and severity[8]

With larger machines becoming more popular and collisions involving these bikes being more severe, it is necessary to consider factors associated with collisions for motorcycles over 125cc and motorcycles up to 125cc separately so interventions can be effectively targeted.

2. Collision Factors: Motorcycles over 125cc

In the UK, in 2001, the DFT found that out of 1,790 motorcycle casualties 57% were riding bikes with engines over 125cc, with the majority of these being over 500cc (47%).[7] Other research in Britain has also found greater risk for riders on bikes over 125cc; from 2000-2006 a larger proportion of KSI casualties (56%) were on bikes with an engine over 125cc.[8] Data from Cornwall's casualty statistics show an even larger risk for riders of more powerful bikes than national data; 83% of motorcycle fatalities and 61% of motorcycle serious injury collisions involved bikes over 125cc. Due to the increased collision involvement of bikes over 125cc it is important to understand factors associated with these collisions.

2.1 When

Research has suggested that there are high risk times when motorcycles are more likely to be involved in collisions.[8] Statistics from national and Cornish data demonstrate this is also the case for riders of motorcycles over 125cc.

Time of day

Nationally, 46% of fatal and 51% of serious injury collisions occurred in the afternoon from 12.00-18.00. Cornwall's collisions showed a higher percentage; 60% of fatal and 54% of serious injury collisions, occurred during this time. There were a slightly higher percentage of evening fatal collisions than evening serious injury collisions. Figure 3 shows national and Cornwall's fatal and serious injury collisions by time of day.

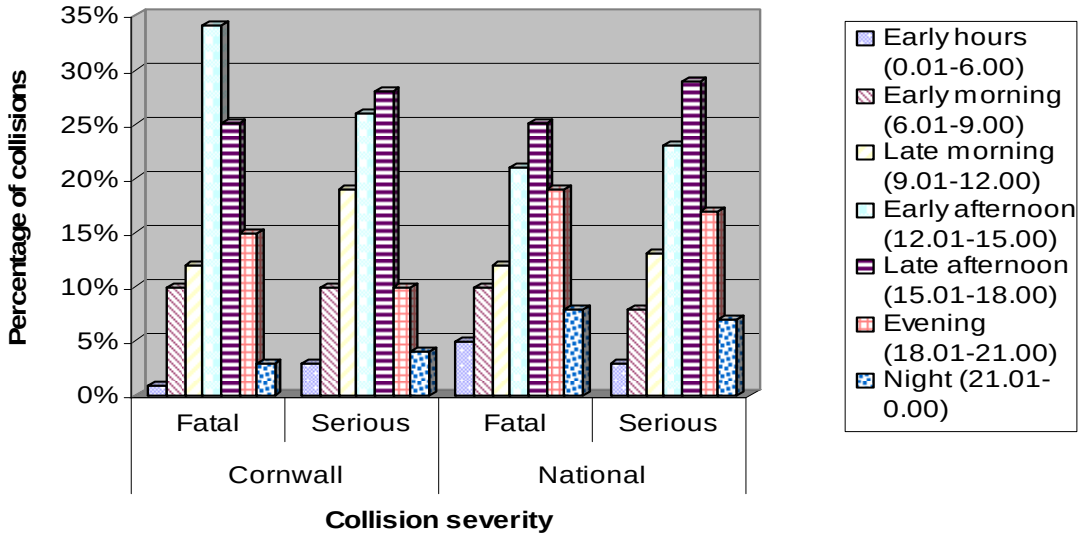

Figure 3 Cornwall's and national fatal/serious injury collisions involving motorcycles over 125cc – percentage distribution by time of day

Day of week

Nationally, the number of casualties on bikes over 125cc is much higher at weekends, particularly on Sundays, than on weekdays. For example, one study found an average of 850 KSI motorcycle casualties per year on Sundays, 700 on Saturdays and 540-590 on each weekday (Monday to Thursday).[8] Cornwall's data show similar results with a higher number of collisions occurring on a Saturday and Sunday than weekdays. This has been suggested to reflect increased weekend riding for bikes with larger engines.[8] Cornwall's fatal collisions show an even higher percentage of

collisions occurring at weekends. This may reflect the highly rural nature of Cornwall's roads encouraging more weekend leisure riders. Figure 4 shows the percentage of collisions that occurred on each day of the week.

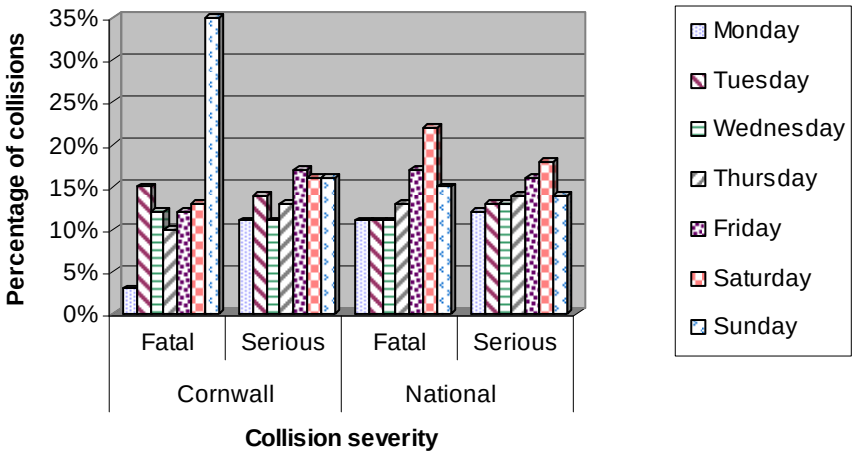

Figure 4 Cornwall's and national fatal/serious injury collisions involving motorcycles over 125cc – percentage distribution by day of the week

Month

Nationally, 37% of fatal and 35% of serious injury collisions and in Cornwall; 32% of fatal, 35% of serious injury collisions occurred during the summer months (Figure 5). There is also a large drop in the winter months with only 13% of collisions nationally and 12% of Cornwall's serious injury collisions occurring during this time. Cornwall's fatal collisions however, show a higher percentage occurring during winter months (25%).

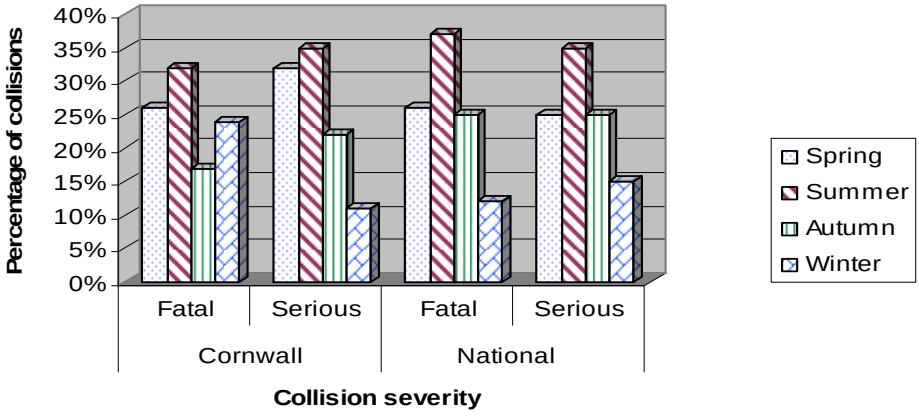

Figure 5 Cornwall's and national fatal/serious injury collisions involving motorcycles over 125cc – percentage distribution by month of the year

2.2 Where

The next section of the report focuses on where serious injury and fatal collisions involving motorcycles with engines over 125cc occur.

Road class/type

Nationally, 72% of fatal and 55% of serious injury collisions occurred on rural roads. A slightly higher proportion of Cornwall's collisions; 79% of fatal and 65% of serious injury, occurred on rural roads. Nationally and in Cornwall, more fatal collisions occurred on rural roads than serious injury collisions. Figures 6 and 7 show the percentage of collisions that occur on A (main roads that tend to have heavy traffic flow), B (local routes that have lower traffic volumes than main roads), C and unclassified (both minor roads and lanes with lower traffic volumes than B roads) roads in urban and rural areas.

Figure 6 Cornwall's and national fatal/serious injury collisions on urban roads involving motorcycles over 125cc – percentage distribution by road class

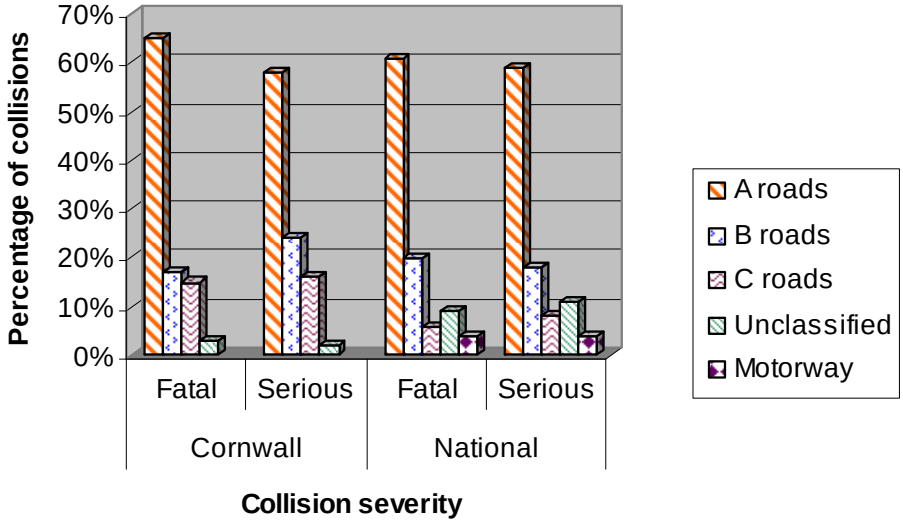

Figure 7 Cornwall's and national fatal/serious injury collisions on rural roads involving motorcycles over 125cc – percentage distribution by road class

Figures 6 and 7 show most fatal and serious injury collisions occur on A roads in both urban and rural areas. In Cornwall the differences between road classes are more marked for rural than urban roads:

- On rural roads in Cornwall, 65% of fatal and 58% of serious injury collisions occurred on single carriageway A roads.
- On urban roads in Cornwall, the collisions were more evenly spread across A, B, and C roads.

A higher percentage of collisions occurred on unclassified roads in urban areas than rural areas.

2.3 Circumstances

Junctions

Nationally, 39% of fatal and 60% of serious injury collisions occurred at junctions. A slightly smaller proportion of Cornwall's collisions; 29% of fatal and 48% of serious injury, occurred at junctions. Research suggests a smaller proportion of motorcycles over 125cc (43%) are involved in collisions at junctions than motorcycles up to 125cc (49%). Research has also found higher rates of collisions at junctions for motorcycles compared to other vehicle types. One study found 54% of junction collisions on major roads involved motorcycles, compared to 36% for cars.[9] In Cornwall T-junctions were the most common form of junction that collisions occurred at, followed by private junctions and cross-roads.

Bends

Nationally, 35% of fatal and serious injury collisions occurred when the motorcycle was negotiating a bend. A slightly smaller proportion of Cornwall's collisions; 29% of fatal and 20% of serious injury, occurred on bends. More collisions occurred on bends in rural areas than urban areas and in rural areas a higher percentage of collisions on bends involved motorcycles over 125cc than motorcycles up to 125cc. This again may reflect leisure riding on rural roads on larger bikes.

Research has found that motorcycle collisions on left hand bends are much more common than motorcycle collisions on right hand bends.[10] [11] It has been suggested this may be due to collisions occurring on left hand bends having more serious consequences due to hitting a vehicle on the other side of the road, and perhaps an underreporting of less serious right hand bend collisions.[12] The main contributory factor in motorcycle collisions that occur on bends is loss of control due to speed.[7] It was found that these types of collisions are nearly always the fault of the rider and are more associated with riders that ride for pleasure than other riders. One study found that these type of collisions consisted of the rider 'sliding out and falling due to over braking' and 'running wide of a curve due to excess speed or under-cornering'.[19]

Going ahead

Nationally, 25% of fatal and serious injury collisions occurred when the motorcycle was going ahead. This is similar to Cornwall's fatal collisions (27%); however, Cornwall's serious injury collisions had a smaller proportion that occurred while the motorcycle was going ahead (17%). Higher proportions were found in urban compared to rural areas. Loss of control due to speed (75%) was the main contributory factor in these collisions in Cornwall.

Overtaking

Nationally, 12% of fatal and serious injury collisions occurred when the motorcycle was overtaking a moving vehicle. 16% of Cornwall's serious injury collisions involving motorcycles over 125cc occurred whilst overtaking, however, Cornwall's fatal collisions showed higher rates (21%). In rural areas a larger proportion of these were motorcycles over 125cc (12%) than up to 125cc (8%). In 64% of Cornwall's fatal collisions misjudgement was a contributory factor, in 45% speed was a contributory factor, in 27% failure to see was a contributory factor, and in 18% racing or disobeying the lining was a contributory factor.

2.4. Contributory factors

Figure 8 shows the main contributory factors to fatal collisions in Cornwall. These contributory factors related to the rider in 73% of these collisions; loss of control due to speed was the most prominent factor in collisions on bends, straight roads and when overtaking. Research suggests that loss of control collisions are usually the fault of the rider.[13] National research has also found

that loss of control (normally due to excess speed) was the most commonly recorded collision type in fatal motorcycle collisions.[14]

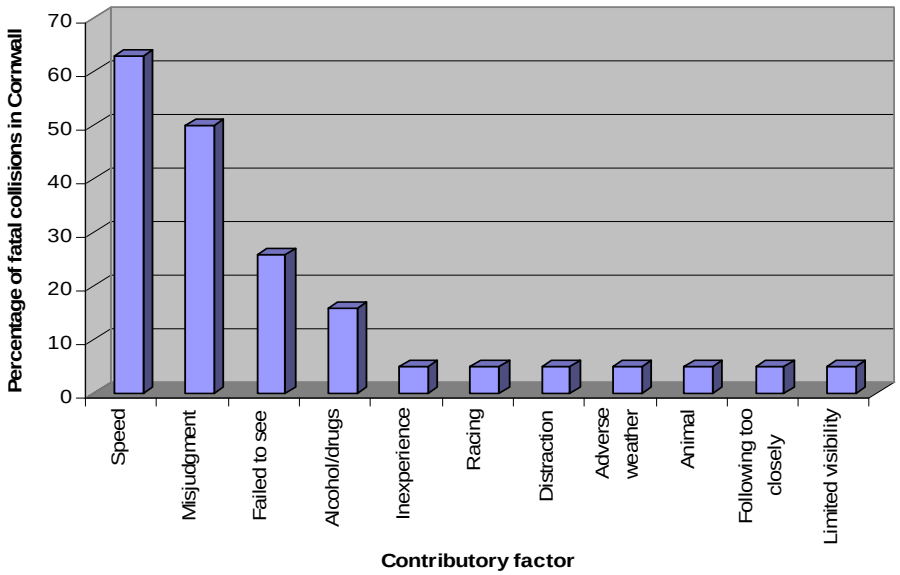

Figure 8 Cornwall's fatal collisions involving motorcycles over 125cc – percentage distribution by contributory factor

UK research into causal factors suggests fatal collisions are dominated by collision patterns that appear to be entirely within the control of the rider:

- Loss of control and left road
- Head-on corner cutting
- U turn
- Shunt
- Head-on whilst overtaking[16]

National research suggests the contributory factors for serious injury collisions are similar to those for fatal collisions, however, the order of importance varies; 'looked but failed to see' and 'failed to look' occur more prominently in serious injury than in fatal collisions.[15]

Single/multiple vehicle

Nationally, most motorcycle KSI collisions involved another vehicle (75%). A larger proportion of collisions with motorcycles over 125cc were involved in single vehicle collisions than motorcycles up to 125cc. In Cornwall, 25% of fatal collisions involving motorcycles over 125cc were single vehicle collisions.

Weather and road surface conditions

Nationally and in Cornwall most collisions occurred in fine weather with dry road surfaces (Figure 9). Research suggests this may reflect 'fair weather' leisure riding associated with larger bikes.[8] More serious collisions, nationally and in Cornwall, occurred when it was raining than fatal collisions.

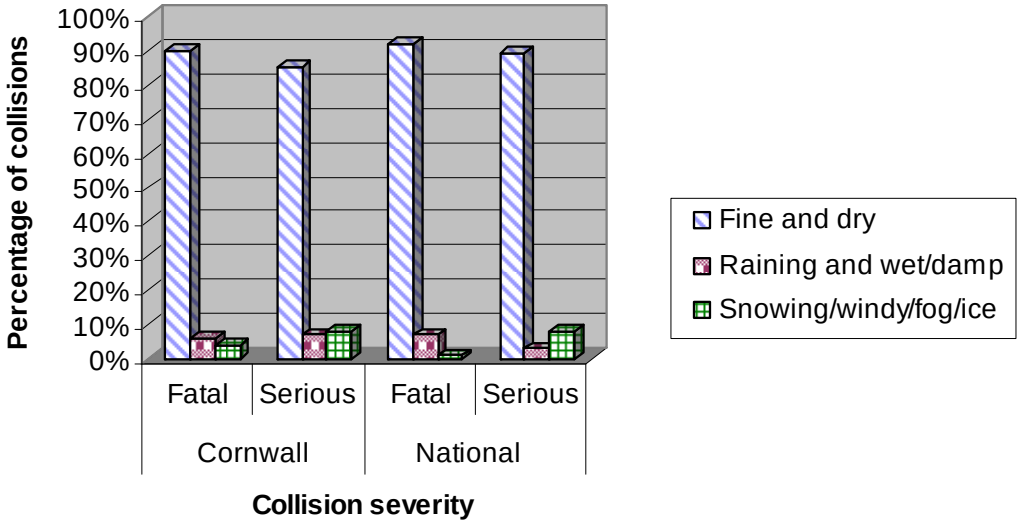

Figure 9 Cornwall's and national fatal/serious injury collisions involving motorcycles over 125cc – percentage distribution by weather and road surface conditions

Most collisions (83%) also occurred during the day when it was light and therefore no street lighting was present.

Hitting an object

Nationally, 30% of fatal and 15% of serious injury collisions involved hitting an object. Cornwall's collisions showed similar findings; 42% of fatal and 18% of serious injury collisions involved hitting an object. Hitting an object involves the motorcycle losing control and subsequently hitting an object either off or on the road. Collisions that did involve hitting an object mostly occurred on rural A class roads (64% of fatal and 72% of serious injury collisions). One study examined collision reports where a rider had lost control and fatal injuries had been sustained due to impact with an object. Overall, 60% of riders initially hit a large fixed object, 17% hit a narrow object (for example a pole) and 15% hit a stationary vehicle.[15] In rural areas the most common objects hit were permanent road side objects, trees and kerbs whilst in urban areas permanent objects, kerbs and parked vehicles were the most common objects hit.

Riding in convoy

Information regarding convoy riding was available for Cornwall's fatal collisions. 21% of all motorcycle fatal collisions were riding in convoy; all were riding bikes over 125cc. The factors associated with these collisions are listed below.

Who:

- All were males who were local to the area
- 75% were between 30-49 years of age
- All but 1 were riding sports bikes over 500cc, of which 75% were under 5 years of age

When:

- All occurred at a weekend, from 12.30-17.30
- 50% occurred during the summer months, 25% during spring months and 25% during winter and autumn months

Where:

- All occurred on rural A roads

Circumstances:

- 50% occurred when the rider lost control, 25% occurred during overtaking, and 25% occurred when the rider drifted off the road or attempted a U-turn
- The main contributory factors were
    - 50% speed
    - 25% misjudgement

- 15% failed to see
- 12% weather

Anecdotal evidence from traffic police suggests that 'point' riders (front riders) and 'tail-end' riders (rear most riders) are most vulnerable. This may be due to point showing-off riding skills by pulling ahead and tail-end riding beyond their skill level to try and keep up.[88]

Convoy/group riding is essentially hierarchical where the most experienced rider is seen as a role model.[108] This suggests encouraging personal responsibility of more experienced riders in groups and encouraging anticipated regret mechanisms may be beneficial.

Due to the high proportion of Cornwall's fatal collisions involving convoy riding, it would be useful for this information to be collected nationally.

2.5 Summary

National and Cornish statistics indicate collision factors that are common for motorcycles over 125cc:

- Collisions are most likely to occur during the afternoon, at weekends and during the summer months.
- Collisions are most likely to occur on rural, A class, single carriageway roads when the weather is fine and the road surface is dry.

A number of circumstances have been found to be associated with collisions involving larger bikes:

- The most common collisions were those which occurred at junctions and on bends. Collisions at junctions tend to be the fault of the other motorist turning and pulling out in front of a motorcycle. T-junctions are featured most commonly nationally and private driveways are also common in Cornwall. Collisions on bends tend to be the fault of the rider losing control due to excess speed.
- In a high proportion of fatal collisions a motorcycle hit an object; this was most common on rural roads.
- 21% of Cornwall's fatal collisions occurred when the motorcyclists were riding in convoy.

A number of differences were found between fatal and serious injury collisions:

- A higher proportion of fatal collisions occurred during the evening than serious injury collisions.
- A higher proportion of fatal collisions occurred on rural roads than serious injury collisions.
- More fatal collisions hit an object than serious injury collisions.

Recommendations

- Initiatives aimed at riders of bikes over 125cc could be targeted at times and places identified as high risk. Statistics show collisions most commonly occur during the afternoon at weekends, and during the summer months, on rural A class single carriageways, at junctions and on bends.
- Initiatives could target convoy riding; 21% of all Cornwall's fatal collisions involving motorcycles occurred when the motorcyclists were riding in convoy, all but 1 were riding sports bikes over 500cc. Due to this high percentage in Cornwall, it may be beneficial to collect data on convoy riding nationally.
- Initiatives could target speeding; loss of control due to speed was the most common cause of collisions.

3. Collision Factors: Motorcycles up to 125cc

Although motorcycles over 125cc feature more heavily in collisions in Cornwall, there are still a high proportion of collisions involving bikes up to 125cc. Nationally, 40% of KSI casualties were on bikes up to 125cc. In Cornwall, 17% of fatal and 39% of serious injury collisions involved riders on bikes up to 125cc. Research suggests that when factors such as annual miles and exposure are taken into consideration bikes up to 125cc are over-represented in collisions.[8] Research also suggests collisions involving bikes up to 125cc have different associated factors than collisions involving bikes over 125cc[8]; it is therefore important to consider these factors so interventions can be effectively targeted to this group of riders.

3.1. When

Time of day

Nationally, the number of serious injury collisions is slightly higher from 15.01-18.00 (28%) than any other time of the day. In contrast, fatal collisions are more evenly spread across times of day. In Cornwall, fatal and serious injury collisions are also higher from 15.01-18.00, but fatal collisions are also high in the early morning from 6.01-9.00. Research has suggested this reflects peaks at rush hour times of the day.[8] **16**

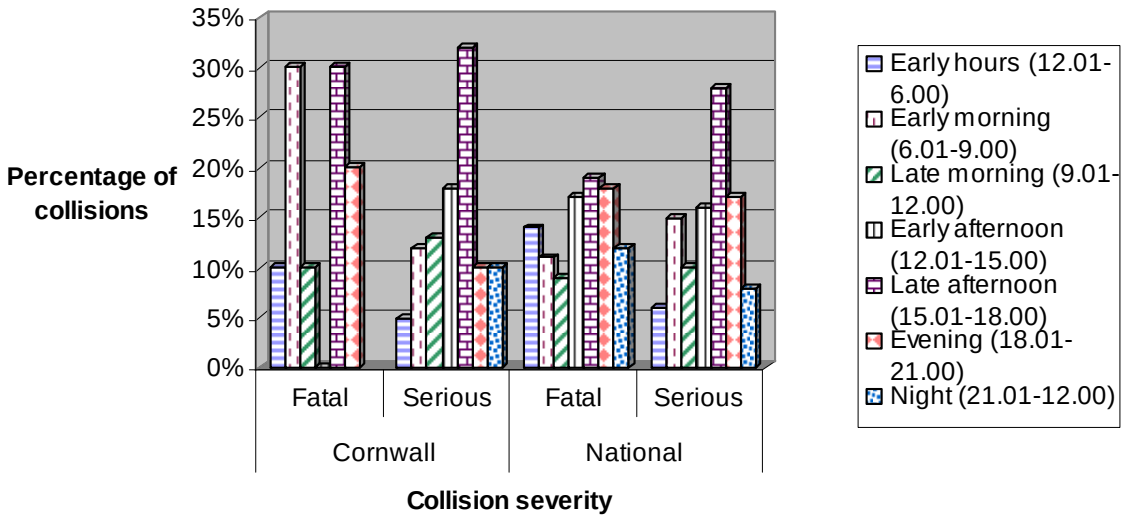

Figure 10 Cornwall's and national fatal/serious injury collisions involving motorcycles up to 125cc – percentage distribution by time of day

Day of week

Nationally and in Cornwall, fatal and serious injury collisions are much more evenly spread across days of the week for bikes up to 125c, compared to bikes over 125cc. Cornwall's fatal collisions occurred slightly more on a Thursday than any other day of the week, however, it is important to note that absolute numbers for this group are low, reducing the significance of considering this data alone.

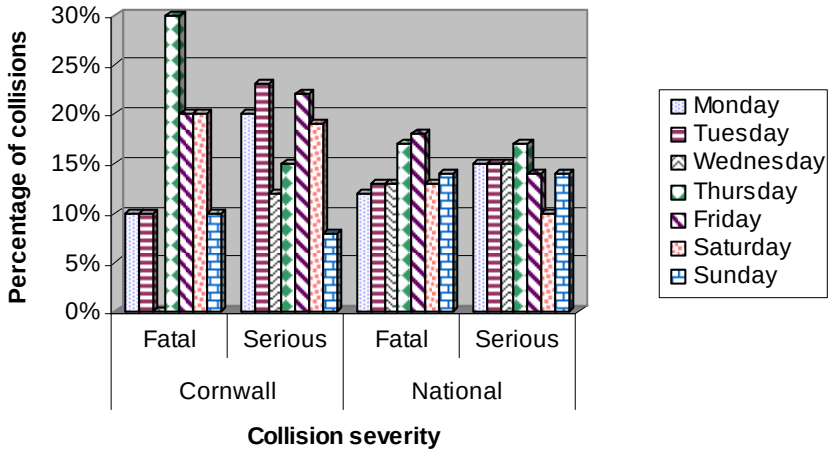

Figure 11 Cornwall's and national fatal/serious injury collisions involving motorcycles up to 125cc – percentage distribution by day of the week

Month

Nationally and in Cornwall, fatal and serious injury collisions are split relatively evenly across months of the year. National data suggests a slight increase in both fatal and serious injury collisions in the summer and autumn months. Research suggests this may be due to the high use of all year round commuting for bikes of smaller engine sizes, and the preponderance of young riders on smaller bikes who are less likely to have access to a car as an alternative when riding conditions are less favourable. [8]

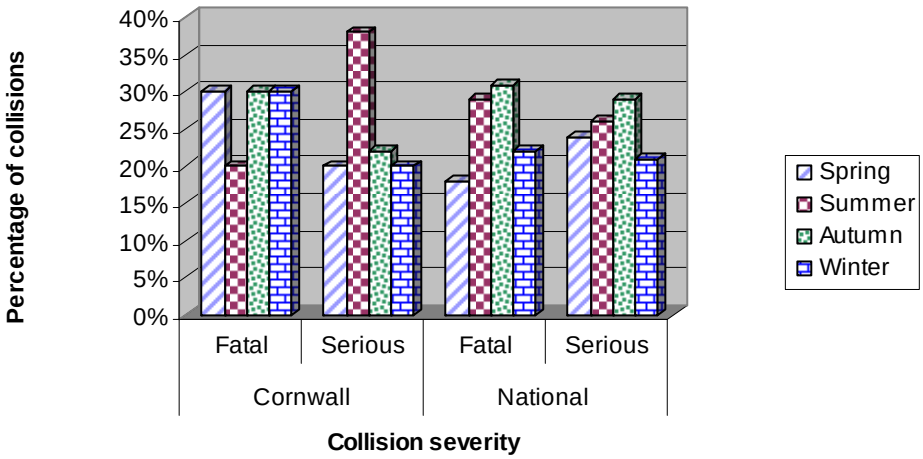

Figure 12 Cornwall's and national fatal/serious injury collisions involving motorcycles up to 125cc – percentage distribution by month of the year

3.2. Where

Road class/type

National statistics show more collisions occur on urban roads; 58% of fatal and 72% of serious injury collisions, than rural roads. In Cornwall, the difference wasn't as pronounced; 55% of serious injury and 50% of fatal collisions occurred on urban roads. Both nationally and in Cornwall, there are more serious injury collisions in urban areas than fatal collisions. Figures 13 and 14 show the percentage of collisions that occur on A, B, C and unclassified roads, and motorways in urban and rural areas.

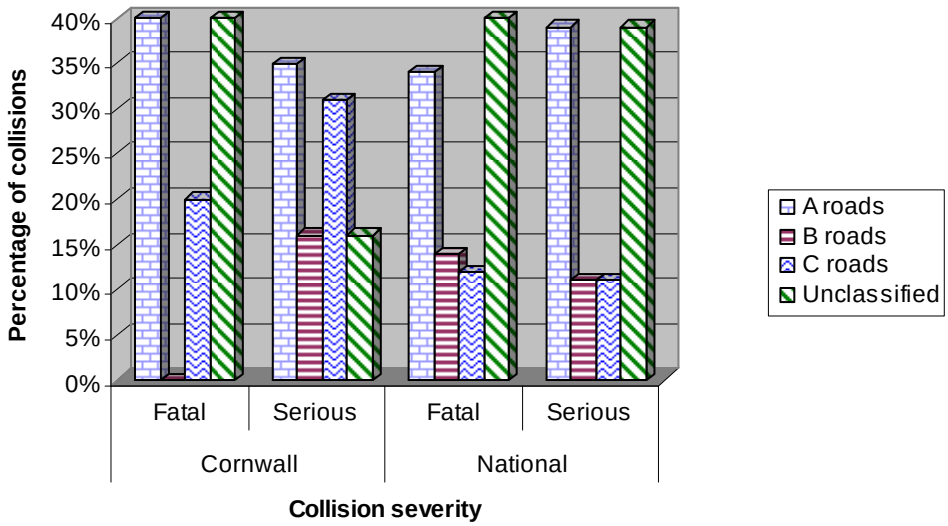

Figure 13 Cornwall's and national fatal/serious injury collisions on urban roads involving motorcycles up to 125cc – percentage distribution by road class

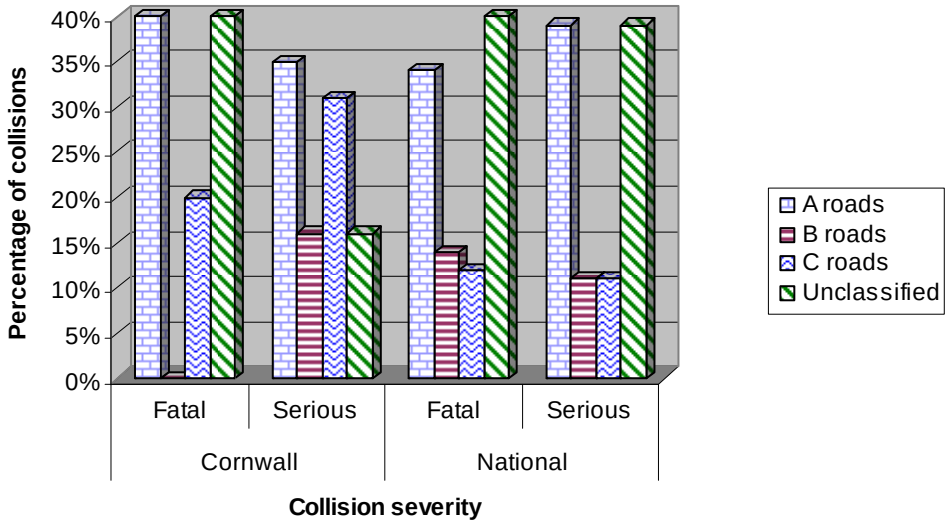

Figure 14 Cornwall's and national fatal/serious injury collisions on rural roads involving motorcycles up to 125cc – percentage distribution by road class

In urban areas, nationally, more fatal and serious injury collisions occur on A roads and unclassified roads, than B or C roads. Cornwall's fatal collisions also show this pattern. More of Cornwall's serious injury collisions occur more on A and C roads in urban areas than B and unclassified roads.

In rural areas, nationally and in Cornwall, more collisions occur on A roads than any other road type. There are also differences between fatal and serious injury collisions with more serious injury collisions, both nationally and in Cornwall, occurring on unclassified roads than fatal collisions.

3.3. Circumstances

Junctions

Junction collisions were the most common form of collision. Nationally and in Cornwall, more serious injury collisions occurred at junctions (66% and 61%, respectively) than fatal collisions (49% and 30%, respectively). There were also more junction collisions in urban areas than rural areas. T-junctions were the most common junction that collisions occur at in both rural and urban areas (35%). In Cornwall, there are also a high number of junction collisions that occur at private drives or entrances (13%). The most common contributory factor to fatal collisions in Cornwall was the motorist failing to see the motorcycle. Research suggests 'looked but failed to see' collisions at junctions are more common in bikes up to 125cc then bikes over 125cc.[16]

The most common occurring collision at a junction involved a vehicle emerging from a junction to perform a right hand turn into the path of a motorcycle.[17] Research suggests these collisions tend to be the fault of the other motorist.[7] This may involve the other motorist:

- Failing to see the motorcycle
- Failing to judge the speed and/or distance of the motorcycle
- Not paying attention

A number of reasons have been suggested for a motorist failing to see a motorcycle:

- Inattentional blindness - motorists may be less likely to register an object if they look directly at it rather than if it falls outside the centre of their vision.[18]
- Too much information in busy situations – motorcycles may go unnoticed due to the motorist taking in other information.[17]
- Familiarity – motorists don't expect to see a motorcycle if it is uncommon for them to see one.[19]

However, speed and/or careless and reckless riding of the motorcycle have also been found to be a large contributory factor in collisions at junctions.[20]

Going ahead

Nationally, 52% of fatal and 47% of serious injury collisions occurred when the motorcycle was going straight ahead. Cornwall had similar findings; 40% of fatal and 52% of serious injury collisions occurred when the motorcyclist was going ahead. In the UK, larger proportions of collisions on bikes up to 125cc were going ahead than bikes over 125cc.[8] In Cornwall, the most common contributory factor in fatal collisions that occurred while going ahead was inexperience.

Bends

Nationally, 30% of fatal and 26% of serious injury collisions occurred when the motorcyclist was negotiating a bend. Similar findings were found for Cornwall's fatal collisions (30%), however a higher proportion of Cornwall serious injury collisions occurred on bends (42%). In Cornwall, the most common contributory factors in fatal collisions on bends were inexperience and speed.

Overtaking

Nationally, 7% of fatal and serious injury collisions occurred when the motorcycle was overtaking a moving vehicle. Slightly more collisions in Cornwall occurred during over taking; 20% of fatal and 10% of serious injury collisions. In Cornwall, the most common contributory factor in fatal collisions that occurred while overtaking was inexperience.

3.4. Contributory factors

Figure 15 shows the main contributory factors to fatal collisions in Cornwall. These contributory factors relate to the rider in 80% of collisions. UK research into causation patterns suggests more collisions are within the remit of the other motorist, compared to collisions involving larger bikes.[16]

This may suggest some need for training to improve defensive riding techniques, with consideration of road positioning.

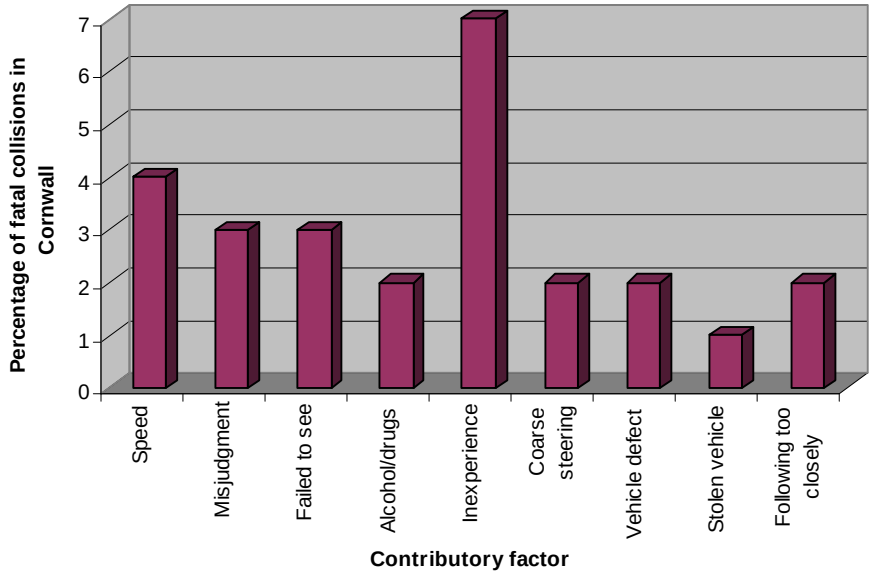

Figure 15 Cornwall's fatal collisions involving motorcycles up to 125cc – percentage distribution by contributory factor

There were no differences in contributory factors between urban and rural roads.

Single/multiple vehicle

A larger proportion of collisions with motorcycles up to 125cc, nationally and in Cornwall, are involved in multiple vehicle collisions than motorcycles over 125cc. In Cornwall, 80% of fatal collisions involved another vehicle.

Weather and road surface conditions

Most collisions occurred in fine weather with dry road surfaces (Figure 16). Slightly more of Cornwall's fatal collisions occurred when it was snowing/windy or foggy than Cornwall's serious injury collisions. In the UK, a larger proportion of KSI collisions on bikes up to 125cc were in the rain and on wet or damp roads in fine weather, than bikes over 125cc. This may reflect more all year round riding on smaller bikes, but may also reflect less experience of riders of bikes up to 125cc.[8]

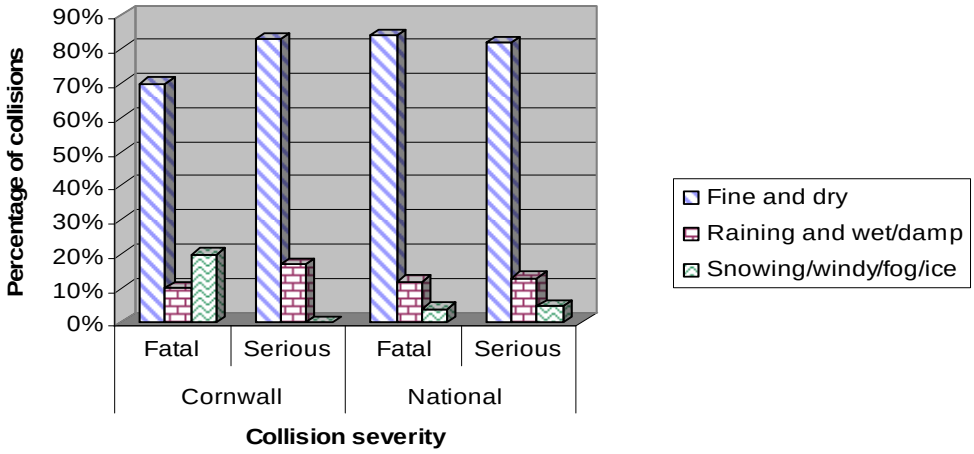

Figure 16 Cornwall's and national fatal/serious injury collisions involving motorcycles up to 125cc – percentage distribution by weather and road surface conditions

92% of Cornwall's serious injury collisions occurred during the day when it was light; therefore no street lighting was present. 40% of Cornwall's fatal collisions occurred when it was light, 50% occurred when it was dark and 10% occurred when it was dusk.

Hitting an object

In Cornwall 40% of fatal collisions involved the motorcyclist hitting an object, compared to 15% of serious injury collisions. Collisions that did involve hitting an object occurred on both urban and rural, A, B and C roads and the most common contributory factor was loss of control. The objects hit during fatal collisions consisted of a hedge, a wall, a kerb and a fence.

3.5. Summary

Nationally and in Cornwall, collision statistics indicate factors that are common for motorcycles up to 125cc. Collisions are more likely to occur from 15.01-18.00 than any other time of the day, these collisions are quite evenly spread across day of the week and month of the year. Collisions are most common on urban A and unclassified roads, than any other road type, when the weather is fine and dry.

A number of circumstances have been found to be associated with collisions involving smaller bikes. The most common types of collision were those that occurred at a junction and when the motorcyclist was going ahead and the most common contributory factor to these collisions was inexperience of the rider. A high proportion of Cornwall's fatal collisions involved the motorcycle hitting an object.

Differences were found between fatal and serious injury collisions:

- A higher proportion of fatal collisions occurred on rural roads than serious injury collisions.
- More fatal collisions hit an object than serious injury collisions.

Recommendations

- Initiatives aimed at riders of bikes up to 125cc could be targeted at times and places identified as high risk. Statistics show collisions most commonly occur during rush hour times, at junctions on urban A class and unclassified roads.
- Research suggests more collisions are in the remit of the other motorist for bikes under 125cc, compared to collisions involving larger bikes. The most common contributory factor to collisions involving bikes under 125cc was inexperience, suggesting initiatives could target increasing the defensive riding skills of riders of smaller bikes.

4. Motorcycle Riders

It is important to consider the type of riders who are having collisions on bikes so interventions can be effectively targeted. This section of the report considers factors associated with riders that make them more susceptible to the risk of a fatal collision.

4.1. Gender

Males are over-represented in motorcycle collisions for all bike sizes (89%).[8] However, research suggests males tend to ride larger bikes than females. In 2004 the most popular bikes for male riders in the UK had engine sizes between 501-600cc, whilst for female riders, the most popular bikes had engine sizes between 1-50cc.[21] One study analysed 693 riders in England and found the average rider of larger bikes was male.[22] This is reflected in Cornwall's data where 100% of fatal and 96% of serious injury collisions involving motorcycles over 125cc had male riders. Males are also over represented in motorcycle collisions on smaller bikes. In Cornwall, riders were male in 80% of fatal and 87% of serious injury collisions involving bikes up to 125cc.

Reasons for this include males having increased exposure to the risk of collisions due to having higher annual mileage[21] and higher motorcycle ownership[23] than females. When collision rates were adjusted for exposure, females were found to have a higher crash risk than males.[24] Despite this males are still the most common riders involved in collisions. Males have also been found to engage in more risky behaviours than women.[25] Research has found women's greater perceived likelihood of negative outcomes and lesser expectation of enjoyment partially affected their lower tendency towards risky choices in gambling, recreation and other health domains.[25] One study examined 683 young motorcyclist's (18-28 years) risk and benefit perception of riding. They found males were more confident in their riding ability, more comfortable with unsafe riding, more interested in the benefits gained, more easily ignored traffic conditions and more likely to engage in risky riding, than females.[26] Another study found similar results; males (18-28) perceived less risk and were higher in sensation seeking than females.[27]

4.2. Age

Research has shown a link between engine size and age of rider. Britain's statistics show the proportion of casualties who were riding bikes over 125cc increased up to the age of 40-49 years, with 59% aged 30-49, and decreased among older riders (Figure 17).[8] This trend may reflect the progression of younger riders from small bikes to larger bikes or driving cars.

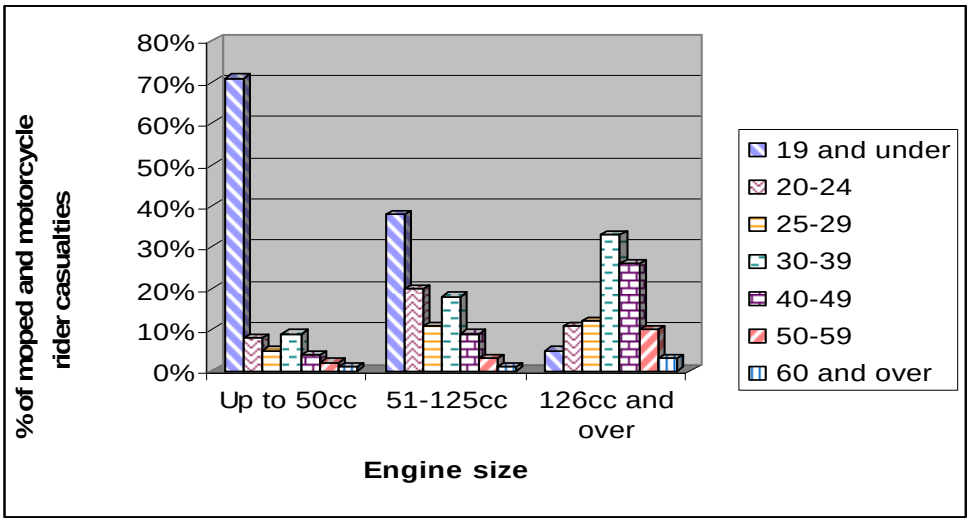

Figure 17 Moped and motorcycle casualties in the UK – percentage distribution by age of rider and engine size (2000-2006)

Other research has shown similar results; in 2008 the DFT found that the majority of KSI casualties on larger bikes were 25-50 years of age, this was found for all collision types.[28] Another UK study found the average age of riders of larger bikes was 41 years.[22] Nationally, 55% of fatal and serious injury collisions on bikes over 125cc had riders aged 25-44. Again Cornwall's data show similar findings; in 76% of fatal and 70% of serious injury collisions on bikes over 125ccthe rider was between 30-49 years of age.

National research has shown most riders who were casualties on bikes up to 125cc were young people: 67% were under the age of 25. [8] Cornwall's data shows similar findings; 70% of fatal and 74% of serious injury collisions on bikes up to 125cc had riders under the age of 25. Despite a general decrease in collisions involving smaller bikes, when exposure is accounted for, young riders are still over represented in collision risk. One study compared riders' reported collision involvement with mileage ridden and found that after taking into account mileage, age and experience, riders on bikes over 125cc reported 15% fewer collisions than riders on bikes up to 125cc.[13]

4.3. Age Vs experience

One possible reason for the increased risk of younger riders when exposure is accounted for is their lower levels of experience. The effects of experience are difficult to disentangle from that of age as the two are related; however, there is less of a link between age and inexperience in motorcycle riders than car drivers. This may be explained by a wider variation in the age motorcycle tests are taken compared to car tests.[8] Breaks from riding are also common, for example; one study found 22% of riders returned to riding after a break of 10 years or more.[22]

The reduced amounts of riding experience young riders have means that there is a lack of skills development. Relationships between experience and motorcycle collisions have been found, showing more experienced riders have better hazard perception skills than novice riders and that some novice riders were overconfident in their riding ability.[29]

Research in New Zealand compared 463 motorcyclists that had been involved in collisions to 1233 control cases. Findings demonstrated a protective effect from riding for more than 5 years compared with less than two years; however, this protective effect did not remain when age was included in the analysis. The only experience factor that did have a protective effect on collisions was familiarity with a specific motorcycle.[30] Returning to riding after a break did not increase rider's risk of a collision after taking into account age and mileage ridden.[21]

Other research has also shown youth plays a much greater role in the prediction of motorcycle collisions than experience.[31] This may be due to riders buying larger and faster bikes as they become more experienced, therefore, reducing the protective effect.[21] In 1993, research in the Netherlands split 926 motorcyclists into four groups; young (under 25 years of age) and inexperienced (under 5 years of riding), young and experienced, old and inexperienced and old and inexperienced. Rates of collisions per million kilometres travelled showed young riders had a greater risk than older rider irrespective of experience but older rider's risk of collision reduced as experience increased.[32]

Young people are going through a 'period of time when rapid and extreme physical, cognitive and psychosocial changes are occurring'.[33] Greater control over the area of the brain involved in planning complex cognitive tasks and management is gained through development to adulthood. Cognitive maturation, whereby consideration is given to multiple aspects of their actions and the consequences, is also developing through adolescence. These are also linked to psychosocial development which involves peer pressure and autonomy. This development influence 3 categories related to riding; expertise, regulatory competency and perception of risk.[33]

The research implies both experience and age lead to involvement in collisions. Limited experience leads to a lack of skills needed to deal with complex situations and young riders tend to be over confident in their riding ability which affects their perception of risk.

4.4. Deprivation

There is evidence to suggest riders from more deprived backgrounds are involved in more collisions.[11] One study found the average rider of larger bikes was married (or living with a partner), without any children living at home, and with an average income of £20,000-£24,000 as an employee within a small organisation or self-employed.[22] Examination of casualty statistics and Index of Multiple Deprivation (IMD) data, a system which classifies the UK population into levels of deprivation, gives some indication as to whether deprivation affects motorcycle collision rates. Figure 18 shows the percentage of fatal/serious injury casualties involved in motorcycle collisions by their level of deprivation.

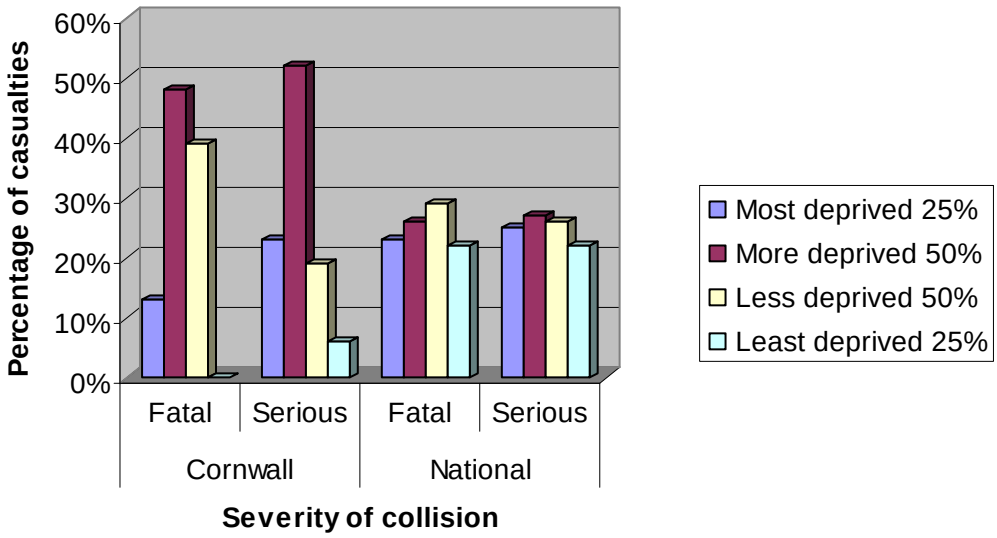

Fig 18 Cornwall's and national fatal/serious injury collisions involving motorcycles– percentage distribution by level of deprivation

Nationally, casualties are quite evenly spread across all levels of deprivation. In Cornwall, more casualties are from more deprived areas than less deprived areas, and more casualties are from the most deprived areas than the least deprived areas. There were no differences between bikes over 125cc and up to 125cc.

4.5. Individual differences

Risk-taking

There have been mixed findings into risk taking among motorcyclists. Some research claims there are cognitive and personality factors that make motorcyclists more susceptible to risk than drivers[34], others, however, believe motorcyclists are the same as other individuals and external factors are to blame for motorcyclists increased risk of collisions.[34] Considering cognitive factors, research in the UK has shown some motorcyclists have an over optimistic perception of risk, compared to actual risk level, and their own ability to cope with this risk.[35]

In a UK study, 106 motorcyclists were compared to a matched group of non-motorcyclists car drivers on behavioural measures known to be linked to collision involvement. When motorcyclists were asked to imagine riding a bike they chose faster speeds than motorcyclists who were asked to imagine driving a car and car drivers.[36] This suggests risk taking behaviour in motorcyclists may

be a characteristic of riding a motorcycle as apposed to being a motorcyclist. Other research has found the enjoyment of taking risks and the enjoyment of speed, in particular, are higher for motorcyclists than they are for car drivers; drivers tend to be slower as the road environment becomes more risky, which is not the case for motorcyclists.[37] [38]

Research suggests riders prone to high risk riding behaviour may choose more powerful and performance-orientated motorcycles and that motorcycle performance capability also may influence the likelihood that drivers will speed or engage in other risky manoeuvres.[39]

Risk taking may also account for the increased collision risk of younger riders. When compared to older drivers, younger drivers have lower risk aversion and a stronger tendency towards experience-seeking, excitement, underestimation of risk and irrelevance of risk.[40]

This research implies motorcyclists may have an over optimistic perception of risk and that young riders and riders of high powered motorcycles may be higher risk takers than other motorcyclists.

Sensation-seeking

Sensation seeking is a personality construct defined as "The seeking of varied, novel, complex and intense sensations and experiences, and the willingness to take physical, social, legal and financial risks for the sake of such experiences".[42] High sensation seekers are believed to either underestimate or accept risks as a price of the sensation or experience.[41] People who ride motorcycles are thought to be higher on sensation-seeking than non riders[42], especially those that chose to ride high powered bikes for leisure purposes.[43]

Sensation-seeking has been found to be linked to risky driving, traffic violations, and collisions.[44] [45] One study found sensation-seeking significantly predicted riders intentions to push limits, intentions to bend road rules to get through traffic, and intentions to perform stunts/ride at excess speed.[46] An analysis of riders of motorcycles over 250cc found favourable attitudes towards speeding were enhanced by affective factors (concentration and perceived enjoyment) which in turn, led to a higher likelihood to speed, but only for motorcyclists with a high level of sensation-seeking. Cognitive factors tended to inhibit speeding intentions of motorcyclists low in sensation-seeking.[48] Research also shows that high sensation-seekers are more prone to attentional blindness.[108]

Young people tend to have higher sensation-seeking than older individuals, which increases to adolescence and then gradually decreases throughout life.[47] Males have also been found to have increased sensation-seeking levels when compared to females.

Attitude

Having positive attitudes towards risky riding behaviours has been linked to engaging in risky riding. A UK study into 4929 riders over the age of 30, found that those who rode larger bikes had higher intentions to speed and 'go for it' on rural roads, and had positive attitudes towards speeding. Research has shown a liking for speed not only predicts an increased likelihood of riding at excess speed, but also predicts violations, stunts and control errors, which turn predicts collisions.[48]

Research in the UK has shown that those who intend to speed tend to perceive control factors; such as 'I would feel complete control over whether I went for it', as facilitating rather than inhibiting speeding, do not perceive pressure from important others not to speed, and tend not to posses a self-identity as a safe-rider. [22] This suggests interventions could focus on changing riders attitudes to speed by convincing riders they are in control of their actions and that specific situations should inhibit their propensity to speed, by challenging rider's positive beliefs towards speeding and attempting to instil negative beliefs, and raising awareness of the impact of speeding on significant others. For those riders who intended to speed, speeding was associated with exhilaration and the ability to beat traffic, suggesting interventions could aim to down play these benefits. [22] Similar findings for rider's attitudes were found for those who intended to take corners too fast. [22]

There has been no available research, to date, into the attitudes of riders on small powered motorcycles. There has however, been some data collected on the attitudes of young riders. As under 25 years is the most common age for riders on small bikes, this research is considered here. International research into 257 student motorcyclists, aged 18-28, found that attitude towards traffic safety (traffic flow versus rule obedience, speeding and fun riding) was related to risky riding behaviour (self-assertiveness, speeding and rule violations).[49] The greater a young riders risk-taking attitude, the greater the likelihood the rider will engage in risky riding behaviours. It was suggested interventions aimed at changing attitudes towards traffic safety may be effective in reducing young rider's risky riding behaviours.

Research into risk perception has found young riders (18-24 years) underestimate the risk of being involved in a collision in the next two years but overestimate the risk of being killed.[50] An Australian study, found adolescent rider's (14 and 15 years) risk perception corresponded to the actual risk of motorcycle collisions, but they neither modified their risk-taking behaviours nor reduced risk-taking levels, even after experiencing a collision or injury.[51] It has been suggested risk-taking behaviours among young riders may represent an outlet for stress and aggression, an expression of independence, or a means of impressing other people.[52] As a result, researchers suggested health-promotion education only using negative consequences of motorcycle riding intended to reduce risky-riding may not readily succeed, even if they do increase risk-perception.[103]

Motivations

In order to understand collisions it is important to consider why individuals chose to ride motorcycles. Investigations have grouped motivations of motorcycle riders into three categories:

1. Biking for pleasure; motivations include; escapism, hedonism, flow, identification with the bike, and social aspects.
2. Biking as a fast competitive sport; motivations include; dynamic aspects, performance aspects, exhibition riding, thrill seeking, and rivalry.
3. Control over the motorcycle; motivations include; control beliefs and safety behaviour.[53]

One UK study analysed the motivations of 1000 riders and segmented motorcyclists into seven groups based on motivations, attitude to risk and behaviour.[54] 5 of these related to riders of motorcycles over 125cc; riding disciples, riding hobbyists, performance disciples, performance hobbyists and look-at-me enthusiasts.

Appendix 1 shows each segment's motivations, demographics, bike choice, safety gear, riding experience, attitudes to risk and factors that would inform choice of whether to ride or not ride. On measures of collisions-per-year and collisions-per-mile, both riding disciples and riding hobbyists had a relatively low collisions propensity. Performance disciples and performance hobbyists had a higher collision propensity; these riders were motivated by feelings of power and belonging of the motorcycle. Look-at-me enthusiasts had the highest collision propensity; these riders were motivated by showing off. The stability of each segment and the exact nature of interventions based on this model has not yet been developed or tested.

3 of these segments related to riders of motorcycles up to 125cc; look-at-me enthusiasts, car aspirants and car rejecters. Appendix 2 shows each segment's motivations, demographics, bike choice, safety gear, riding experience, attitudes to risk and factors that would inform choice of whether to ride or not ride. On measures of collisions-per-year and collisions-per-mile, both look-at-me enthusiasts and car aspirants had the highest collision propensity.[54]
The segments suggest young riders value 'looks' of a helmet more importantly than safety aspects and 'safety features' are not 'top of the mind' factors when buying a bike. They are most likely to wear their helmets again once they have been dropped on a hard surface and least likely to wear protective clothing every time they ride compared to other riders.

Research has identified ‘cheap to run’, ‘enjoyment’, and ‘independence’ as principle reasons for riding motorcycles among a young population.[55] This suggests safety is not a prominent value for young motorcyclists’ choices in traffic.

4.6. Social influences

Research suggests social factors have a large influence on young people, for example; parental influence is an important factor in shaping attitudes towards road use[56]. Parents driving styles have been found to influence young drivers driving styles, suggesting young drivers may develop their driving behaviours from their parents.[56] Parents can also influence young riders by monitoring and managing their riding in terms of when they take their test, supervising practise and enforcing certain riding rules.

The media is another influence prominent in young people’s lives, there is a tendency for the media to glorify speed and reckless driving.[57] There is a gap in the evidence that links behaviours and attitudes portrayed in the media to an individual’s riding.

4.7. Summary

The evidence available suggests reasons for motorcycle riders being over involved in road traffic collisions. Riders tend to have an over optimistic perception of risk and positive attitudes towards risky riding. Other factors such as gender, age and socio-economic status also influence risk; young males, and those from lower socio-economic backgrounds are more at risk of collisions.

There were a number of differences between riders of bikes over 125cc and riders of bikes up to 125cc. Riders of larger bikes tend be male and have an average age of 30-49, they tend to ride for leisure purposes and accumulate a high number of miles, increasing their exposure to collisions. They enjoy the power of bikes and the challenge of riding and tend to have a positive attitude towards speeding. Those choosing more powerful bikes may also be higher in sensation-seeking and risk-taking. Those who are motivated to ride for performance purposes and enjoy the power of a bike tend to have a high collision risk than other riders.

Riders of smaller bikes tend to be male and under 25 years of age. Young males tend to have high levels of sensation-seeking and positive attitudes towards risk-riding. Research suggests safety is not a prominent factor in these riders motivation to ride motorcycles. In addition, social influences, such as parents, may increase the risk of being involved in a collision.

Considerations

It is important to note males and older riders increased collision involved can be explained by the amount of riding they engage in, compared to females and younger riders. When considering reasons behind collisions, these factors would only be meaningful when considered as a measure of miles travelled, however, these factors are important when designing and developing intervention programmes.

Recommendations

- Statistics show males aged 30-49 who ride for leisure purposes are most at risk of collisions on bikes over 125cc, and young males (under 25 years) who ride for commuting purposes are most at risk of collisions on bikes up to 125cc. In the previous section it was shown bikes of different sizes also have different types of collisions. Different initiatives could be developed for different bike sizes and therefore different collision types. Cornwall Wheels to Work and Learn provides mopeds to young people (16+) who have difficulties

getting to work or education. Projects such as these may provide a target audience for initiatives aimed at riders of small bikes.

- Research into motivations suggests ‘look-at-me enthusiasts’, ‘car aspirants’ and those motivated by performance (‘performance hobbyist’ and performance disciples’) are most at risk of collisions. Initiatives could target these groups of riders.
- Research into the motivations of riders on small bikes suggests safety is not a prominent factor for young riders. Initiatives could focus on raising the awareness of the benefits of safety features when riding.

5. Initiatives

Information from coroner's reports and collision factors suggest Cornwall's motorcycle collisions are predominantly the fault of the motorcyclist. Therefore, this report covers initiatives aimed at motorcyclists themselves, as apposed to initiatives aimed at other driver's awareness and safety towards motorcyclists.

There are a number of different types of interventions aimed at increasing motorcyclist's safety on the roads including training, education and publicity, and engineering. Theories can be used to inform initiatives as to which target behaviours and attitudes place motorcyclists at high risk; however, lots of road safety interventions are not theoretically driven. Some of the theories that are commonly used in influence initiatives are described below:

- The Theory of Planned Behaviour (TPB) maintains an individual's intentions determine their behaviour,[58] and that intentions can be predicted by attitudes towards the behaviour, subjective norms (perceived pressure or approval to perform a behaviour), and perceived behavioural control (ease or difficulty of performing a behaviour).[41] Perceived behavioural control can also be directly linked to behaviour. This theory suggests risky riding can be predicted by a positive attitude towards risky riding, perceived approval of others towards risky riding, and low perceived control over risky riding.

- The health belief model (HBM) suggests that behaviour is determined by:
  - *Perceived susceptibility* – assessment of the risk of being involved in a collision
  - *Perceived severity* – assessment of how serious the collision will be and potential consequences
  - *Perceived barriers* – to adopting a particular behaviour
  - *Perceived benefits/costs* – positive and negative consequences of adopting a behaviour[59]

  In addition to these aspects there are a number of mediating factors that link perceptions and behaviour. These include demographic variables, social psychological variables (social economic status, personality, coping strategies), perceived efficacy (individuals assessment to whether they can adopt the desired behaviour), cues to action (external influences promoting the desired behaviour), health motivation (whether an individual has the determination to commit to a behaviour), perceived control (self efficacy) and perceived threat (whether the danger of not adopting the behaviour is great). This theory suggests risky riding can be predicted an individual having an over optimistic perception of the risk of being involved in a collision and the associated consequences, perceiving benefits to risky riding and barriers to safer riding.

- The Locus of Control (LOC) model defines people who perceive events as dependent on their own behaviour as having internal beliefs, and people who perceive events as a result of luck, chance, fate, or under the control of others as having external beliefs.[60] This theory suggests risky riding can be predicted by having the belief that collisions occur as a result of external factors that a rider has no control over.

One study investigated the usefulness of the TPB, HBM and T-LOC (Traffic Locus-of-Control) in explaining rider's behaviours.[48] Results demonstrated that all three models were mostly related to deliberate and intentional rider behaviours:

- Increased shunts and speeding violations were predicted by:
  - High levels of external beliefs on the LOC
  - Low levels of cues to action on the HBM
  - Low levels of perceived severity on the HBM
- Reduced usage of safety equipment was predicted by:
  - High levels of fate on the HBM
  - Low levels of perceived control on the TPB
  - Low levels of intention to use safety equipment on the TPB
  - High levels of perceived barriers on the HBM
  - Low levels on cues to action on the HBM

However, control errors were also related to high levels of external beliefs and low levels of perceived barriers and cues to action.

With regards to engine size, only one study has differentiated between riders on larger and smaller bikes; the TBP was examined specifically for riders of larger bikes. This study found attitude significantly predicted intention to speed, however the effects of subjective norm and perceived behavioural control were not significant within this group of riders.[22]

5.1. Training Initiatives

Current legislation requires that all learner motorcyclists must attend and successfully complete a course of Compulsory Basic Training (CBT). Successful completion of CBT allows the rider to ride a bike up to 125cc on the road (excluding motorways or carrying a pillion) with L-plates for a maximum of two years before being required to take and pass the final DSA motorcycle test in order to gain a full motorcycle license. The main focus of motorcycle training is developing individual's skills of safe riding. Methods traditionally centre upon bike-handling and control skills, with instruction taking place in the form of theory and off and on-road practice.

5.1.1 Pre test

Compulsory Basic Training (CBT) was introduced in 1990 and is the first stage for learner riders who wish to become legal on the roads. The course aims to cover basic skills and knowledge relating to safe motorcycle operation. It is made up of a series of elements:

- A – This is an introduction to CBT which includes an overview of the course, information on equipment and clothing, and an eyesight check.
- B – Practical on-site training includes motorcycle controls, basic safety checks and the use of stands, wheeling the motorcycle and braking to stop, and starting and stopping the engine.
- C – Practical on-site riding includes riding in a straight line and stopping, riding slowly, using the brakes, changing gear, riding a figure of eight, emergency stop, rear observation, turning left and right and U-turns.
- D – Practical on-road training includes the information needed to ride legally and safely on the roads, for example; being visible to other road users, hazard perception, attitude and weather conditions.
- E – Practical on-road riding which is a 2 hour ride on the road with a certified trainer.[61]

There is limited evidence into the effectiveness of CBT in reducing motorcycle casualties. It has been suggested that the introduction of the course may have played some part in the reduction of motorcycle casualties in the 1990s[62]; however, reductions in the number of motorcyclists on the road at this time could also have had a large effect.[63] There has also been no evidence to examine whether CBT is effective in improving rider's knowledge or skill.[64]

One study investigated the attitudes and opinions of trainers and trainees towards the course and found generally positive attitudes towards CBT among both groups.[65] Another study looked at rider's attitudes towards existing training and found that riders of all age groups viewed existing training as not relevant enough, particularly, CBT was seen as being 'short of the mark'.[66] Rider training, particularly basic training, tends to emphasize control skills and neglect higher order cognitive skills, such as those related to anticipation, detection and hazard perception.[63]

5.1.2. Test

Before being able to take a practical test, riders must pass a theory test. The theory test consists of questions on the Highway Code and road safety topics and a hazard perception screen based test in which road scenes unfold and riders have to spot potential hazard.

Once a rider who has passed their CBT and theory test, they may take a practical test to obtain a full motorcycle licence. There are two types of full motorcycle licence for riders under the age of 21 years:

- A light motorcycle licence (A1) which restricts riders to any bike up to 125cc and a power output of 11kW. This test must be taken on a bike of between 75cc and 125cc.
- A standard motorcycle licence (A) is obtained if the practical test is taken on a bike of over 120cc but not more than 125cc and capable of at least 100km per hour.

After passing the standard motorcycle practical test riders are restricted for 2 years to riding a bike of up to 125cc.

5.1.3. Post test

Post test training is for riders who have passed their standard test and hold a full riding licence. It aims to enhance skills and confidence and iron out any bad habits that may have been picked up since passing the test. There are options for riders who are 21 years of age or over and riders who reach 21 before their 2 year restriction ends to be able to ride heavier bikes; Accelerated Access and Direct Access, there is also voluntary training available for those riders who wish to increase their skills; Advanced Training and the Enhanced Rider Scheme.

Although there has been a worry that quicker access to larger bikes may increase the risk of collisions due to riding a powerful bike with limited experience, there has been no evaluation of Accelerated Access and Direct Access courses for their effect on road safety.

There has also been limited evaluation of current voluntary training courses. The Institute of Advanced Motorists evaluated their own Advanced Training course and found some improvements to hazard perception skills in those that attended the course.[67] However, improvements in riding may reflect the type of rider who is likely to engage in training rather than the training itself.

5.1.4. Success of training

The fact that training is not recorded in collision data makes it difficult to assess the effect of training on collision rates. There is little evidence for the support of motorcycle training, and the evaluations there have been have had a number of methodological shortcomings:

- Small sample sizes
- Poor control groups
- Respondents dropping out
- Questionable self-reported data[68]

Other research has also found a negative effect of skills training. Evaluation of an RAC voluntary training course which consisted of 24 hours of instruction, half in a classroom and half practical showed significant differences between the groups; however, it was the trained riders who had significantly more collisions after the course than the untrained group.[69] Similar findings have also been shown for young drivers; skills programmes such as skid training were found to increase driver's confidence of coping with difficult driving situations, increasing their exposure to collisions.[70]

The research above examined the effects of training on collision rates which are often difficult to measure. It may beneficial to consider whether courses increase rider skills that they are

attempting to train. One study in the UK investigated the effectiveness of a one-day off-road training course on the rider's skills, knowledge and attitudes. Trained riders committed significantly fewer errors than non-trained riders; however, there were no differences between the groups in knowledge or attitudes.[71]

Methodological issues are one possible explanation for the lack of proven success of training; however, there are also several other possibilities. Firstly, skills may not be being learnt by the riders. One study in the US evaluated the Motorcycle Operator Skill Test (MOST) and found that riders who had previously attended a skills training course were actually assessed as having less skill than untrained riders.[72]

Secondly, training may not address the skills related to collision involvement. There has been evidence to suggest training increases rider's skills[71], there is however, little evidence to determine how long these skills last, which factors may improve or impede these skills, and whether these skills are related to collision involvement.[64] Training focusing on skills and techniques tends to ignore higher order cognitive skills, such as hazard perception. Research into car drivers has shown that drivers with low hazard perception scores are more likely to have a collision within 18 months of passing their test than those with high hazard perception scores.[73] Research has also found that more experienced riders had better hazard perception skills than novice riders.[29] Research has also found that training concentrating on control skills may even increase collisions.[64] Skills' training tends to ignore psycho-social aspects of riding (attitudes, personality, motivations and awareness).[74] Research has found riders who have had a collision in the past rated themselves as 'better' or 'much better' for control skills and getting out of hazardous situations, than riders who had not had a previous collision.[75] This suggests that an awareness of lack of skills is also important. It has been suggested training should include how to interact properly with other road users and teaching the rider to see road safety as a good thing and to respect the rights of other road users. An analysis of behavioural antecedents of collisions would be beneficial in identifying skills that should be taught in these training programmes.[64]

Finally, skills learnt during training may not be being translated into on-road riding behaviour.[64] Studies have found that riders identified risky riding as a danger, but also the major appeal of motorcycling.[66] This suggests additional factors, such as attitude and motivations, will affect whether the skills learnt during training will be used when riding. Learning transfer was reviewed for social care training in Cornwall.[76] One model outlined four stages of evaluating the effectiveness of training:

1. Reaction – how did trainees feel at the end of the training?
2. Learning – what had been learnt?
3. Behaviour – how has that learning been transferred into action?
4. Results – how has training helped to achieve these?

Levels 3 and 4 of evaluation are generally recognised to be more difficult and costly to measure, due to long-term follow up being needed. Consequently, most training is evaluated at the reaction level.[76] This is despite an increasing body of evidence that suggests reaction to training has a variable relationship with its long-term effect. It was suggested that instead of looking at training as a single event, which is unlikely to enhance effectiveness, it should be viewed as a long-term process incorporating preparation, training and implementation. One study examined training for mental health professionals and found including a module which aimed to raise awareness of the barriers of transferring learning into practise increased the transfer rate at follow up. It was also suggested the use of log books and action plans may be beneficial as they encourage trainees to consider what definite knowledge and actions can be transferred to real life situations.

5.1.5. Summary

There is limited evidence of success of both pre and post motorcycle training. The lack of proven training effects may be due to poor evaluation, however, it could also be due to inappropriate design or content of the training or limitations in what training can achieve. It is important every

intervention is evaluated appropriately and that training content considers skill limitation, higher order cognitive skills, and rider's attitudes, motivations and intentions.

Recommendations

- Training tends to focus on control skills and ignore higher order cognitive skills and psycho-social factors. Training initiatives could take into consideration cognitive skills such as hazard perception, and rider's motivations, attitudes and personality.
- Research has found skills training can have negative effects on collision risk, this implies caution should be taken when developing skill based training courses for young riders.
- Evaluations could be carried out on existing and future motorcycle training in order to establish which are most effective at increasing rider's safety so an evidence base can be built in this area. Evaluations should include before and after questionnaires, with questions that relate to the aims of the course, and follow up data should be collected relating to traffic offenses and collisions.

5.2 Education Initiatives

Research into individual differences between riders indicates that collisions may be linked to attitudes and motivations towards riding. It is therefore important to consider ways in which these factors can be targeted. Most rider education focuses on presenting the risks faced by motorcyclists and the consequences of risky riding. It aims to increase knowledge and change attitudes with the underlying assumption that this will increase safer riding behaviours and lead to a reduction in collisions.[77] There are limited education initiatives available specifically for motorcyclists; however, there are a variety of different styles of education and publicity that have been developed to address risky road behaviour in general that could be applied to motorcycle riders. There is little evidence available that suggests which method works best in increasing safe road behaviours but what is available is discussed.

5.2.1. Persuasive communication

Persuasive communication programmes attempt to introduce new prominent beliefs (beliefs that first come to mind when asked a question) to reduce risky riding behaviour. One study designed 4 videos to target changing 4 different beliefs surrounding speeding behaviours of card drivers; normative beliefs (beliefs about what others think about their behaviour), behavioural beliefs (beliefs about the consequences of performing a behaviour), perceived behavioural control (beliefs about factors that may facilitate or impede the performance of a behaviour), and anticipated regret. The normative beliefs and anticipated regrets videos had a significant positive impact on car driver's attitudes and beliefs towards speeding; however, the perceived behavioural control video decreased driver's perceptions of control. It was suggested that the persuasive communications introducing normative beliefs and anticipated regret, used in this study may induce a shift from a pre-contemplative state of mind (being unaware of the issue) to a contemplative state of mind, in which individuals start to consider that they should change their behaviour.[78]

Two independent reviews of speeding interventions for car drivers found effective interventions should target:

- Attitudes (beliefs and values) towards speeding
- Beliefs about the acceptability and ubiquity of speeding
- Responsibility for speeding choice
- Perceptions of the likelihood of being detected
- Perceptions of the benefits and costs of speeding
- Perceived barriers to driving at an appropriate speed
- The way in which speeding makes the driver feel

- Drivers perceptions of their ability to drive at an appropriate speed
- When and where drivers will reduce speed[79]

They also found persuasive messages should be paired with strategies that promote elaboration, for example group discussion, and should include interactive problem solving sessions to help individuals identify and adhere to appropriate speeds. They also suggested evaluation of interventions should be carried out before and after the intervention and a further evaluation 12 months later. The questions should focus on intentions to speed, attitude towards speeding and subjective norms, and subsequent speeding offenses should be recorded in the group that underwent the education and a control group who had not.

Research has also suggested road safety campaigns are most effective when they elicit emotions relevant to motivations underlying the behaviour.[80] This indicates taking into consideration riders motivations is important for targeting at risk groups.

5.2.2. Elaboration

Elaboration involves individuals expanding on situations and potential outcomes of these situations. According to the Elaboration Likelihood Model (ELM), there are two routes to changing attitudes. The first, ('central' route) requires an individual to actively process the persuasive message and elaborate on the message by generating additional thoughts. The second, '(peripheral' route) does not involve the elaboration; therefore no cognitive processing of the persuasive communication is achieved. This may lead to only short term changes in attitude which can be influenced by other factors, such as peer pressure.[81] This model suggests individuals should be encouraged to elaborate on the persuasive message in order for useful changes in attitude to be achieved.[64] This model has not been used for motorcycle initiatives, however, one study examined the potential of this approach with 352 young male drivers, aged 18-23. The experimental group were asked to imagine a severe collision scenario and visualise their feelings and consequences on their future lives. Self-reported risk-taking was measured pre-initiative and at follow up. All the groups reported less risk-taking behaviour at follow up than pre initiative.[82] The main limitation was that results were based on self-reports which could be biased and it is unclear how long effects would last.

Research examining behaviour change interventions across multiple health fields has identified techniques that may be effective in encouraging individuals to change behaviours.[83] These include; prompting the self-monitoring of behaviour, individual goal setting and action planning. These techniques encourage an individual to elaborate on a persuasive message by considering their own behaviour and how they can achieve the desired behaviour.

5.2.3. Threat appeals and fear

Threat is the undesirable consequences of behaviour, whilst fear is the emotional reaction of the audience from the threat.[84] Threat appeals are commonly used within road safety to induce fear, anxiety and apprehension in a target audience.

Research suggests there are 4 main steps to the threat appeal technique:

- Attract and hold the target's attention
- Generate fear or anxiety
- Suggest a safe behaviour to cope with the threat
- Increase the targets confidence to successfully perform the behaviour[85]

Campaigns often tend to over look steps three and four when using threat appeals.

The literature examining the effectiveness of threat appeals is inconclusive. There is some suggestion of effectiveness when specific conditions are met; the appeal must describe a threat and suggest a specific plan for reducing or avoiding the threat. The plan should be possible to

carry out, be perceived as effective and allow the individual to believe they are capable of performing the behaviour.[80] For example, one study found advertisements that advised drivers how to drive slowly were more effective than advertisements that just attempted to induce fear.[64]

However, a number of studies have found threat appeals to induce maladaptive responses in that the audience do not try and remove the fear by performing the desired behaviour, but try to cope with the unpleasant feelings. For example; avoiding or ignoring the message, and denying personal relevance of the message.[80] The threat should also be relevant to the target audience, for example, using threats of injury may not be important to motorcyclists who are suggested to be high sensation-seekers[42]**,** threats of a loss of licence may be more effective.

Recent evidence points towards the effectiveness of using positive emotional messages as an alternative to threat appeals in road safety campaigns, particularly for males.[80] Public health literature suggests that negative appeals might have a diminishing effect over time while positive appeals become more persuasive over time.[80] One study conducted an experiment in which participants viewed road safety ads with different appeals. The study found greater persuasiveness of negative (fear) appeals immediately after exposure but greater improvement for positive humorous appeals over time (up to a month).[86] There is a need for further research investigating message content for positive emotional appeals in road safety campaigns, particularly for different audiences, such as motorcyclists.

5.2.4. Current education initiatives in the UK

Ride

One motorcycle education intervention that considers attitudes, motivations and intentions is the national RIDE scheme. The national RIDE scheme is an alternative to prosecution from offenses of careless, and inconsiderate riding, and excess speed. Is consists of a one-day course that involves presentations by instructors and group discussions of the risks faced on the road. The course aims are:

- To increase awareness of current riding behaviour
- To encourage a positive and responsible approach to motorcycling
- To examine riders individual attitudes, motivations, approach to risk, and beliefs about inappropriate riding
- To consider the positive effects and benefits of mindset change and maintain these positive effects after completion of the course

The RIDE program was structured using the Transtheoretical model, also known as the stages of change model. The model proposes there are 5 stages an individual must pass through if a lasting behavioural change is to be achieved:

- Pre-contemplation – unaware of issue
- Contemplation – unengaged with issue
- Preparation – planning to act within a month
- Action – practising new behaviour for 3-6 months
- Maintenance – continuing commitment of behaviour

The course covers each stage and provides participants with personalised action plans.[87]

Evaluation of this course involved interviews, focus groups and questionnaires with 304 participants who had completed the course and a control group of 255 who had not. RIDE participants had a positive response to the course with 92% reporting that it gave them a better understanding of the hazards riders face on the roads. Ride participants were more receptive than controls to the possibility that a change in their riding behaviour is required to become safer. RIDE participants also reported greater appropriate changes in speed preference and braking sharply less frequently than controls.[88]

Bikesafe

Launched in 2000, Bikesafe is a multi-agency initiative offering on the road assessments of motorcycling skills, and theory from trained police motorcyclists. The vast majority of Bikesafe participants are male, with 67% between 35-54 years of age. The course was evaluated in Scotland by a self-completed before and after survey. Almost 100% of respondents found the course 'very' or 'fairly useful' and there seemed to be an improvement in the proportion of respondents who said they 'never' or 'hardly ever' brake too quickly on a slippery road. However, while the proportion of respondents saying they would normally ride below the speed limit on urban roads increased after the course, the proportion who said they would ride at 10 mph or more above the speed limit on rural roads increased.[89] This could be due to training causing overconfidence in riders, therefore, creating a distortion between their actual and perceived abilities. It was suggested that to compensate for this, an education component centred on higher-ordered planning, cognitive and self-monitoring skills may be appropriate.[90]

5.2.5. Summary

Education specifically for motorcyclists is limited, a number of potential forms of education and their effectiveness have been discussed. It is important initiatives are relevant to the target audience, suggest techniques to achieve the desired behaviour and take into consideration rider's attitudes, intentions, and motivations. All initiatives should be evaluated appropriately with before and after surveys and questions based on the aims of the initiative.

Recommendations

- Research has found getting participants to elaborate on the persuasive messages given in an intervention increases the interventions effectiveness; therefore rider education initiatives could pair persuasive messages with elaboration techniques.
- Risky riding behaviour, for example speeding, is considered an enjoyable activity for some riders, and these riders often tend to overestimate their abilities. Therefore, education and publicity initiatives should give consideration to rider intentions, motivation and attitudes towards riding.

5.3. Engineering Initiatives

Some features of roads are predominantly designed for the safety of four wheeled vehicles; these have potential disadvantages for motorcycles. The next section of this report examines road environment initiatives that may increase motorcycle safety.

5.3.1. Road surface

There are a number of road surface conditions that may present a hazard to motorcyclists; unevenness, slippery surfaces, road markings, use of cobbles, longitudinal parallel groves, drain covers and gratings, and repaired patches on the road.[64] One study compared road repair surface dressings to determine the physical movement of motorcycles as they crossed road surfaces containing bitumen and road surfaces containing tarmac. Skid resistance measurements showed a much lower value of friction for wet bitumen compared with wet tarmac.[91] It was suggested extensive repair work using a plain bitumen surface should be avoided. Changes in surface level and texture also need to be clearly visible with warning signs so motorcyclists know when to take particular care.

However, despite poor road surface conditions being frequently mentioned by motorcyclists, road surface was found to only contribute to 5% of errors made by riders on built-up roads and half of this on non-built-up roads.[15]

5.3.2. Road side furniture

Due to the high percentage (42%) of Cornwall's fatal motorcycle collisions involving the motorcyclist hitting an object it is important to consider possible ways to reduce this problem. Research suggests that wherever possible roadside furniture and signage should not be positioned on the outside of bends.[92] Other options are:

- Set the signs as far back as possible; falling riders loose speed quickly on open verges.
- On right-hand bends with sufficient forward visibility, position the signs on the inside of the bend.

Buckinghamshire County Council implemented site-specific engineering solution on a bend where there had been three motorcycle fatalities in five years. The principle behind the scheme was 'where you look is where you go'. Hazard marker posts were positioned on the outer edge of the bend, at a closer spacing the normal, to concentrate rider's eyes on the vanishing point. The owner of the adjacent land removed bramble so visibility was improved on the inside of the road. Since the intervention there have been no injury collisions on this bend for more than two years.
Not having road-side furniture where views may be obscured is particularly important at roundabouts and junctions where a high proportion of collisions are caused by other motorists failing to see a motorcyclist. Vegetation and signage may cause the motorcyclist to be obscured from another motorists view.[92]

5.3.3. Junctions and roundabouts

Low entry angles on roundabout approaches mean riders in the circulatory area can be obscured by the central pillar to emerging cars. Entry angles that are too high can lead to excessive speed on approach and tail-end collisions. Wide entries encourage drivers to pull up on the offside of the rider, especially if the rider is on a smaller motorcycle. Both of these problems can be reduced with entry angles between 30 and 40 degrees and entry widths no greater than absolute necessary. These measures should also reduce entry speed.[92]

5.3.4. Crash barriers

A crash barrier is designed to redirect vehicles away from hazards such as trees and lampposts, slowing them down over a short distance. A cars rigid external structure and secondary safety technology does the rest to minimise injury. Riders however, do not have this secondary safety to cushion the impact and protect from aggressive components.[93] There are three types of crash barriers used in the UK; steel-beam barriers, concrete barriers and wire-rope barriers.[94] Research indicates that hitting a crash barrier is a factor in 8-10% of motorcycle fatalities[95], and injuries can be up to 5 times more severe than if the rider had hit the rigid object the barrier was guarding against.[96]

It has been recommended the use of a shield (secondary rails) on barriers would increase the safety of riders. Those being promoted are secondary rail systems such as; Bikeguard, Moto.Tub, Plastrail, Motorail and Shield, which are metal rails or plastic tubes that fit below the existing barriers to prevent riders from sliding under the horizontal beams. Research has shown the use of modified steel secondary rail systems reduces the risk of injury to riders, particularly injuries to the head, and that fatalities can be halved. However, testing in Germany has indicated secondary rail systems can have adverse effects on cars; increasing the risk of mounting the barrier.[93]

The shape of the support posts of the barrier is also important, SIGMA designs (Figure 19) have been found to result in bruising, where traditional I-shape posts result in fractures and amputations, in comparable conditions.[97] Impact attenuators, that cover individual support posts as apposed to secondary rails which cover the whole barrier, are easier to install where riders are most vulnerable, such as bends and curves. Research shows attenuators can halve impact deceleration and force and double impact time, and are capable of saving 25% of motorcycle fatalities.[93]

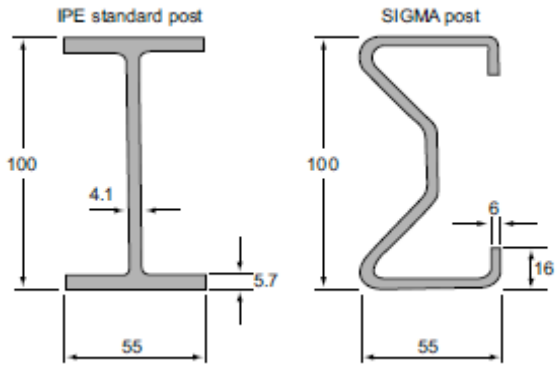

Figure 19 I-shape and SIGMA support posts

In 2008, EuroRAP (European Road Assessment Programme) published a document on crash barriers and made the following recommendations:

- Motorcycle-friendly systems have been shown to halve fatalities and offer high rates of return.
- There is sufficient evidence to justify new and immediate interim guidance on crash barrier design to give road engineers clear guidance on where motorcycle-friendly systems should be incorporated at new sites, and to be able to review motorcyclist risk at existing sites. The Netherlands is commended for its 'decision tree' approach (Appendix 3).
- Barrier support posts are particularly aggressive, irrespective of the barriers' other components, causing a five-fold increase in injury severity compared to the average motorcycle crash.
- 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.
- Introduce a cultural change to the way in which risk is viewed by a road authority.[93]

5.3.5. Other considerations

The shared use of specifically designed Advanced Stop Lines (ASL) by cyclists and motorcyclists could provide similar benefits to motorcyclists as they do for cyclists:

- They offer a head start reducing the possibility of conflict for turning vehicles.
- They allow motorcyclists to be visible away from other traffic.

This was trialled in the London Borough of Newham. Results showed:

- Before the trial of the shared use of ASLs a majority of motorcyclists (77%) and cyclists (51%) were supportive of motorcyclists using ASLs.
- After implementation 73% of motorcyclists thought the layout was an improvement along with 48% of cyclists.
- 80% of cyclists surveyed thought that the layout was better or unchanged and only 5% believed it had become worse.
- Across all sites the number using the new ASL filter lane "after" was greater than the number that filtered on the outside "before".

- The number of motorcyclists filtering between the nearside kerb and queuing traffic fell from 13% to 6%.
- There was no change in the number of cyclists managing to reach the front of the traffic queue.
- The percentage of motorcyclists managing to reach the front of the traffic queue rose from 40%'before' to 53%'after'.
- Conflict between motorcyclists and cyclists did not arise.
- Overcrowding was not an issue.
- Motorcyclists would tend to wait on the right hand side of the ASL reservoir, cyclists on the left. Conflict could arise, however, between left turning motorcyclists and right turning cyclists. This was not an issue as the majority of movements were straight ahead.

The use of ASLs by motorcyclists needs further trials in different local authorities. The approach should be consistent on a specific route and appropriate signing would be needed to inform all.[92]

The shared use of bus lanes was trialled and evaluated in Bristol with results indicating there were no detrimental effects to other road users. Reductions in motorcycle collisions between 0% and 31% were found at trialled sites, with no increase in overall collisions at any trialled site. There were also no adverse effects to bus journey times. Again, this needs to be trialled in other areas for more definite results.[92]

5.3.6. Summary

Roads are predominately designed for four wheeled vehicles which can produce adverse effects for motorcycle safety. However, there are initiatives that can be undertaken in terms of road surfacing, crash barriers and signage to increase the safety of riders on the roads.

Recommendations

- Crash barriers have been found to increase injury severity for motorcyclists involved in a collision. There have been mixed findings for the success of using secondary rail systems, which may increase the risk for car drivers. Impact attenuators have been found to increase motorcyclists safety during a collision, the shape of the support posts is also important with SIGMA posts causing less damage to the motorcyclist than traditional shape posts. It may be beneficial to consider the shape of support posts and impact attenuators on crash barriers where motorcycle collision rates are high.
- Research suggests road-side furniture and vegetation may obscure motorist's views of motorcyclists, and furniture positioned on the outside of bends may increase the severity of a collision if the motorcyclist collides with this furniture. Initiatives could target removing or repositioning vegetation and roadside furniture in collision hot spots.

5.4. Enforcement Initiatives

Law enforcement is responsible for ensuring compliance with laws and regulations intended to promote and maintain road safety. Research has found previous traffic offences[98] and stunts[99] predicted increased motorcycle collision risk. In an analysis of motorcycle collisions it was found a large proportion of motorcycle riders involved in collisions did not have a motorcycle license, or had previously had their license revoked. Motorcycles with modifications were also over-represented in the collisions.[19] Research in the US examined fatal motorcycle collisions and found that 27% were operating the motorcycle without a valid license, more than 5% had at least one previous conviction for riding whilst intoxicated, 30% had a previous speeding conviction and 18% had a recorded suspension or revocation of their license.[100] This suggests there may be certain types of individuals (such as those with previous offenses) that motorcycle road safety initiatives could

target, for example; lack of a licence and ownership has been found to correlate with youth[101] [102], and all three factors were associated with higher risk of a collision.[103] Possible initiatives for not having a licence include; showing proof of a licence as a prerequisite for purchasing a motorcycle, more stringent enforcement of licensing laws, and severe penalties for the lack of a licence.[103] It has also been found that riders borrowing a bike have increased collision risk. Young riders on a borrowed bike had 9 times the risk of being involved in a collision than riders riding their own bike.[51]This may reflect the familiarity protective effect mentioned earlier.

Although it has been found that riding violations, such as speeding, are associated with increased collision risk; motorcyclists have little perceived threat of being caught and even less fear of the consequences,[63]suggesting increasing perceived severity and perceptions of getting caught could be targeted.

Speed cameras are a main component of road safety enforcement. Although there is no data specific to motorcyclists, research has shown a significant positive impact of speed cuts on all road casualties.[63] An American study found that speed camera networks reduced all types of injury collisions, including those occurring in daytime and night time, on roads with speed limits of 30 and 60-70mph, for collisions that injured motorcyclists and other road users.[104] Other research has also found that when enforcement was visible average speeds were sharply reduced.[105] One study examined speeding behaviour of all vehicles on motorways and found that high-intensity enforcement was the most effective, supporting the relationship between perceived chance of getting caught and speed choice. This study also showed on-road stopping was more effective than mailing fines in reducing speeding behaviour.[106] Another study examined the effectiveness of a week of active police presence and a week of 'police speed check area' warning signs on driver's speeding behaviour. Fewer drivers broke the speed limit during the interventions, with the effects of active police presence lasting 9 weeks and the effects of warning signs lasting 8 weeks.[107] A high police presence was also rated as inhibiting rider's propensity to speed by older riders.[22] It has been suggested that unless increased enforcement levels are undertaken over a prolonged period of time, an individual's behaviour will be less likely to change and it may revert back to habitual behaviour.[108]

5.4.1. Summary

Evidence suggests enforcement is fundamental to increasing motorcycle safety. Research indicates the more intense the enforcement, the more effective it will be over an increased length of time.

Recommendations

- Research has shown collision involvement is related to previous riding convictions. Enforcement initiatives could target individuals with previous drink-riding and speeding convictions and recorded suspensions.
- Research suggests the more intense the enforcement the more effective it is in reducing speeding. Speeding could be targeted through increased on-road stopping and police presence.

5.5. Improving Visibility

Collision factors point to drivers not noticing motorcycles as a main cause of multi-vehicle motorcycle collisions. It is therefore important to consider ways in which the visibility of motorcyclists during the day can be increased. Research suggests two ways in which riders can improve their visibility:

- Daytime running headlights
- Colour and fluorescent clothing

5.5.1. Daytime running headlights

Research has shown using headlights during the day appear to have a positive result in raising other motorist's awareness of motorcycles and reducing the risk of collision involvement.[23] Countries such as Austria, Belgium, Germany and Spain have compulsory daytime headlight laws for motorcycles over 125cc. Research examining the effects of these laws found a 16% reduction in motorcycle casualties in daylight conditions.[64] It is thought daytime headlights increase the contrasts between motorcycles and the background. However, they can only be expected to influence whether a motorcycle is detected when the motorcycle approaches at an angle within 30 degrees of a driver's central vision.[63] Research examining light intensities has also found daytime running lights should have a minimum intensity of 1,600cd for two lamps greater than 180mm diameter.[63]

However, other research has shown daytime running headlights have no effect on motorcycle fatalities. In a comparison between three countries with laws for daytime running headlights and three countries without these laws, it was found that countries without laws had a higher overall reduction in fatalities compared to those with the laws over the same time period.[109] If too much emphasis is placed on daytime running headlights it may remove attention away from more important factors of collisions such as:

- Better awareness and training for motorcyclists
- Improvement of data collection and further research to target interventions effectively.

Possible explanations for these mixed findings include methodological issues; for example, the use of daytime headlights is assumed to be effective only for fatal and serious injury collisions[110], therefore, using all collisions as a measure may reduce the effectiveness of findings.[111] Another possibility is that increased visibility may be at the expense of other riders who do not use their lights, since car drivers may adopt a strategy of looking for a light rather than a motorcycle.[103]

Research has found that motorcyclists in Britain are less likely to use all types of conspicuous equipment than motorcyclists in Australia. For example in Australia 60% of motorcyclists used voluntary daytime running lights compared to 28% of motorcyclists in Britain.[112]

5.5.2. Colour and fluorescent clothing

Research suggests wearing reflective/high visibility clothing could reduce motorcycle fatal/serious injury collisions by one third.[113] One study examined 463 riders who had been involved in collisions and 1233 control riders and measured the use of reflective or fluorescent clothing. Results showed that riders who wore reflective or fluorescent clothing had 37% lower risk of a collision than riders who did not wear this clothing.[113] A caveat to this finding is that the lower risk of collisions may reflect the type of rider who chooses to wear reflective or fluorescent clothing, for example; safer riders may chose to wear clothes that may increase their safety, rather than the effects of wearing the clothing. Other studies have also reported improved visibility for fluorescent garments compared with conventional clothes[114] [115], however, some studies have found no benefit of wearing fluorescent clothing compared to not wearing fluorescent clothing.[116] It has been suggested the colour of the motorcycle and its rider can be used to improve visibility but its effectiveness depends on the contrast between the motorcycle and its background.[63]
Fluorescent yellow-orange and plain yellow materials were detected faster and further away than any other colour; however, weather was found to affect the speed in which colours were detected. White was useful on clear sunny days whilst on overcast days, fluorescent red-yellow was better. It was also found that drivers respond more quickly and accept longer safety gaps when riders wear red and/or fluorescent jackets than when they see low beam headlights or no extra visibility equipment. Coloured helmets were found to have no effect on detection rate.[63]

It has been found that the use of coloured and fluorescent clothing and daytime headlights can be increased by publicity and campaigns, however, the effects did wear off after 9 months.[99]

5.5.3. Summary

One of the main causes of motorcycle collisions is the motorcycle not being seen by a motorist. Research suggests a number of ways in which to increase the visibility of a rider, for example; daytime headlights and fluorescent clothing, however, so far findings have been mixed; more research is needed as to whether these methods are effective in increasing motorcycle safety.

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8. Appendices

Appendix 1 Segments of riders on motorcycles over 125cc

	Riding Hobbyists	Performance Disciples	Performance Hobbyists	Riding Disciples	Look-at-me Enthusiasts
Motivations	High - power of bike and challenge of riding Low - self-assurance	High - power of bike and belonging Low – feelings/ sensations and showing off	High – feelings/ sensations and power Low – belonging and showing off	High – belonging, sensations, self-sufficiency, release and relationship with bike. Low – showing off	High – showing off and all other factors except: Low – relationship with bike and release
Demographics	Male and older (45) Married with children Well off	Male 25-54 Married with children	Male 25-44 Married with children	Mostly male 45+ Married, less likely to have children	Male under 25 Single and living with parents
Bike	700cc+ Owns bikes Rides oldest bikes Values brand/ make and classic style More likely to buy new	750cc+ sports bikes Values speed, performance and size	500-700cc sports bikes Most likely to buy second hand Values acceleration	1000cc classic and custom bikes Highest multiple owned bikes Value comfort, manoeuvrability, and manufacturer More likely to buy second hand	Average across all engine sizes and bike types Value looks, acceleration, power and sound Second hand bikes
Safety gear	Wears helmet Least likely to continue wearing if dropped on hard surface Wears leather without armour Choice is on reputation Below average wearing of high visibility clothing High awareness of safety standards Buys from specialist	Wears helmet Less likely to wear if dropped Armoured jackets, trousers, gloves and boots (not every time) Below average wearing high visibility clothing	Most likely to continue wearing helmet after dropped Least likely to consider reputation Average awareness of safety standards Average wearing of protective clothing	Highest of open face helmets Leather but armoured Least likely to wear helmet if dropped Likes comfort and good fit Buys from specialist Average awareness of safety standards Owns high visibility clothes – only wears if conditions require	Wears helmet every time Most likely to entertain riding in t-shirt and trainers Cares about how the gear looks Average wearing of high visibility clothing
Ride/not ride	Less likely than average to ride when fatigues, in a rush, or in poor visibility	Most likely to ride in a rush, when tired or after a long distance	Most likely to carry on riding having seen a serious motorcycle collision	Less likely to ride in negative conditions except is willing to continue over 2 hours	More likely to ride on all occasions except after having seen a serious collision involving a motorcyclist
Riding career	Long riding career, half had a break Low millage-summer leisure on rural roads Highest %car drivers High % of full licence holders Low levels of training Average exposure to safety agencies (dealers/media)	Long riding career, likely to have had a break Highest millage, all-year business and pleasure Full licence holders Most likely to have advanced training High exposure to safety agencies	Average riding career Summer only for commuting and pleasure Full licence holders More likely to received training than riding hobbyists Low exposure to safety agencies	Ridden longest and most likely to have had a break All-year round for leisure and fun, urban and rural Also car drivers Full licence holders but less likely to have had training or seek it Most likely to be member of m/cycle organisation, attend event, read magazines	High level of novices All year round High provisional licence holders Most likely to have received some form of training Likely to visit motorcycle dealers and websites

Attitudes to risk	Average assessment of general and personal risk Lowest level of collision propensity Lowest experience of risky situations Least likely to attribute risk to other road users Lowest on 'constantly thinking' of risk of riding	Highest riding risk – personally and generally Moderate risk of collision liability High risky situations Most likely to attribute fatalities to lack of training Highest on 'I can live with the risk'	High and low collision propensity groups Most likely to admit to having over-estimated own ability, taken a risk to impress others and riding when tired Most likely to respond 'life without risk would be boring' to fatality statistics	Average attitude to risk – small minority consider themselves safe Spread of collisions propensity Below average experience of all risk events except speeding Strong views about reducing risk but would not give up riding if risk was too high	Rated motorcycling safer than anyone else Highest collision propensity Highest experience of risky situations Most likely to agree with 'I am a good rider so risk doesn't apply to me'

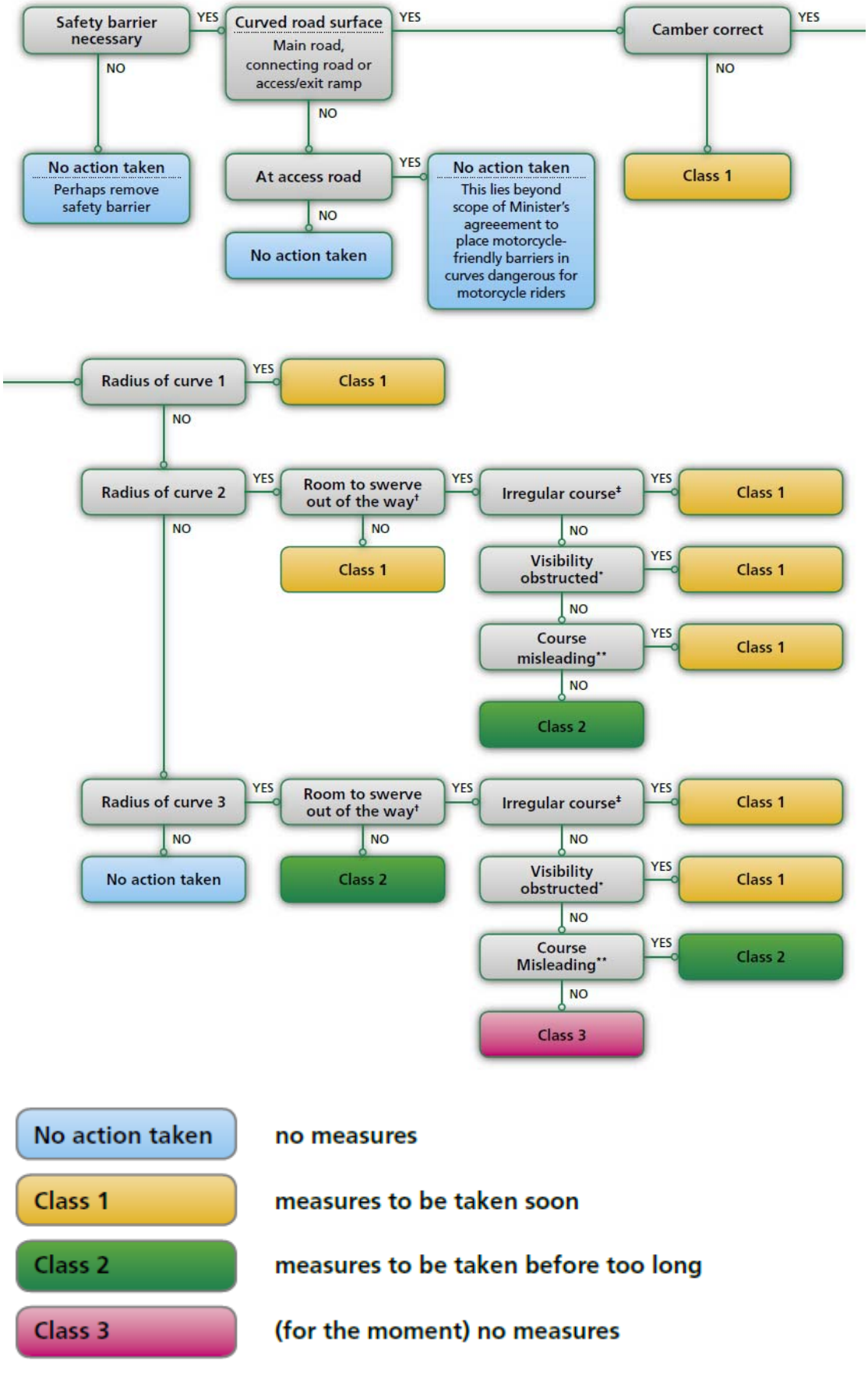
Table 2 Segments of riders of motorcycles over 125cc[54]

Appendix 2 Segments of riders on motorcycles up to 125cc

	Look-at-me enthusiast	Car aspirant	Car rejecter
Motivations	High – showing off and all other factors except: Low – relationship with bike and release	High – challenge of riding, self-sufficiency. Low – everything else, especially release Least committed to motorcycling	High – release Low – power of bike, belonging and feeling sensations Second lowest on commitment to riding
Demographics	Male under 25 Single and living with parents	Male and youngest riders Single and living with parents Most likely to be students	Male but more women than any other segment Average age profile, slight peak at 25-44 Married/living together with children Lower income <20k
Bike	Average across all engine sizes and bike types Value looks, acceleration, power and sound Buys second hand bikes	Scooters and mopeds (<50cc) Lowest level of multiple bike ownership Values running costs and fuel economy Buys new and second hand	Bikes under 125cc
Safety gear	Wears helmet every time Most likely to entertain riding in t-shirt and trainers Cares about how the gear looks Average wearing of high visibility clothing	Wears helmet on every occasion Average wearing of protective and high visibility clothing Lowest awareness of safety standards Main factors in choice are comfort and safety certification	Most wear full face helmets, otherwise flip helmets Textile clothing preferred to leather or armour
Ride/not ride	More likely to ride on all occasions except after having seen a serious collision involving a motorcyclist	Most likely ride wearing t-shirt and trainers Least likely to ride if dropped helmet on hard surface, a long journey, needed a coffee.	
Riding career	High level of novices All year round High provisional licence holders Most likely to have received some form of training Likely to visit motorcycle dealers and websites	Shortest careers All year round commuting and low mileage High on urban-only riding Most likely to hold a provisional licence Least likely to be exposed to safety agencies (dealers, media)	Quite recent riders (1/3 under 2 years) All year round commuting and summer leisure fun Low mileage Over 2/3 also drove a car Lowest intention to get full licence Lowest exposure to safety agencies
Attitudes to risk	Rated motorcycling safer than anyone else Highest collision propensity Highest experience of risky situations Most likely to agree with 'I am a good rider so risk doesn't apply to me'	Rate motorcycling as very safe High collision propensity Unlikely to have experienced risky situations Most likely to state 'not being seen' as a reason for collisions.	Rates motorcycling as risky Average collision propensity (however this hides half who are very at risk and half who are very safe) Unlikely to have experienced risky situations Most likely to agree with 'my primary purpose is to arrive safe'

Table 3 Segments of riders on bikes up to 125cc

Appendix 3 Netherlands 'decision tree' approach for crash barriers



Classification of radius of curve

	Curve [m]
Radius 1	R < 100
Radius 2	100 < R < 250
Radius 3	250 < R < 400

* Problems of visibility

The present guidelines are considered standards in determining if there are problems of visibility. Below is a table that summarises the minimum distances for vision in various situations.

	distance of vision in various situations [m]		
design-speed [km/h]	continuous view of course of road	view of stationary traffic queue	view of obstacle in one lane
120	165	260	235
90	120	135	165
70	90	80	100
50	55	40	70

† Room to swerve out of the way

There is sufficient room to swerve out of the way if on the outside of the curve there is a hard strip of at least 1.75 m between the inside of the sideline and the safety barrier.

‡ Irregular course

e.g. sudden changes in the radius of the curve.

** Course misleading

Misleading course occurs if the appearance of the road suggests something other than its actual course. This is often the case if vertical elements (trees, lampposts) follow a course that differs from the hard surface.

Compiled by the Dutch Ministry of Transport (AVV), Motorcycle Action Group (MAG) Netherlands, & Royal Dutch Motorcycle Club (KNMW)