Older Road Users

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

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Acknowledgements

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Executive Summary

The aims of this report are to examine whether there are any differences between serious and fatal road traffic collisions involving older road users and identify initiatives that may increase older road user safety. Older road user collision statistics (national and local) will be examined, along with older road user characteristics and the evidence regarding whether initiatives increase older road user's safety on the roads.

Evidence suggests older road users are over represented in fatal and serious injury collisions. This is, in part, because as people get older they become more fragile and so more vulnerable to injury if they are involved in a collision. Older road users were not at more risk of being involved in slight injury collisions than other age groups.

Examination of local (Cornwall) and national collision data suggest collisions involving older road users tend to occur during the day between 9am-6pm on A class, single carriageway roads that have speed limits of 60 or 30mph. Car occupant collisions occur mostly on rural roads, however, pedestrian collisions occur mostly on urban roads. All three road users are involved in a high number of collisions at junctions, particularly stag and T junctions. Failing to judge another persons speed or path, failing to look properly and loss of control were key contributory factors. Driver casualties were predominately male, compared to passenger casualties who were predominantly female. Pedestrian casualties had a slightly more even gender divide.

A number of recommendations for practice can be made from the evidence on older road users:

- Initiatives could target all older road users (drivers, passengers and pedestrians) as research suggests all categories of older road users, not just drivers, are at increased risk of being killed or seriously injured in a collision, specifically older pedestrians who have more risk relative compared to drivers and passengers
- Initiatives could focus on the frailty of older road users as it is their frailty that accounts for their increased over representation in KSI collisions
- Initiatives could target older road users judgement of other vehicles speed and path, looking properly when crossing the road and driving and loss of control as these were key contributory factors in older road user collisions
- Initiatives could increase older road users, and their family and friends, awareness of age related declines that could influence their safety as research suggests declines that have an obvious link with safe behaviours are more likely to be acted upon
- Initiatives could aim to increase males self-regulation as evidence suggests males are less likely to self-regulate than females
- Driving education initiatives could emphasise the importance of attending an on-road practical driving skills session as evidence suggests initiatives are most effective if they have both components
- Self-assessment workbooks designed for older drivers could be given out at education initiatives as evidence suggests workbooks increase knowledge and self-awareness, and self-assessment of own driving provides more benefits than compulsory screening
- The information given to both men and women in driving interventions could be tailored to their needs. Evidence suggests women need information about driving skills and increased confidence for difficult driving skills and men need information that highlight health and age related declines
- Advertising education and training initiatives could focus on the benefits of attending such as increased knowledge and awareness of skills as research suggests this is what older participants of initiatives valued most
- Road infrastructure design, particularly in areas with a high number of older people and places older people are likely to be (for example; hospitals), could consider older road users needs, as research suggests road design is usually based on the abilities of younger adults.

Specifically junctions which have been shown to be particularly common in older road user collisions

- Initiatives could increase awareness of available in-vehicle technologies and adaptations that could increase safety

1 Introduction

The UK has an aging population. During the last 25 years the proportion of the population aged over 65 years grew from 15% in 1983 to 16% in 2008; an increase of 1.5 million people.[1] This trend is set to continue; it is expected that by 2033 23% of the population will be aged 65 years and over. Because of this, and increases in longevity, owing to advances in healthcare, the proportion of older road users in the UK is likely to increase. In Cornwall, the proportion of older people in 2001 was 20%, in 2010 this had grown to 22%, demonstrating a greater proportion of those aged 65 years and over in Cornwall, compared to the rest of the UK.[2]

Increased car ownership and driving careers has been predicted to result in an increase in active license holders among older drivers. In Cornwall in 2011, drivers aged 65 and over accounted for 19% of female full license holders and 23% of male full license holders.[3]

Mobility is essential to the quality of life of older adults, helping maintain independence and health. Research suggests the car remains the most important mode of transport for older people (Figure 1)[1]. In the UK in 2008 63% of all trips made by those aged 70 and over were as a car diver or car passenger, a further 21% were made on foot.[4] Evidence suggests older people are more likely to live in lower density areas less well served by public transport meaning that many older people are reliant upon their cars.[5] This may be particularly prominent in Cornwall due to its largely rural nature.

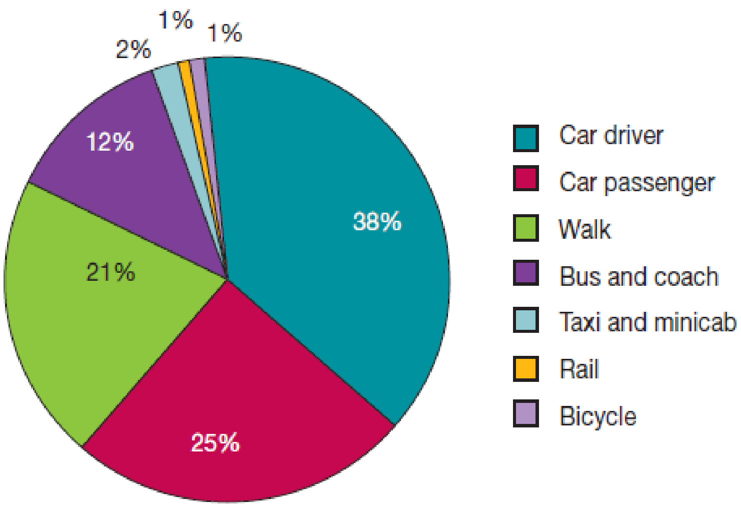

Figure 1 Trips by mode of transport for those aged 70 and over[4]

Due to the expected increase in the number of older road users it is important to identify ways to increase their safety on the roads. This report examines national and local (Cornwall) collision data for older pedestrians, drivers and passengers with particular emphasis on differences between fatal and serious injury collisions. In Cornwall, collision statistics collected from police data show fatal collision trends have tended to differ from serious injury collision trends. Traditionally from 2002-2009 serious collisions showed a steady decline, whilst fatal collisions remained fairly stable. However from 2009-2011 these trends seem to have reversed. This suggests there may be differences between fatal and serious injury collisions in the type of collisions, or the people having the collisions. A review of the literature on older road user characteristics is carried out and initiatives to increase older road user safety are examined.

Data for Cornwall's older road user collisions (2001-2010) and national older road user collisions (2004-2010) were taken from STATs19; an established police recording format with specific definitions and details for contributory factors, location, vehicles, and injuries. When stated, Cornwall's older road user fatal data has also been supplemented with information obtained from Cornwall's fatal database (2003-2011), 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 (76 older road user fatal casualties from 2001-2010), therefore, national data may be more robust when making conclusions

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2 Collision risk

This section reviews the evidence to determine whether older road users are more at risk of being involved in a collision than the general population

Recent research in the UK examined fatality data from 1989-2009 for car drivers, car passengers and pedestrians. Results showed that overall fatality numbers in the population are relatively low for older adult drivers (70 and over). Older adults instead represented the second largest proportion of all passenger fatalities in the population and a much larger proportion of all pedestrian fatalities than any other age group.[6] Older road users tend to make fewer trips than the younger population and tend to regulate their exposure to risk by avoiding challenging conditions, such as bad weather conditions, thefore examining absolute number of collisions may not reflect the risk faced by older road users.[6] Measuring collisions as rates, for example amount of travel or population size, takes into account their exposure to risk. One study found that when measured as a rate per mile travelled older drivers and passengers were no more likely to be fatally injured than 21-29 year olds but older pedestrians were 5.19 times more likely to be fatally injured, compared to 21-29 year olds.[6] Similar findings were found by the DFT in 2009.[7] In the UK, fatality rates per 100,000 population for car drivers and passengers increased in older age, but only older pedestrian fatality rates overtook those of 16-19 year olds. (Figure 2) This suggests older drivers and passengers are not more at risk of a collision than other drivers and passengers but older pedestrians are.

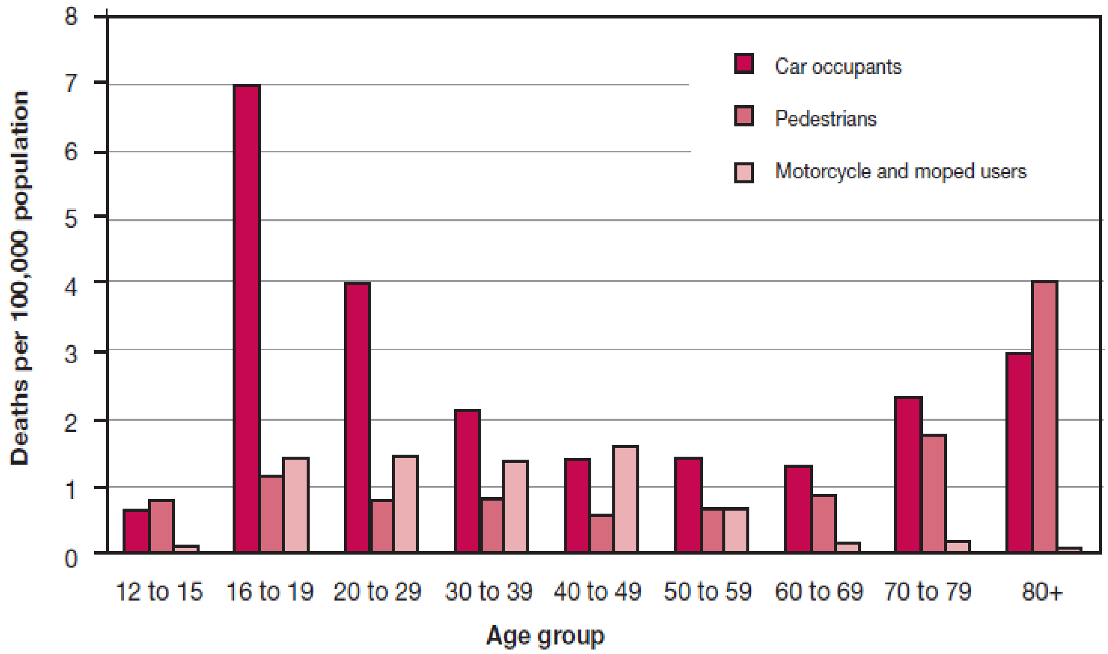

Figure 2 Fatality rates for pedestrians, car occupants and motorcycle and moped users in the UK in 2008[7]

Results also demonstrated older pedestrians represented a disproportionately large number of fatal casualties relative to the percentage of the population who are elderly; however, this was not true for slight injury casualties. (Figure 3)

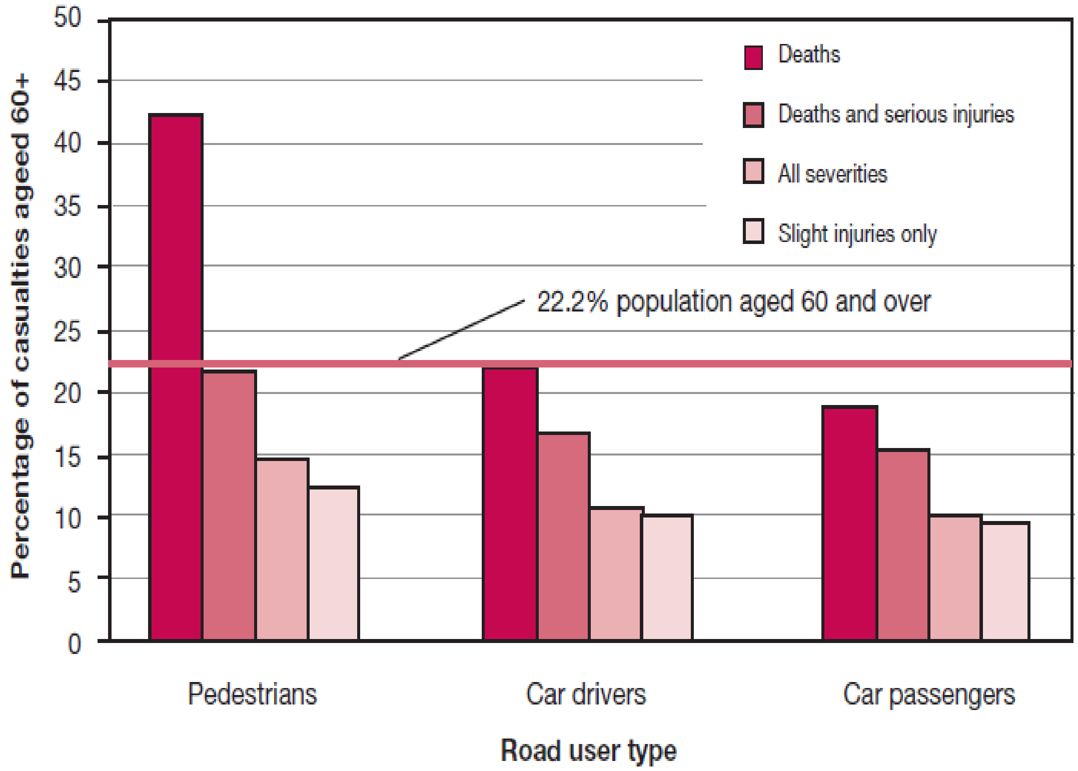

Figure 3 Percentage of Casualties aged 60 and over in the UK in 2008[7]

In 2008, people aged 60 years and over made up 22.2% of the population, however, older pedestrians accounted for 43% of all fatal pedestrian casualties but only 12% of slight casualties demonstrating that older people are over represented in fatal pedestrian collisions. However, older car drivers accounted for 22.2% of all fatal car casualties, and older passengers accounted for 18% of all fatal passenger casualties suggesting drivers and passengers aged 60 years and over are not at any extra risk of fatal collisions than the general population.[4]

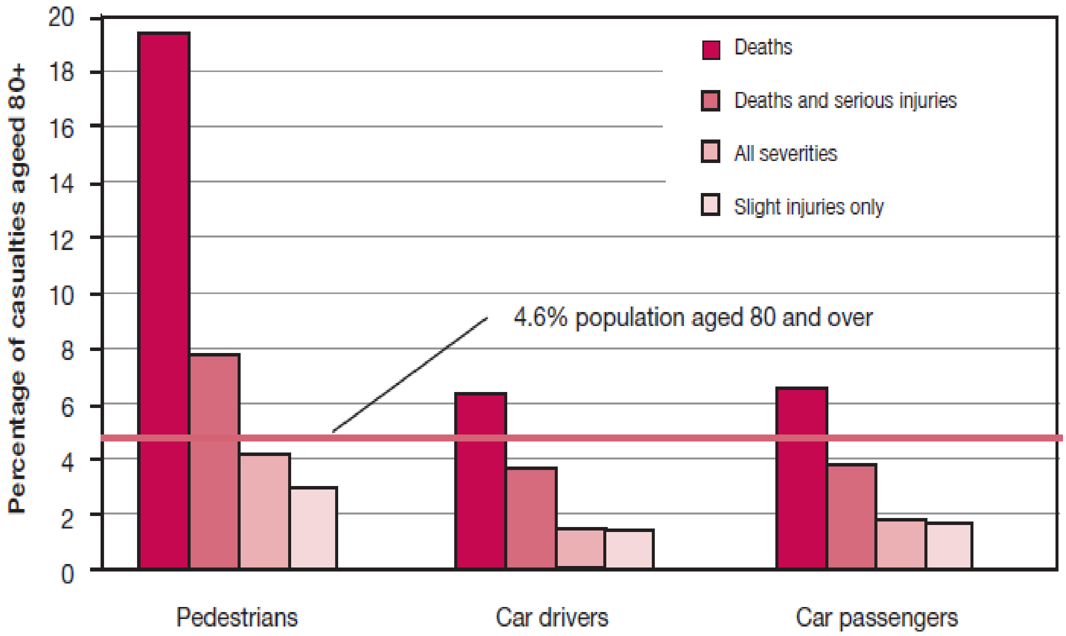

Figure 4 Percentage of casualties aged 80 and over in the UK in 2008[7]

In 2008, people aged 80 years and over made up 4.6% of the population, however, pedestrians over the age of 80 accounted for 19% of all fatal pedestrian casualties, drivers over the age of 80 accounted for 6% of all fatal car casualties and passengers over the age of 80 accounted for 7% of all fatal passenger casualties. This suggests that the older old (over 80) are at increased risk of all road user collisions; however those over the age of 60 are only at greater risk of fatal pedestrian collisions. (Figure 4).

Older people are also likely to require longer hospital treatment; those over 75 years are in hospital for over three times as long as those between 15-59 years of age,[8] and anxiety[9] and post-traumatic stress disorder[10] are also common after a collision.

Analysis was undertaken in Cornwall to examine the percentage of all casualties that were killed and seriously injured for older adults (over 65 years) compared to younger ages (0-64 years). (Figure 5) Results show that KSI casualties accounted for a greater proportion of all casualties for older pedestrians, drivers and passengers, compared to younger casualties.

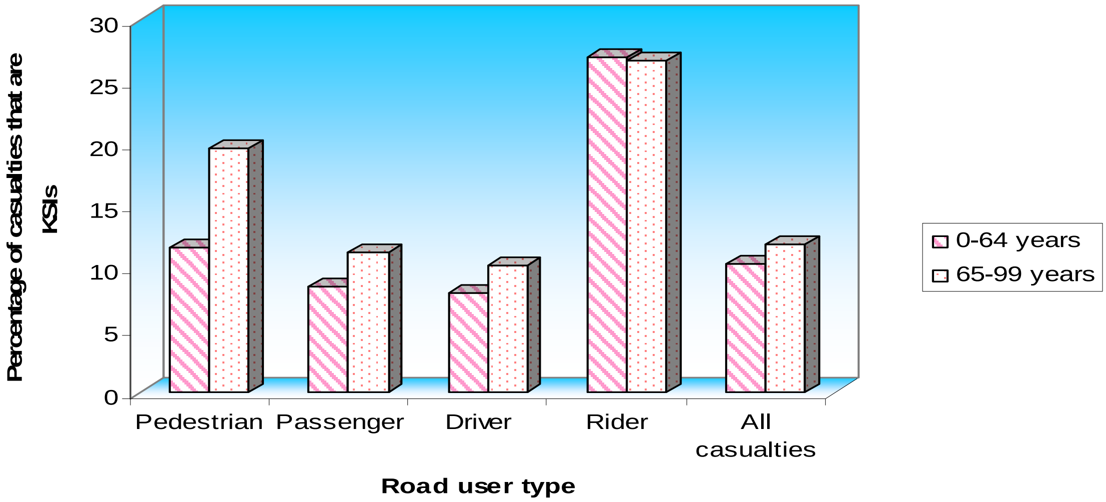

Figure 5 Proportion of KSI casualties in Cornwall, 2001-2011

This research suggests that as people get older they are not more at risk of being involved in collision, however, when they are involved in a collision they have a greater risk of being killed or seriously injured. Research suggests this is because older people are frailer than younger members of the population.[11] Research for individual road users is now reviewed.

2.1 Drivers

In the UK in 2009, car driver casualties were measured as casualty rate per miles driven. (Figure 6) The number of casualties per miles driven for a million drivers increases from 65 years of age, however, the increase is much more dramatic for KSI (Killed and Seriously Injured) casualties than slight, and even more so for fatal casualties.[4] Research suggests this is due to older drivers being frailer than younger drivers, making them more vulnerable to injury or fatality risk in the event of a collision.[12] As a result older drivers have a relatively high fatality rate but their injury rate is not as elevated. Research in the Netherlands found similar results; the fatality rate for drivers aged 75 years was 5 times higher than that for all drivers, however, the injury rate was only 2 times higher.[13]

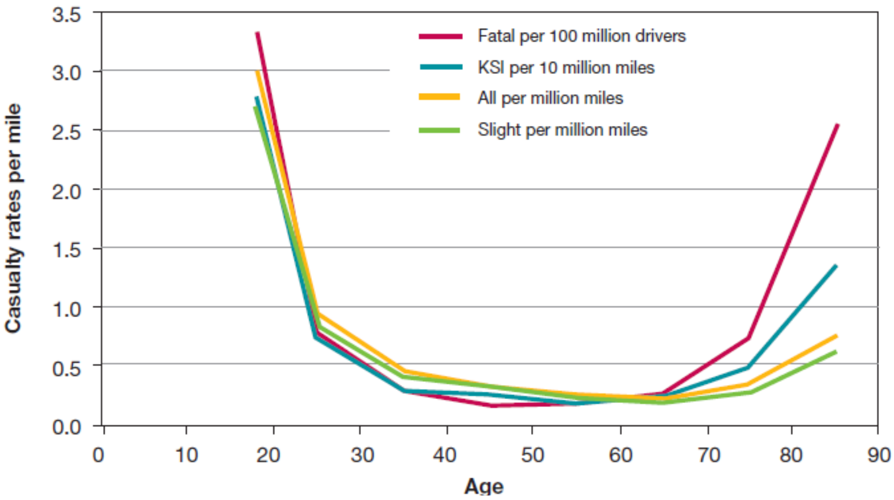

Figure 6 Car driver casualty rates per mile driven in the UK, 2008[4]

2.2 Pedestrians

Several international studies have found that older pedestrians have an elevated risk of collisions when exposure rates, measured by distance walked or number of roads crossed, are taken into account, as well as an increased likelihood of fatality.[14,15,16,17] In 1980 in the UK, the numbers of casualties per hour walked were 5 times more for males over 80 years, and 9 times more for females over 80 years, than for people aged between 18-29 years.[18] In 2000, UK statistics were analysed using road collision statistics, Office of National Statistics, and the National Travel Survey 1996-1998. Several measures of exposure where taken into account; population, number of journeys and distance travelled. Results showed rises in injuries per journey and distance travelled for older pedestrians. The rise was slight from late middle age, but rose more steeply from 65 years. Results also demonstrated that although all casualty rates increased modestly for older people, the fatality rate increased much more strongly suggesting older pedestrians are not markedly more at risk of involvement in a collision, but are more vulnerable to its consequences.[19] Other analysis has also found that large increases in all collision involvement is only seen among the older old. Researchers concluded that only the over 79 year olds could be seen as being ‘at risk’ crossing roads once allowances had been made for frailty. [15]

Hospital admissions data shows similar findings. In 1999 in Los Angeles, mortality rates for pedestrians was 7.7% over all ages but 27.8% for the over 65s.[20] In the UK in 1994, the percentage of pedestrian casualties that were fatal or serious rose from about 25% at 60-64 years, to almost 60% among the over 65s.[21]

2.3 Passengers

There is less research into the collision risk of older passengers. One study analysed collisions involving cars manufactured after 1991. Collisions were matched for impact speed and type of impact (side or frontal impact). Results demonstrated that older (195 people aged 65 and over) front seat passengers did not have more slight injury collisions than other age groups, however, they had a higher proportion of fatalities for frontal impacts when compared to younger age groups. These results were not found for side impact collisions.[22]

2.5 Summary and recommendations

The evidence above suggests older road users are over represented in fatal and serious injury collisions. This is, in part, because as people get older they become more fragile and so more vulnerable to injury if they are involved in a collision, not that they are much more at risk of being involved in a collision.

A number of recommendations can be made from this evidence:

- Initiatives could target all older road users (drivers, passengers and pedestrians) as research suggests all categories of older road users, not just drivers, are at increased risk of being killed or seriously injured in a collision, specifically older pedestrians who have more risk relative compared to drivers and passengers
- Initiatives could focus on the frailty of older road users as it is their frailty that accounts for their increased over representation in KSI collisions

3 Types of collisions for older road users

This section examines national and local collision statistics to determine factors that are associated with older road user collisions. These should be considered when designing and targeting initiatives.

Due to older road users having increased collision severity than younger road users it is important to consider the types of collisions older road users are having so initiatives can better target key factors of older road users safety. The national and local data considered below relate to total number of collisions involving older road users unless otherwise stated. The data looks at absolute numbers so does not control for road users exposure to the roads.

3.1 Older drivers

3.1.1 When

Day of week

Nationally, from 2004-2010, fatal and serious collisions had a slight peak mid week, from Wednesday to Friday (daily average of 16%) and occurred slightly less at the beginning (daily average of 13%) and end of the week (daily average of 12%). Locally, serious collisions also showed a drop at the end of the week (13% on Saturdays and 5% on Sundays) compared to weekdays (daily average of 16%). Fatal collisions locally were more varied across the week but did show less collisions occurring on a Monday (7%) and Sunday (6%) than the rest of the week (average of 17%) (Figure 7).

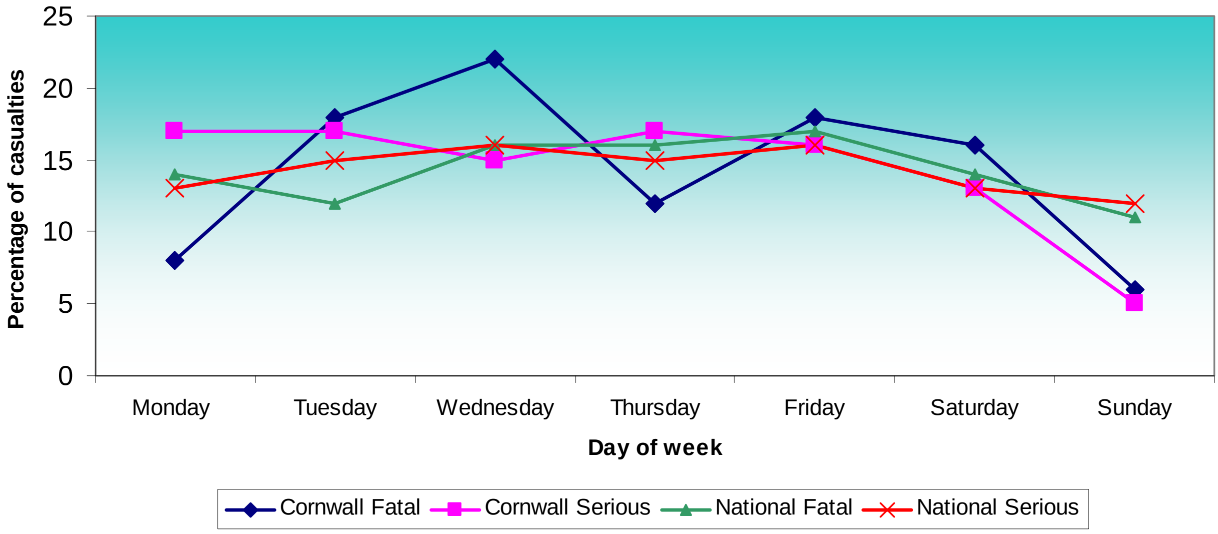

Figure 7 Older driver casualties – percentage distribution by day of week

Time of day

Nationally, from 2004-2010, and locally from 2001-2010, most fatal and serious collisions occurred during the day from 9am-6pm (77% nationally and locally) (Figure 8).

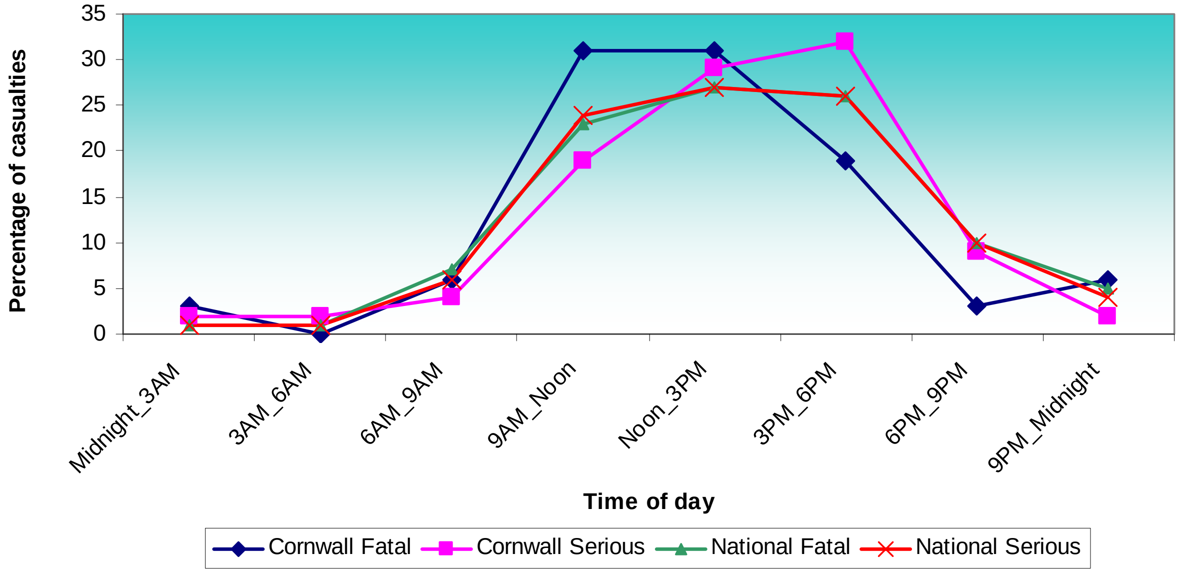

Figure 8 Older driver casualties – percentage distribution by time of day

Month

Nationally, from 2004-2010, fatal and serious collisions occurred evenly across all months of the year. Locally, serious collisions also occurred relatively evenly however, there was more variation with fatal collisions which occurred most in April (16%) and June (16%) (Figure 9).

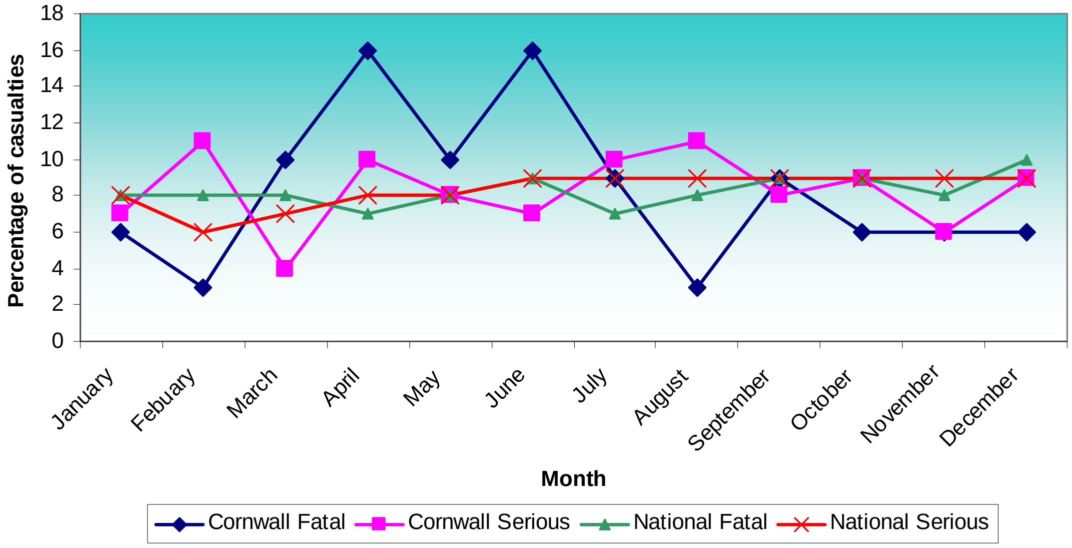

Figure 9 Older driver casualties – percentage distribution by month

3.1.2 Where

Road class

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on A roads; main roads that tend to have heavy traffic flow, (50% serious, both nationally and locally, 60% fatal nationally and 75% fatal locally). Locally, slightly more serious collisions occurred on B roads; local routes that have lower traffic volumes than main roads, (23%) than fatal collisions (8%) and nationally, slightly more serious collisions occurred on unclassified roads; lanes with lower traffic volumes than other roads, (23%) then fatal collisions (14%) (Figure 10).

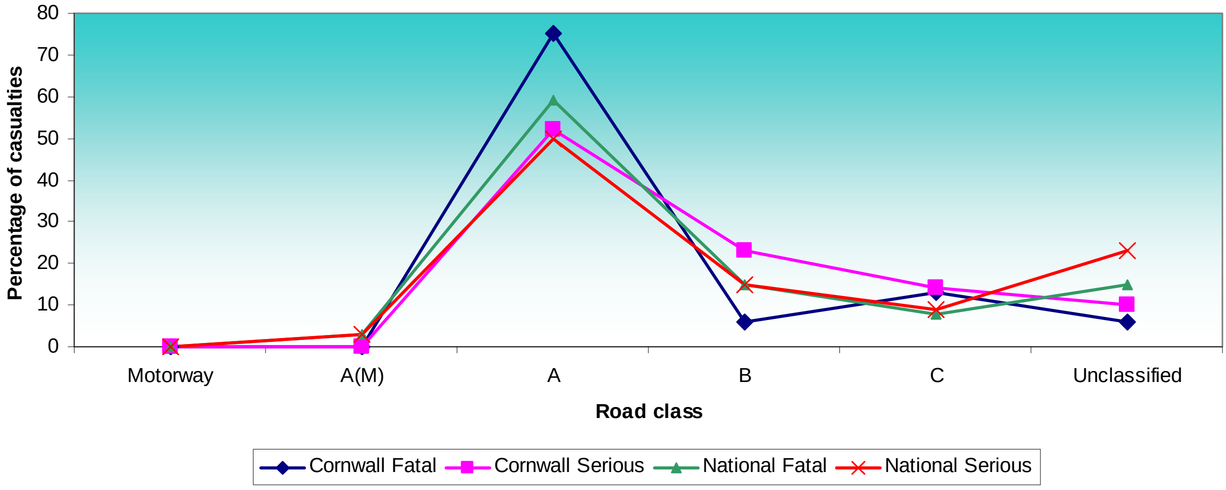

Figure 10 Older driver casualties – percentage distribution by road class

Speed limit

Nationally, from 2004-2010, most fatal collisions occurred on 60mph roads (50%). A high number of serious collisions also occurred on 60mph roads (34%) but most occurred on 30mph roads (44%). Locally, most fatal and serious injury collisions occurred on 60mph roads (57% fatal and 55% serious), followed by 30mph roads (25% serious and 16% fatal) (Figure 11).

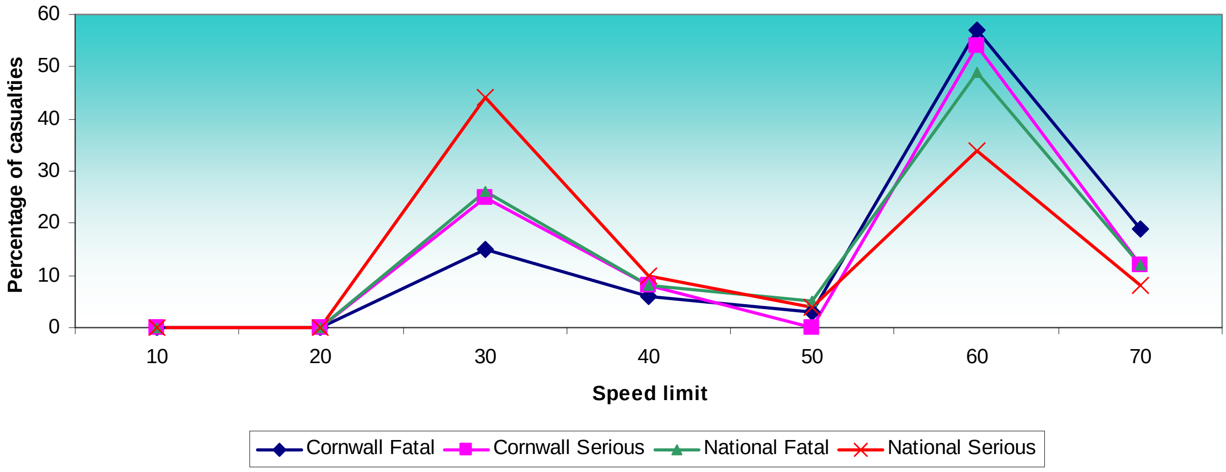

Figure 11 Older driver casualties – percentage distribution by speed limit

Road type

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on single carriageway roads (80% nationally and 72% locally) (Figure 12).

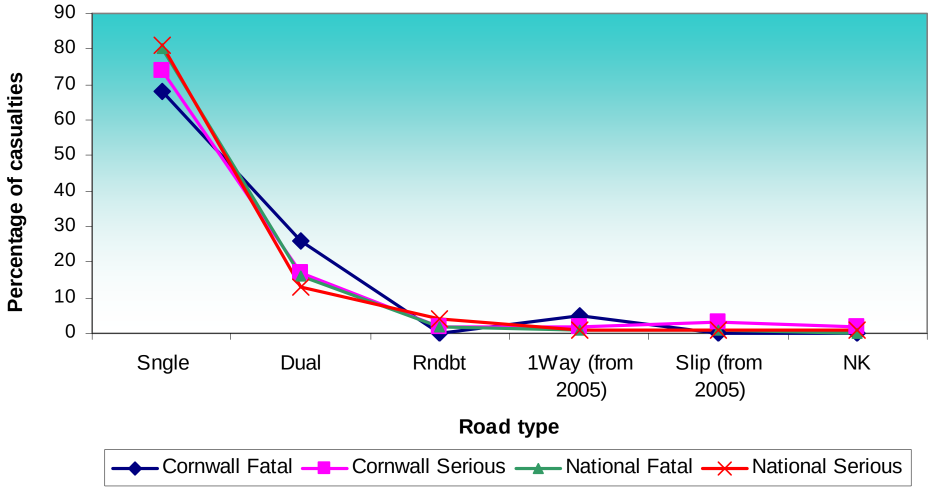

Figure 12 Older driver casualties – percentage distribution by road type (NK refers to those not know)

Urban/rural roads

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal and serious collisions occurred on rural roads (nationally; 75% of fatal and 60% of serious and locally; 94% of fatal and 90% of serious) than urban roads (Figure 13).

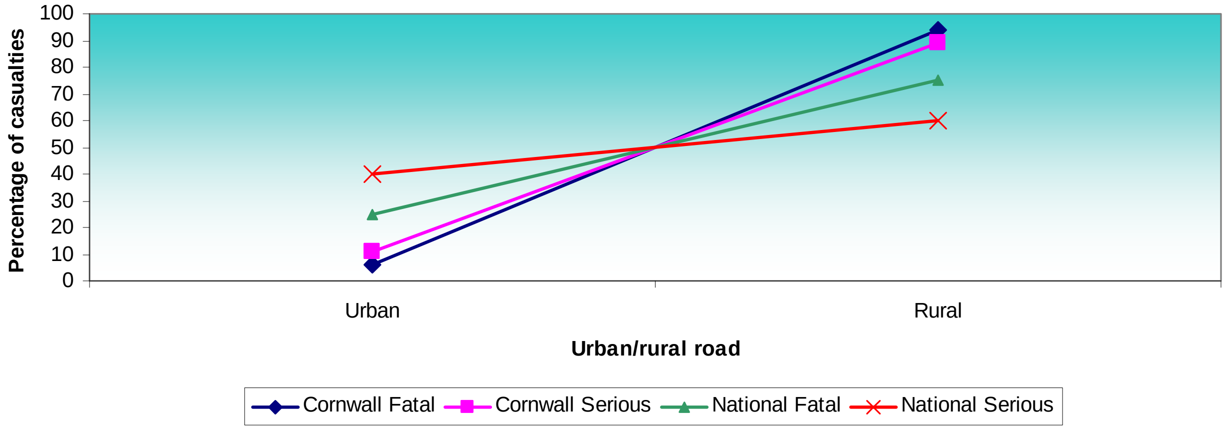

Figure 13 Older driver casualties – percentage distribution by urban/rural road

Junction type

Nationally, from 2004-2010, and locally, from 2001-2010, just under half of all serious collisions, and even more fatal collisions (67% of fatal and 55% of serious) occurred at a junction. (Not within 20M refers to those collisions more than 20M away from a junction) Of these collisions that did occur at a junction mostly occurred at T & stag junctions (average of 30%). Locally, there were also a high number of fatal collisions at crossroads (20%) (Figure 14).

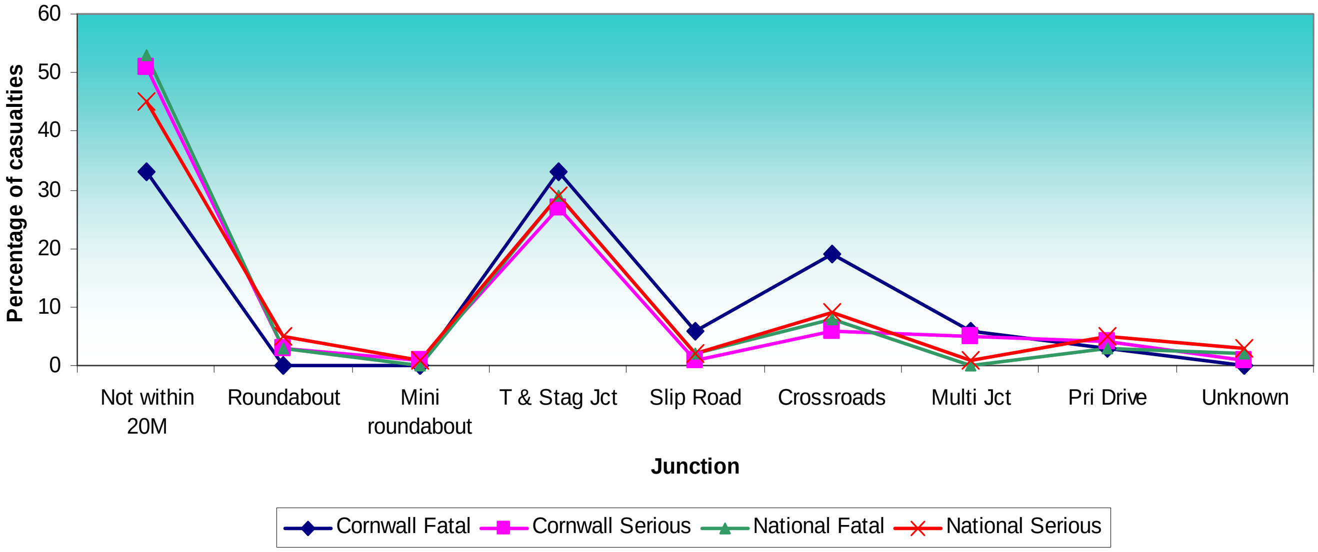

Figure 14 Older driver casualties – percentage distribution by junction type

3.1.3 Circumstances

Weather

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred when the weather was fine and still (85%). (Figure 15).

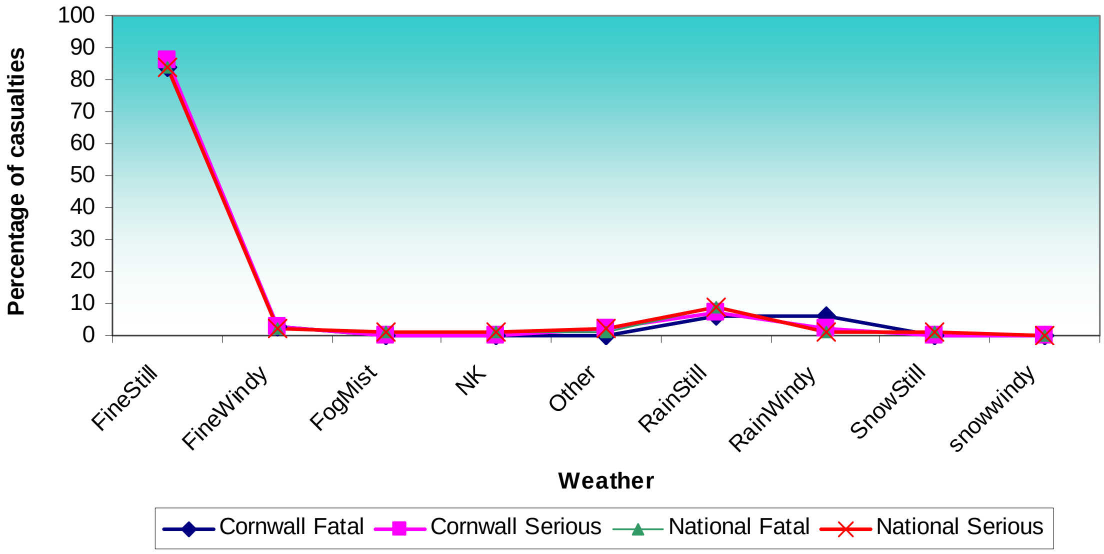

Figure 15 Older driver casualties – percentage distribution by weather

Road surface

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred when the road surface was dry (average of 68%). A relatively high number of collisions also occurred when the road surface was wet/damp (average of 32%) (Figure 16).

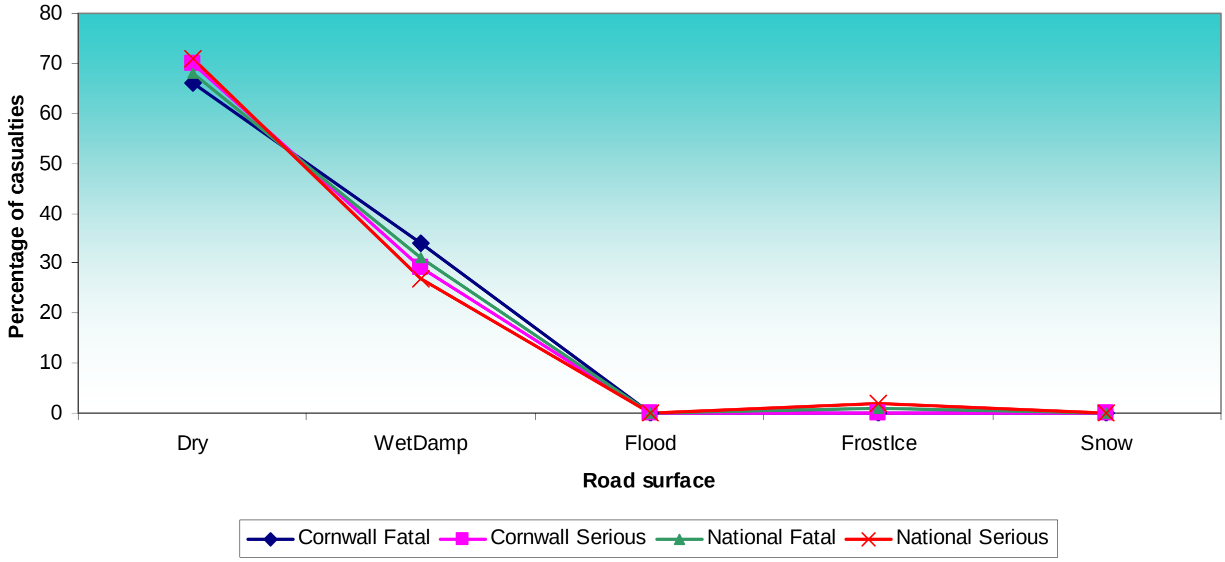

Figure 16 Older driver casualties – percentage distribution by road surface

3.1.4 Contributory Factors

Contributory factor is a term used in the STATs19 form to describe and factors that may have contributed to the collisions by any of the individuals involved or conditions on that day, for example, driver error, weather conditions and road surface.

Cornwall's most common contributory factors for both fatal and serious collisions, from 2001-2010, are shown in the tables below. For fatal collisions (Table 1) 20% of the collisions were due to the driver failing to judge other persons speed or path, 20% were due to the driver failing to look properly, and 10% were due to a poor turn or manoeuvre.

Ranking	Description	Count
1	Failed to judge other persons path or speed	6
2	Failed to look properly	6
3	Poor turn or manoeuvre	3
4	Disobeyed Give Way or Stop sign or markings	2
5	Rain, sleet, snow, or fog	2
6	Illness or disability, mental or physical	2
7	Fatigue	1
8	Junction restart	1
9	Spray from other vehicles	1
10	Impaired by drugs (illicit or medicinal)	1
11	Loss of control	1
12	Road layout (eg bend, winding road, hill crest)	1
13	Illegal turn or direction of travel	1

14	Aggressive driving	1
15	Swerved	1

Table 1 Local older driver fatal casualties – top contributory factors

For serious collisions (Table 2) 16% of collision were caused by the driver failing to look properly, 15% were caused by the driver failing to judge another persons path or speed, 11% were caused by loss of control and 9% were caused by a poor turn or manoeuvre.

Ranking	Description	Count
1	Failed to look properly	12
2	Failed to judge other persons path or speed	11
3	Loss of control	8
4	Poor turn or manoeuvre	7
5	Disobeyed Give Way or Stop sign or markings	6
6	Travelling too fast for conditions	6
7	Junction overshoot	4
8	Swerved	4
9	Exceeding speed limit	3
10	Road layout (eg bend, winding road, hill crest)	3
11	Illness or disability, mental or physical	3
12	Junction restart	2
13	Dazzling sun	2
14	Following too close	2
15	Slippery road (due to weather)	2

Table 2 Local older driver serious casualties – top contributory factors

3.1.5 Who

Casualty gender

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal and serious casualties were male (nationally; 76% of fatal and 68% of serious and locally; 84% of fatal and 76% of serious) than female (Figure 17).

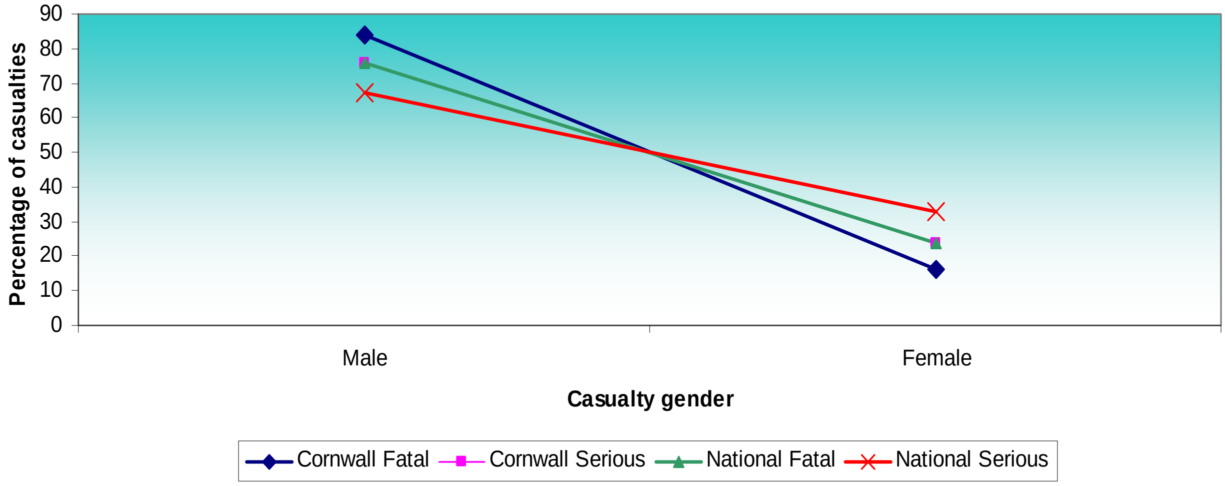

Figure 17 Older driver casualties – percentage distribution by casualty gender

Casualty age

Nationally, from 2004-2010, most older driver fatal and serious casualties were between 65-74 years of age (55% fatal and 54% serious). Locally, from 2001-2010, most older driver fatal and serious casualties were between 75-84 years of age (53% fatal and 42% serious).

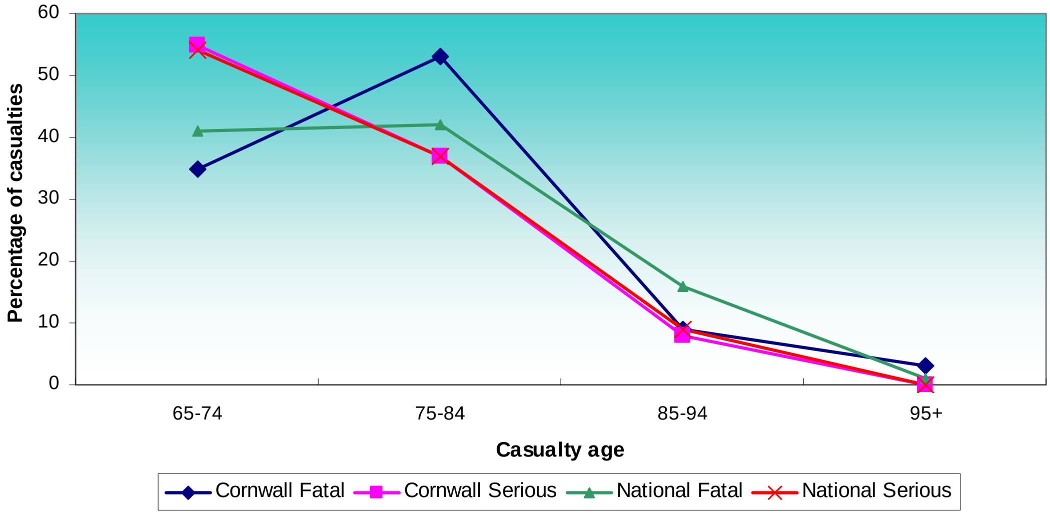

Figure 18 Older driver casualties – percentage distribution by casualty gender

3.1.6 Summary

Examination of local and national data suggests a number of key factors are related to older driver KSI casualty collisions:

- Collisions tend to occur during the week, between the hours of 9am-6pm, on rural, A class, single carriageway roads that have speed limits of 60 or 30 mph
- A high number of collisions occur at junctions, the most common being T and stag junctions, followed by crossroads
- Failing to judge another persons speed or path, failing to look properly, poor turn or manoeuvre, and loss of control were the key contributory factors
- Casualties tend to be predominately male between the age of 65-84 years

There were no differences between fatal and serious injury collisions.

3.2 Older passengers

3.2.1 When

Day of week

Nationally, from 2004-2010, most fatal collisions occurred on Saturdays (18%), followed by Fridays (16%) and Sundays (15%) and most serious collisions occurred on Fridays (17%) and Saturdays (16%). Locally, most serious collisions occurred during the week, specifically on Tuesdays (19%) and Wednesday (21%), with fewer occurring at the weekend (10% on Saturdays and 5% on Sundays). Fatal collisions were more varied with most collisions occurring on Mondays (20%), Tuesdays (20%), and Saturdays (20%) (Figure 19).

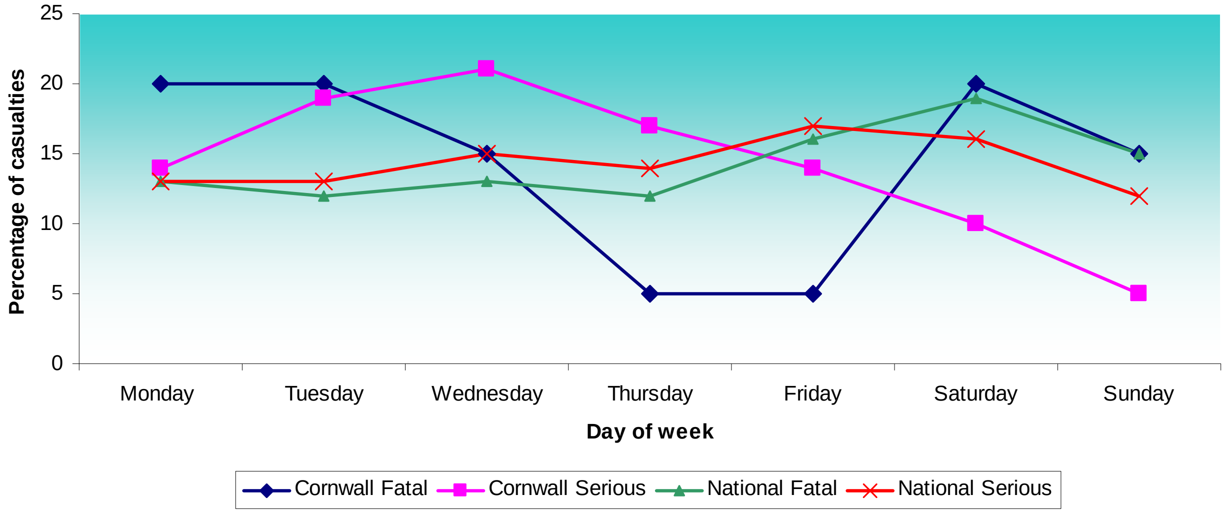

Figure 19 Older passenger casualties – percentage distribution by day of week

Time of day

Nationally, from 2004-2010, most fatal and serious collisions occurred during the day from 9am-6pm (81%). Locally, serious collisions also showed this pattern with 82% occurring during 9am-6pm. Most fatal collisions occurred during 3pm-6pm (30%), 9am-12pm (25%) and 9pm-12am (20%) (Figure 20).

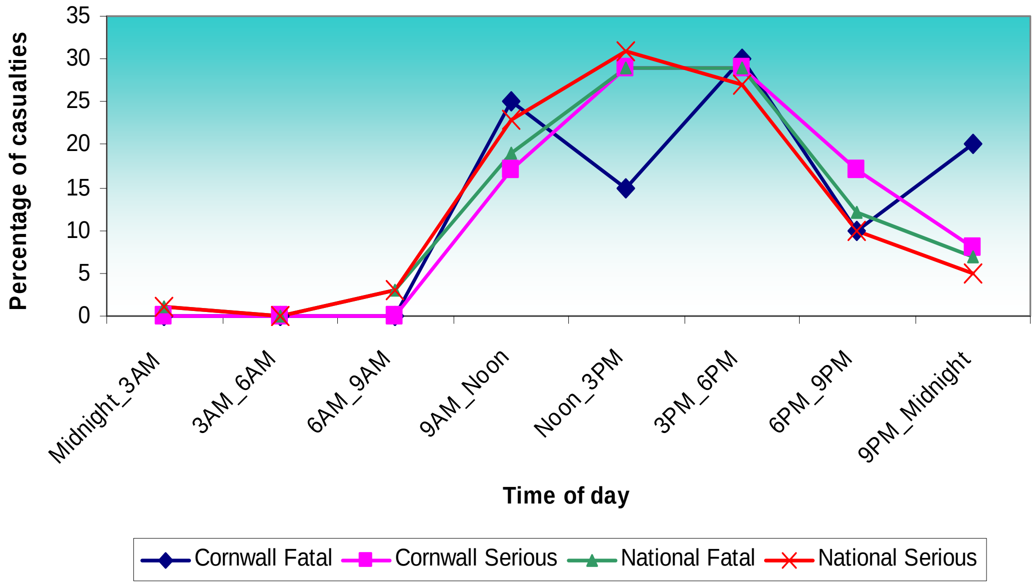

Figure 20 Older passenger casualties – percentage distribution by time of day

Month

Nationally, from 2004-2010, fatal and serious collisions occurred evenly across all months of the year. Locally, serious collisions also occurred relatively evenly however, there was more variation with fatal collisions which occurred most in June (20%), July (20%) and December (20%) (Figure 21).

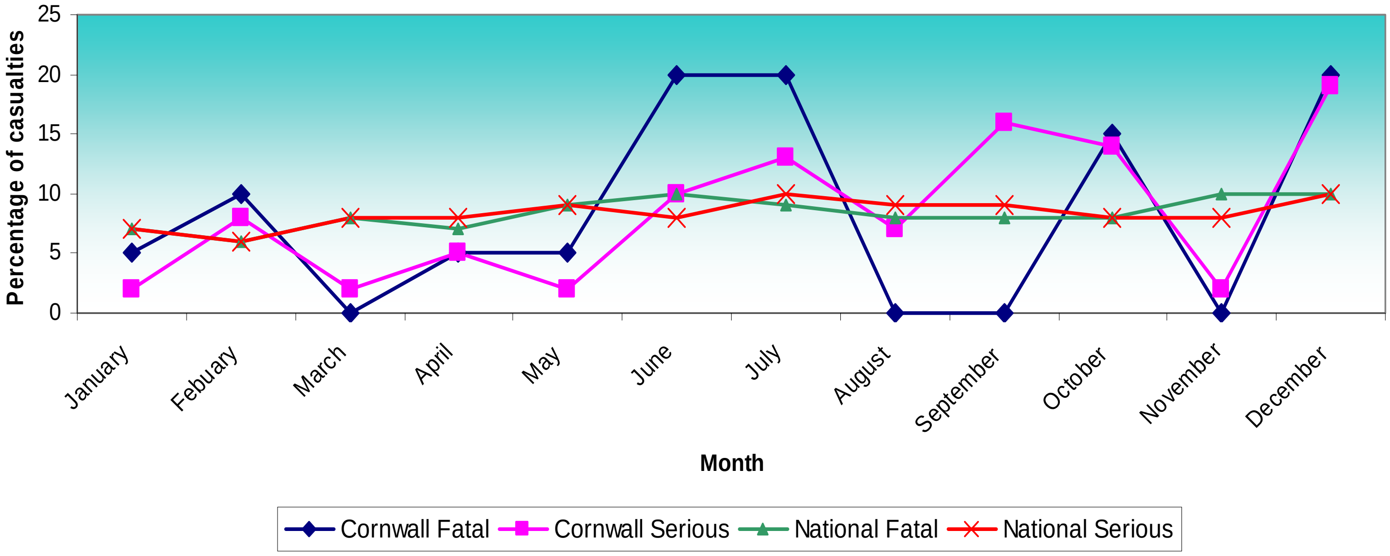

Figure 21 Older passenger casualties – percentage distribution by month

3.2.2 Where

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on A roads (nationally; 60% of serious and 52% of fatal and locally; 75% of fatal and 60% of serious). Locally, slightly more fatal collisions occurred on B roads (30%) than serious collisions (6%) and slightly more serious collisions occurred on C roads; minor roads with lower traffic volumes than A & B roads, (29%) than fatal collisions (13%). Nationally, slightly more serious collisions occurred on unclassified roads (21%) then fatal collisions (11%) (Figure 22).

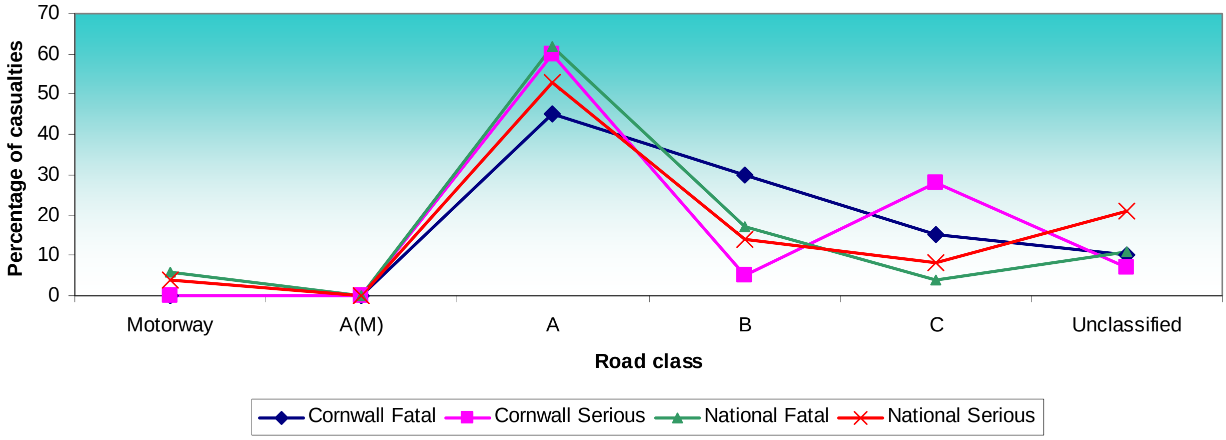

Figure 22 Older passenger casualties – percentage distribution by road class

Speed limit

Nationally, from 2004-2010, most fatal collisions occurred on 60mph roads (45%). A high number of serious collisions also occurred on 60mph roads (30%) but most occurred on 30mph roads (50%). Locally, most fatal and serious injury collisions occurred on 60mph roads (65% fatal and 62% serious), followed by 30mph roads (22% serious and 22% fatal) (Figure 23).

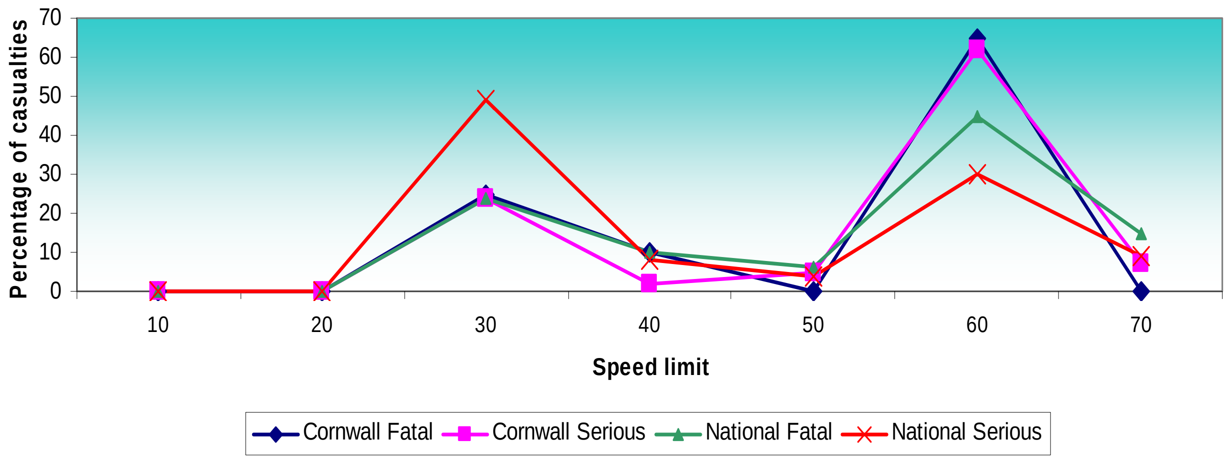

Figure 23 Older passenger casualties – percentage distribution by speed limit

Road type

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on single carriageway roads (nationally; 69% of fatal and 81% of serious and 100% of fatal and 81% of serious locally) (Figure 24).

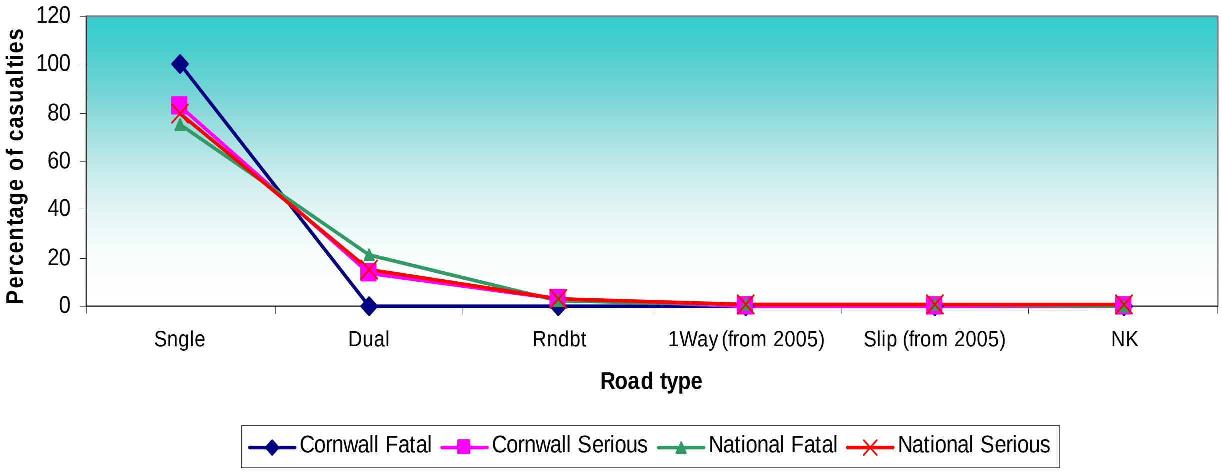

Figure 24 Older passenger casualties – percentage distribution by road type (NK refers to those collisions where the road type in not known)

Urban/rural roads

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal and serious collisions occurred on rural roads (nationally; 73% of fatal and 52% of serious and locally; 90% of fatal and 83% of serious) than urban roads (Figure 25).

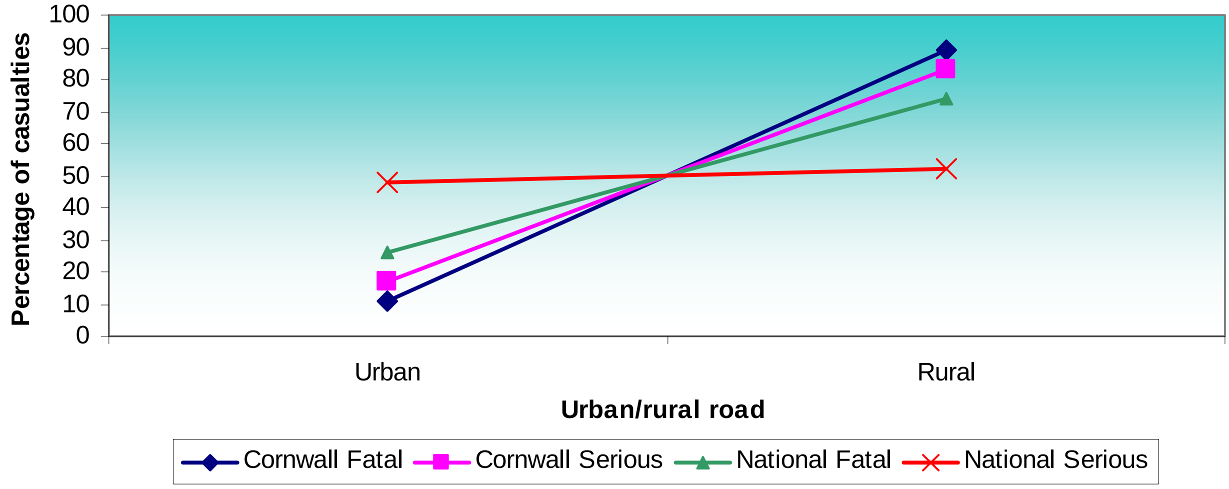

Figure 25 Older passenger casualties – percentage distribution by urban/rural road

Junction type

Nationally, from 2004-2010, around half of fatal and serious collisions occurred at a junction. Locally, from 2001-2010, 60% of serious but only 40% of fatal collisions occurred at junctions. Collisions that did occur at a junction mostly occurred at T & stag junctions (nationally; 25% of fatal and 29% of serious and locally 5% of fatal and 31% of serious). There were also a relatively high number of collisions at crossroads (nationally; 9% of fatal and 10% of serious and locally; 5% of fatal and 11% of serious). 5% of fatal collisions locally also occurred on private drives (Figure 26).

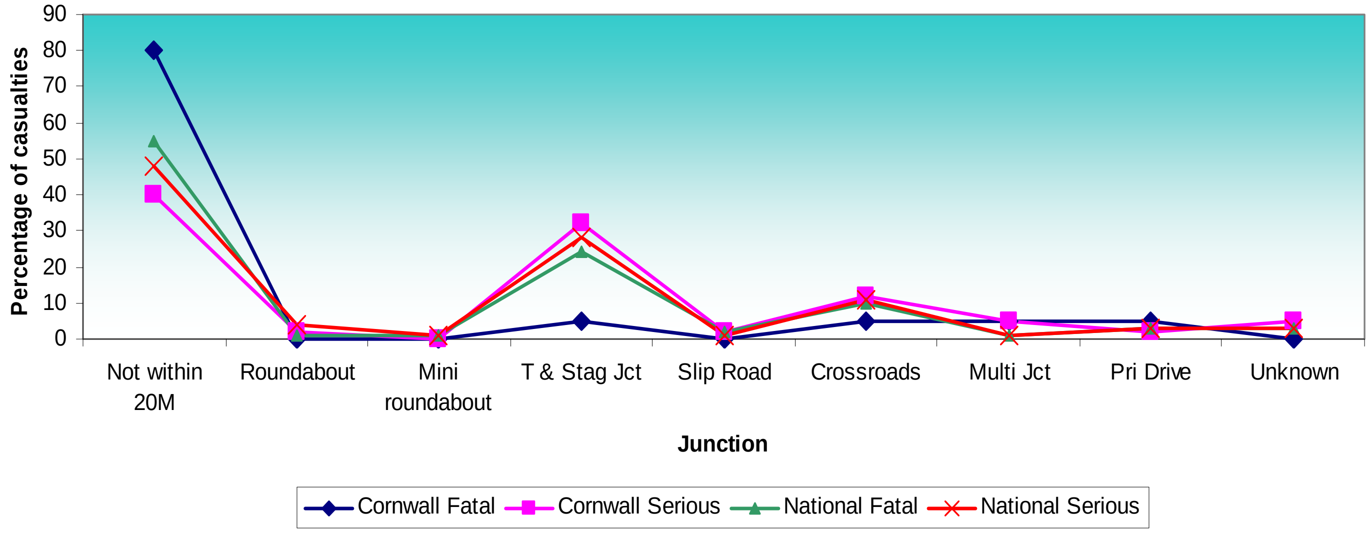

Figure 26 Older passenger casualties – percentage distribution by junction type (not within 20M refers to those collisions more than 20M away from a junction)

3.2.3 Circumstances

Weather

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred when the weather was fine and still (85%). (Figure 27)

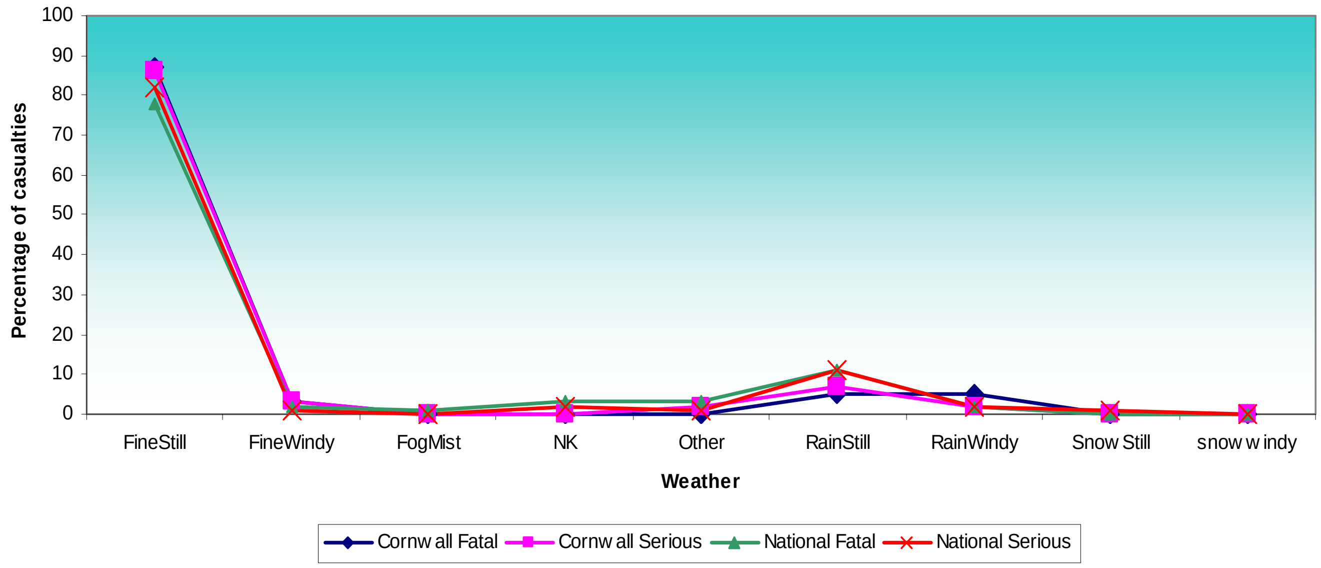

Figure 27 Older passenger casualties – percentage distribution by weather

Road surface

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred when the road surface was dry (nationally; 64% of fatal and 71% of serious, locally; 56% of fatal and 69% of serious). A relatively high number of collisions also occurred when the road surface was wet/damp (nationally; 33% of fatal and 28% of serious, locally 40% of fatal and 28% of serious) (Figure 28).

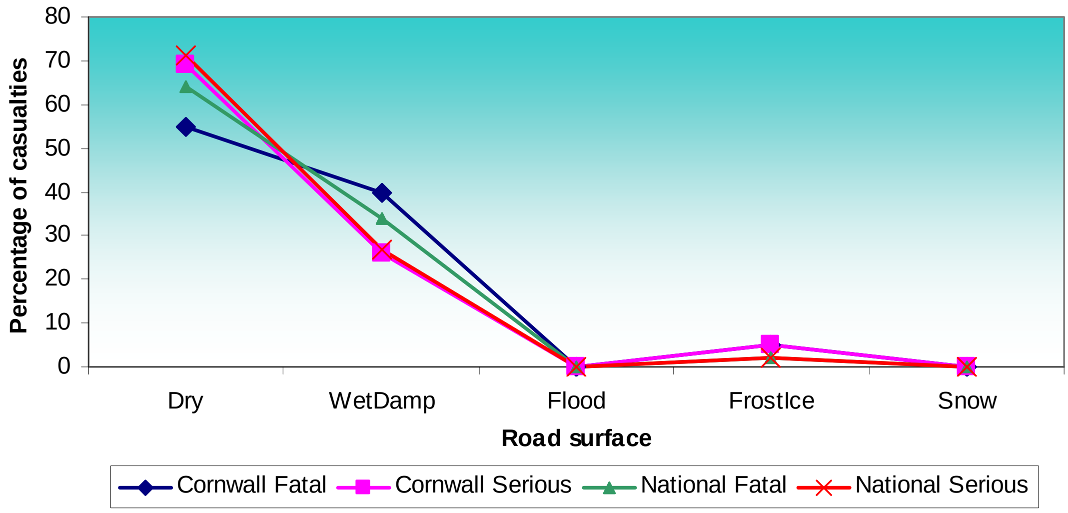

Figure 28 Older passenger casualties – percentage distribution by road surface

3.2.4 Contributory factors

Cornwall's most common contributory factors for both fatal and serious collisions, from 2001-2010, are shown in the tables below. For fatal collisions (Table 3) 16% of the collisions were due to the loss of control, 11% were due to the road layout, and 11% were due to vegetation.

Ranking	Description	Count
1	Loss of control	3
2	Road layout (eg bend, winding road, hill crest)	2
3	Vegetation	2
4	Other	1
5	Animal or object in carriageway	1
6	Illness or disability, mental or physical	1
7	Poor turn or manoeuvre	1
8	Failed to look properly	1
9	Exceeding speed limit	1
10	Slippery road (due to weather)	1
11	Inadequate/Masked signs or road markings	1
12	Fatigue	1
13	Impaired by drugs (illicit or medicinal)	1
14	Failed to judge other persons path or speed	1
15	Travelling too fast for conditions	1

Table 3 Local older passenger fatal casualties – top contributory factors

For serious collisions (Table 4) 16% of collision were caused by the driver failing to look properly, 17% were caused by loss of control, 13% were caused by the driver failing to judge another persons path or speed, 13% were caused by a poor turn or manoeuvre, and 10% were caused by a vehicle swerving.

Ranking	Description	Count
1	Loss of control	5
2	Failed to judge other persons path or speed	4
3	Poor turn or manoeuvre	4
4	Swerved	3
5	Aggressive driving	2
6	Travelling too fast for conditions	2
7	Failed to look properly	2
8	Slippery road (due to weather)	1
9	Illness or disability, mental or physical	1
10	Disobeyed Give Way or Stop sign or markings	1
11	Inadequate/Masked signs or road markings	1
12	Junction overshoot	1
13	Impaired by drugs (illicit or medicinal)	1
14	Exceeding speed limit	1
15	Junction restart	1

Table 4 Local older passenger serious casualties – top contributory factors

3.2.5 Who

Casualty gender

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal and serious casualties were female (nationally; 72% of fatal and 81% of serious and locally; 60% of fatal and 60% of serious) than male (Figure 29).

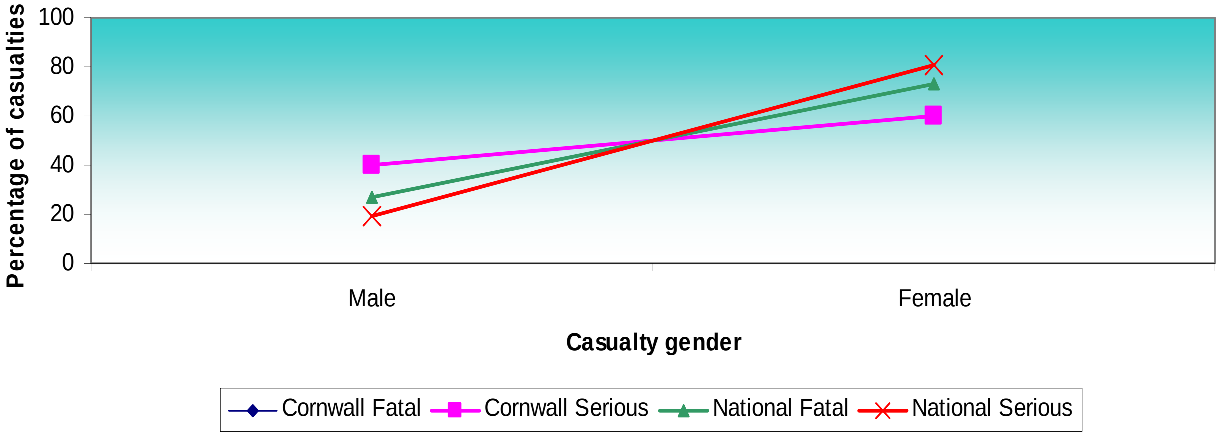

Figure 29 Older passenger casualties – percentage distribution by casualty gender

Casualty age

Nationally, from 2004-2010, most serious passenger casualties were aged between 65-74 years (46%), however, most fatal passenger casualties were aged between 75-84 years (43%). Locally, from 2001-2010, most fatal and serious passenger casualties were aged between 65-74 years (47% fatal and 52% serious) (Figure 30).

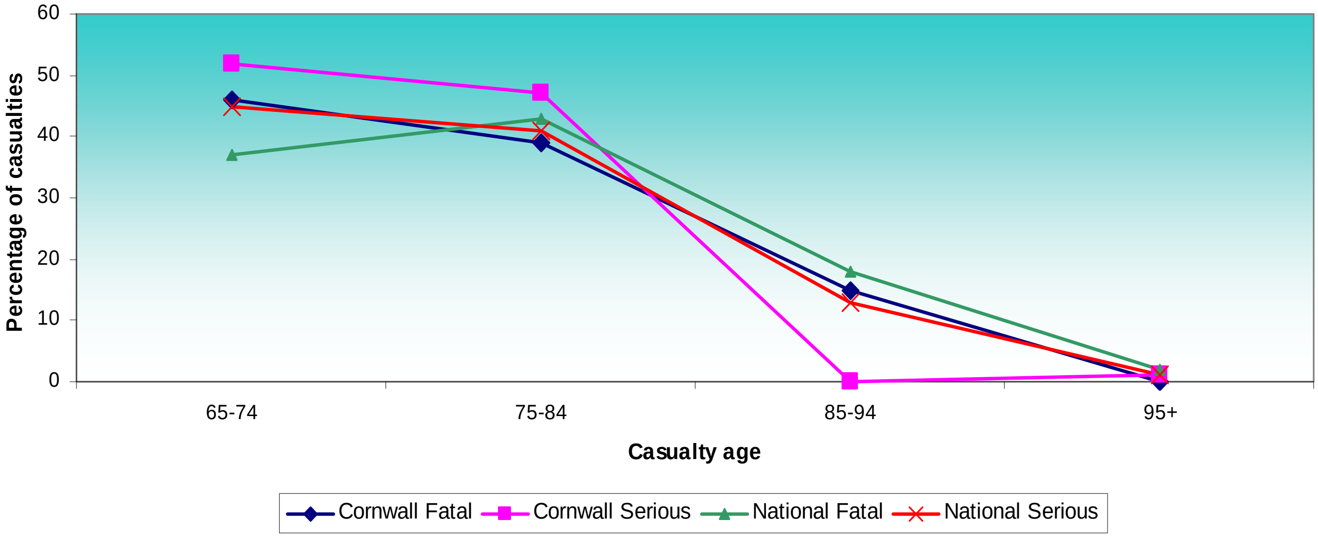

Figure 30 Older passenger casualties – percentage distribution by casualty age

Driver gender and age

The sex and age of the driver of passenger casualties aged 65 and over was identified in Cornwall.

Gender

Locally, from 2001-2010, males were the most common drivers of collisions which resulted in a fatal passenger casualty aged 65 and over (76%) and females were the most common drivers of collisions which resulted in a serious passenger casualty aged 65 and over (70%) (Figure 31).

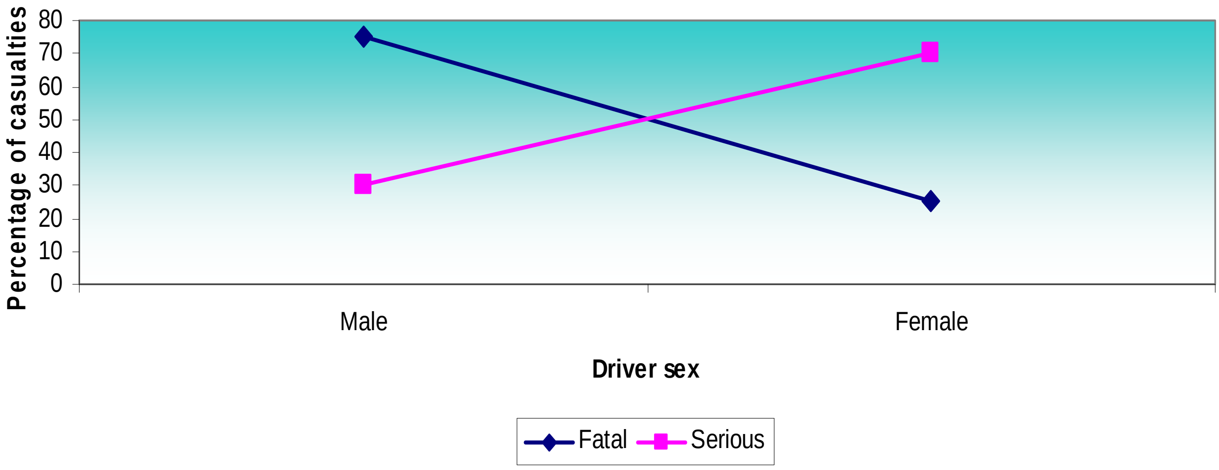

Figure 31 Older passenger casualties – percentage distribution by driver sex

Age

Locally, from 2001-2010, most collisions that resulted in a fatal older passenger casualty had drivers aged between 55-74 years (25% 55-64 years and 25% 65-74 years), most collisions that resulted in a serious older passenger casualty had drivers aged between 75-84 years (Figure 32).

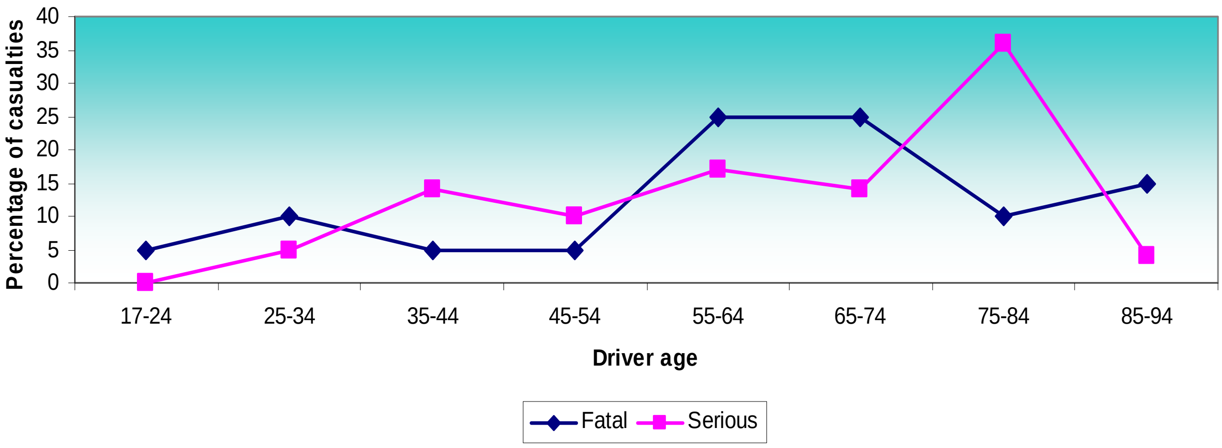

Figure 32 Older passenger casualties – percentage distribution by driver age

3.2.6 Summary

Examination of local and national data suggests a number of key factors are related to older passenger casualty collisions:

- Collisions tend to occur during the day between 9am-6pm on rural, A class, single carriageway roads that have a speed limit of 60 or 30mph
- A high number of collisions occur at junctions, the most common being T and stag junctions, followed by crossroads
- Loss of control was a key contributory factor
- Casualties tend to be predominantly female aged 65-84 years of age

Differences between fatal and serious injury collisions:

- Locally, drivers of fatal older passenger casualty collisions tend to be predominately male and aged between 53-74 years whilst drivers of serious injury collisions tend to be predominately females aged 75-84 years

3.3 Older pedestrians

3.3.1 When

Day of week

Nationally, from 2004-2010, a greater proportion of fatal and serious collisions occurred on week days (daily average of 16%) than weekends (average of 12% on Saturdays and 6% on Sundays). Locally, from 2001-2010, both fatal and serious collisions are much more varied across the week (Figure 33).

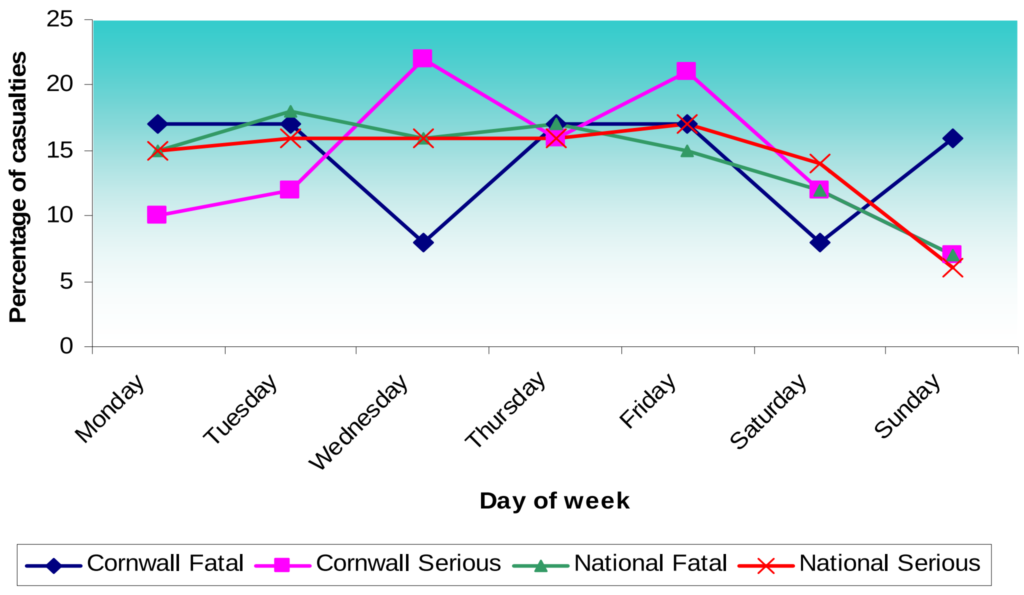

Figure 33 Older pedestrian casualties – percentage distribution by day of week

Time of day

Nationally, from 2004-2010, and locally, from 2001-2010, most collisions occurred between 9am and 6pm (nationally; 79% of fatal and 70% of serious and locally; 50% of fatal and 85% of serious) with a peak between 9am-12pm (nationally; 25% of fatal and 30% of serious and locally; 25% of fatal and 36% of serious). Again, locally there is slightly more variation with another peak in serious collisions between 3pm-6pm (25%) and fatal collisions between 6pm-9pm (25%) (Figure 34).

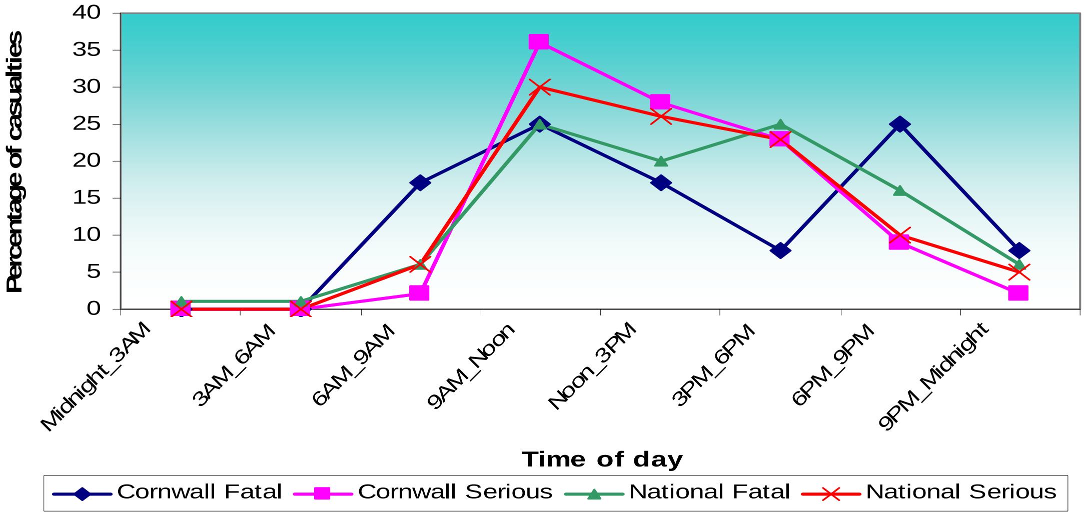

Figure 34 Older pedestrian casualties – percentage distribution by time of day

Month of the year

Nationally, from 2004-2010, and locally, from 2001-2010, a higher proportion of collisions occur during the winter and autumn months (average of 32% in winter and 30% in autumn nationally and 33% in winter and 22% in autumn locally). Locally, fatal collisions also have a high number of collisions in the spring months (41%) (Figure 35).

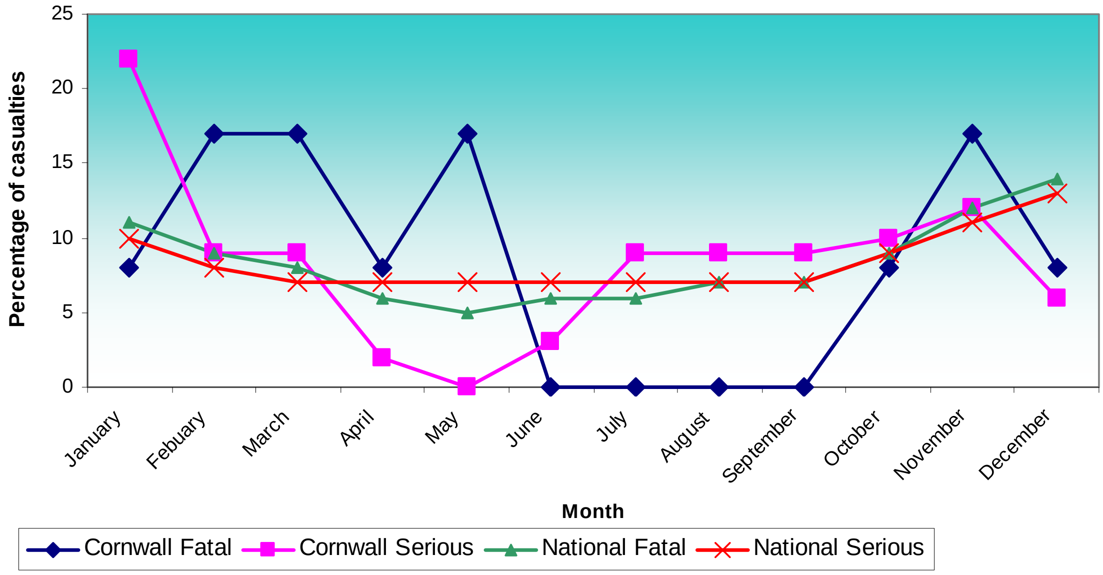

Figure 35 Older pedestrian casualties – percentage distribution by month

3.3.2 Where

Road class

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal collisions occurred on A roads (50% nationally and 59% locally). Serious collisions, both nationally and locally, also had a peak on A roads (36% nationally and 27% locally) but locally more serious collisions occurred on C roads (35%) and nationally more serious collisions occurred on unclassified roads (42%) (Figure 36).

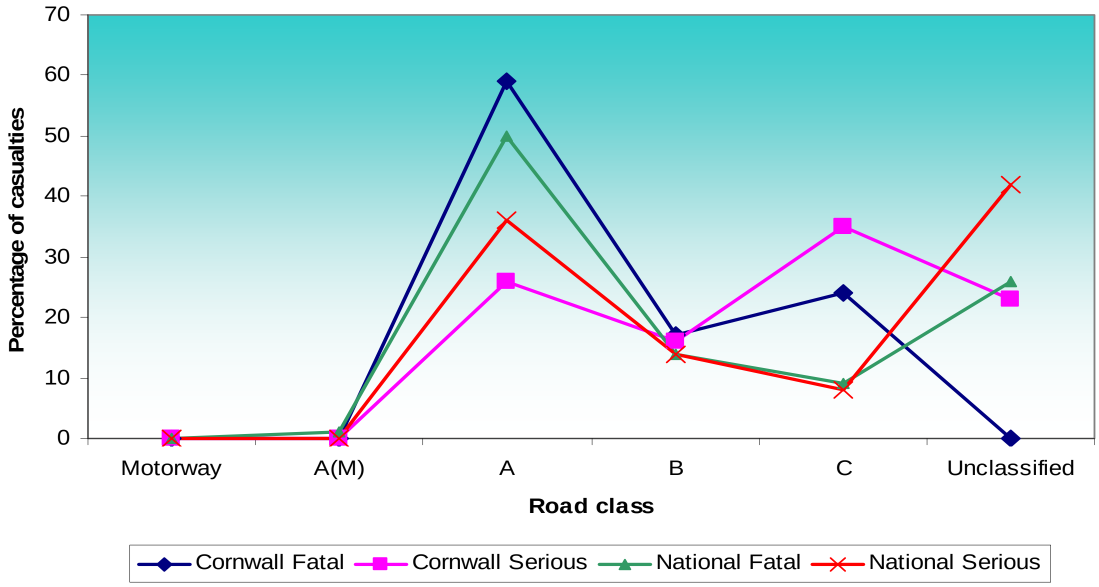

Figure 36 Older pedestrian casualties – percentage distribution by road class

Speed limit

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on 30mph roads (averages of 70% locally and 84% locally). Locally, fatal collisions also showed a peak on 60mph roads (31%) (Figure 37).

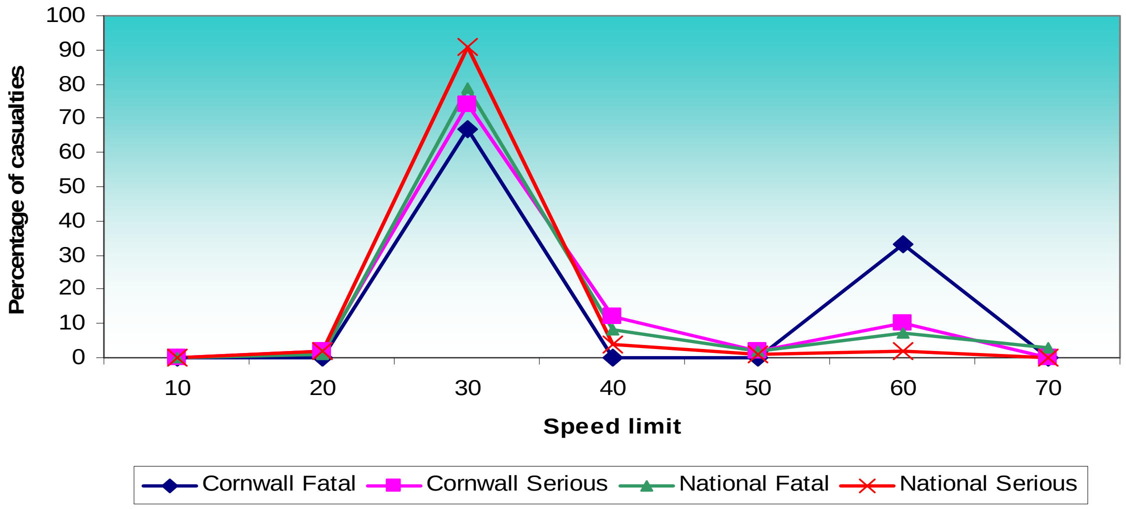

Figure 37 Older pedestrian casualties – percentage distribution by speed limit

Road type

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred on single carriageway roads (average of 79%) (Figure 38).

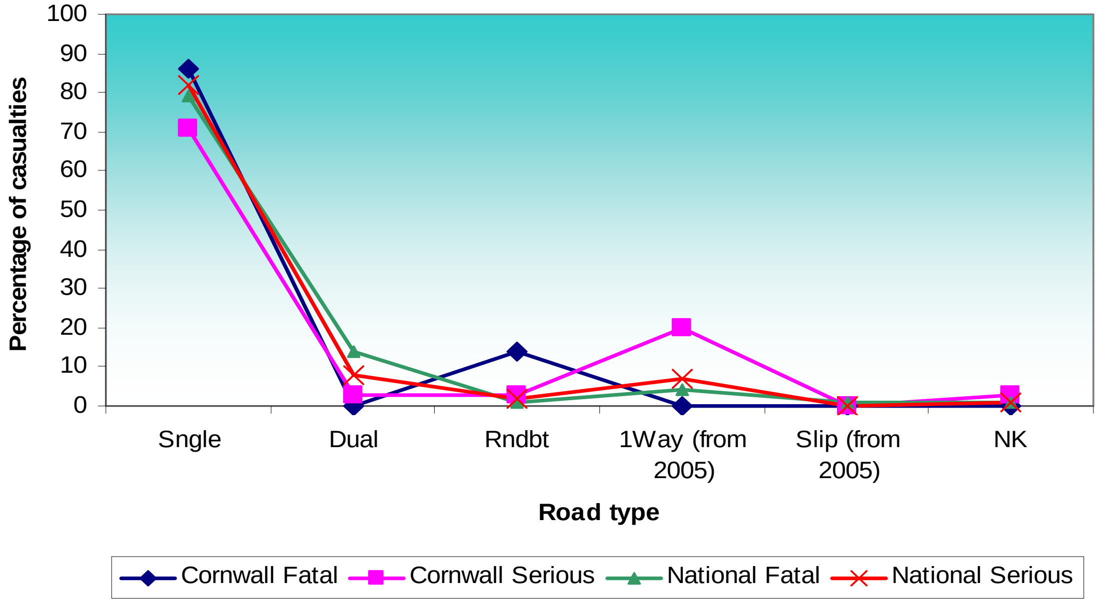

Figure 38 Older pedestrian casualties – percentage distribution by road type (NK refers to those collisions where the road type in not known)

Urban/rural roads

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal collisions occurred on urban roads (88% nationally and 71% locally) than rural roads. Nationally, more serious collisions also occurred on urban roads (79%) than rural roads, however, locally, more serious collisions occurred on rural roads (55%) than urban roads (Figure 39).

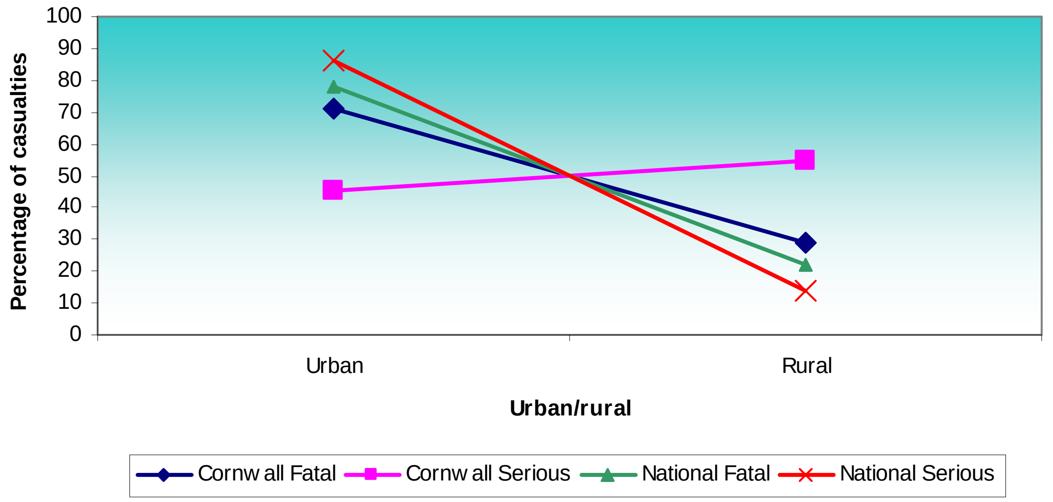

Figure 39 Older pedestrian casualties – percentage distribution by urban/rural road

Junction type

Nationally, from 2004-2010, around 60% of fatal and serious collisions occurred at a junction, locally, from 2001-2010, only 40% occurred at a junction. Collisions that did occur at a junction the most common type, nationally and locally, were T & stag junctions (38% nationally and 25% locally). Nationally, there was also a peak of fatal and serious collisions at crossroads (10%) and locally a peak of fatal collisions occurred at private drives (9%) (Figure 40).

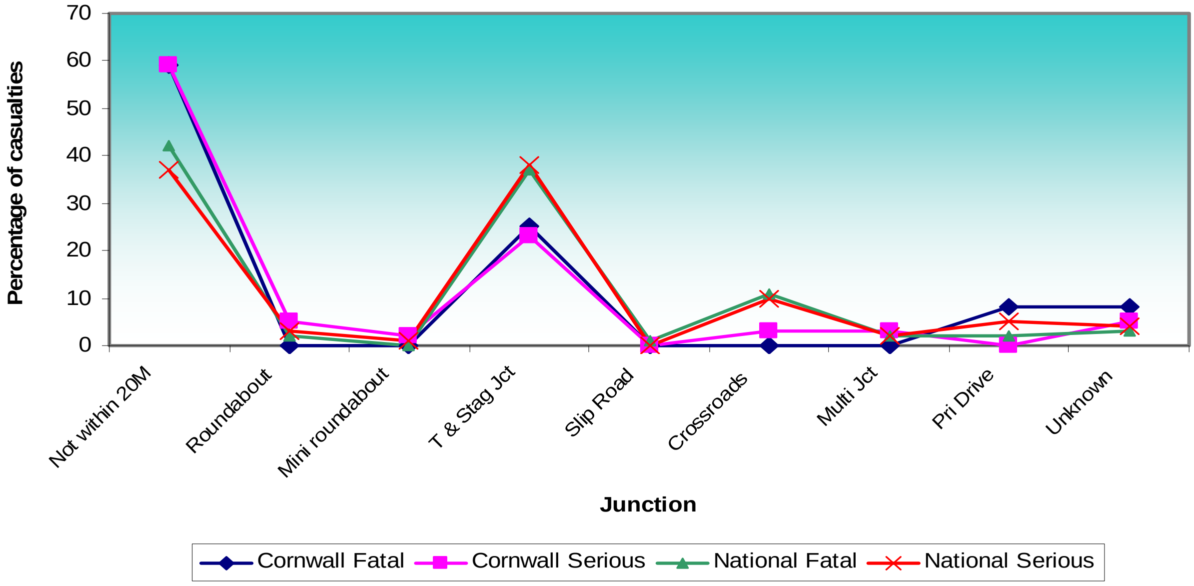

Figure 40 Older pedestrian casualties – percentage distribution by junction type (not within 20M refers to those collisions more than 20M away from a junction)

Casualty location

Nationally, from 2004-2010, most fatal and serious collisions occurred when the pedestrian was crossing the road not at a pedestrian crossing (50%). Locally, most serious collisions also occurred when the pedestrian was crossing the road not at a pedestrian crossing (50%) however, fatal collisions were slightly more varied; 30% were on a pedestrian crossing, 18% were crossing elsewhere, 18% were not crossing, and 17% were standing in the centre of a crossing (Figure 41).

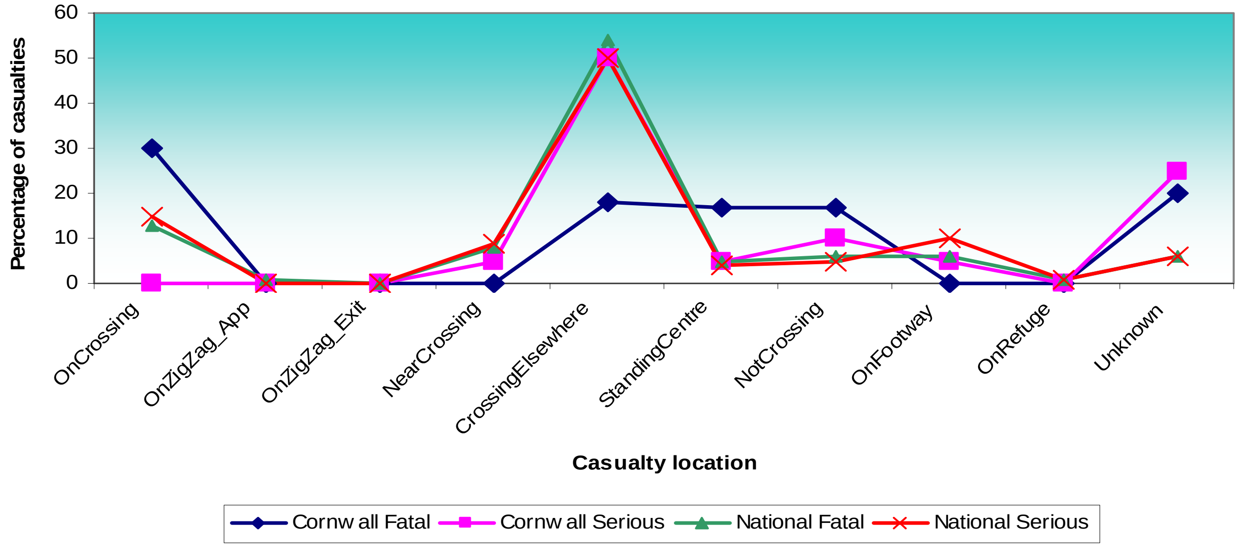

Figure 41 Older pedestrian casualties – percentage distribution by casualty location

3.2.3 Circumstances

Weather

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious collisions occurred when the weather was fine and dry (average 81% nationally and 75% locally). (Figure 42).

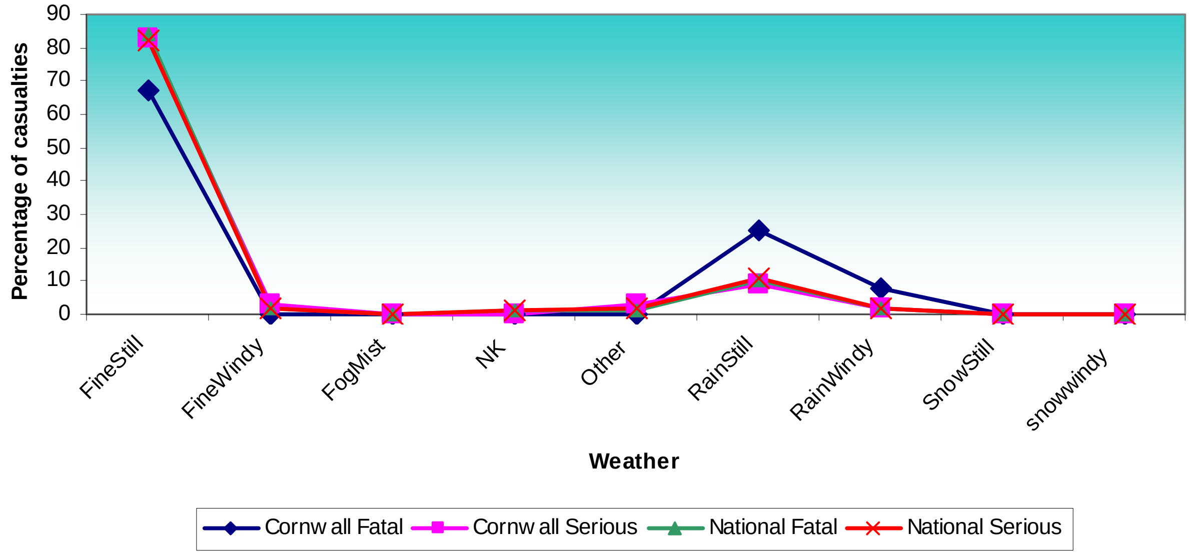

Figure 42 Older pedestrian casualties – percentage distribution by weather

3.2.4 Contributory factors

Cornwall's most common contributory factors for both fatal and serious collisions are shown in the table below. For fatal collisions (Table 5) 50% of the contributory factors were the fault of the pedestrian, 36% were the fault of the driver/rider and 12% were due to environmental factors.

Ranking	Description	Count
1	Driver failed to look properly	1
2	Pedestrian wearing dark clothing at night	1
3	Disobeyed pedestrian crossing facility	1
4	Travelling too fast for conditions	1
5	Pedestrian disability or illness, mental or physical	1
6	Wrong use of pedestrian crossing facility	1
7	Pedestrian failed to look properly	1
8	Dazzling sun	1

Table 5 Local older pedestrian fatal casualties – top contributory factors

For serious collisions (Table 6) the most common contributory factor was the pedestrian failing to look properly (18%), followed by the driver failing to look properly (15%) and the pedestrian failing to judge the vehicles path or speed (13%). Overall 43% of contributory factors were the fault of the pedestrian, 43% were the fault of the driver/rider and 14% were due to environmental factors.

Ranking	Description	Count
1	Pedestrian failed to look properly	11
2	Driver failed to look properly	9
3	Pedestrian failed to judge vehicles path or speed	8
4	Driver was careless/reckless/in a hurry	5
5	Driver failed to judge other persons path or speed	4
6	Pedestrian disability or illness, mental or physical	4
7	Other	3
8	Driver distraction outside vehicle	3
9	Slippery road (due to weather)	3
10	Road layout (eg bend, winding road, hill crest)	2
11	Inexperienced or learner driver/rider	2
12	Wrong use of pedestrian crossing facility	2
13	Travelling too fast for conditions	2
14	Poor turn or manoeuvre	1
15	Pedestrian impaired by alcohol	1

Table 6 Local older pedestrian serious casualties – top contributory factors

3.1.5 Who

Casualty gender

Nationally, from 2004-2010, and locally, from 2001-2010, more fatal casualties were male (52% nationally, 72% locally) than female but more serious casualties were female (56% nationally, 55% locally) than male (Figure 43).

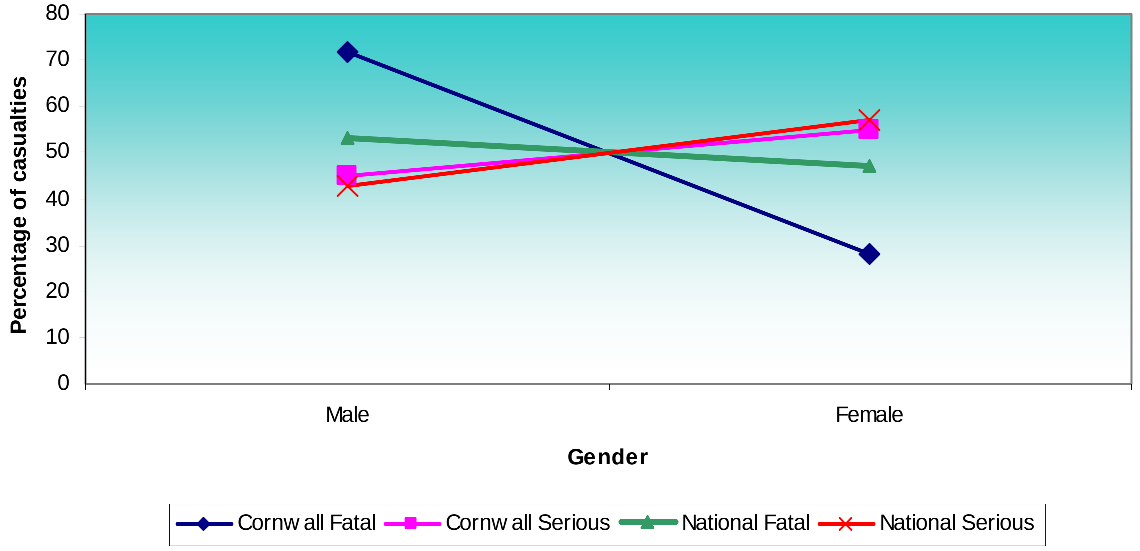

Figure 43 Older pedestrian casualties – percentage distribution by casualty gender

Casualty age

Nationally, from 2004-2010, and locally, from 2001-2010, most fatal and serious pedestrian casualties were aged between 75-84 years (national; 47% fatal and 42% serious, local; 60% fatal and 43% serious) (Figure 44).

Figure 44 Older pedestrian casualties – percentage distribution by casualty age

3.3.6 Summary

Examination of local and national data suggests a number of key factors are related to older pedestrian casualty collisions:

- Collisions tend to occur during the day between 9am-6pm on urban, A class, single carriageway roads that have a speed limit of 30mph

- Locally, a high proportion of casualties occurred on C class roads whilst nationally a high proportion of casualties occurred on unclassified roads
- A high number of collisions occur at junctions, the most common being T and stag junctions, followed by crossroads
- Most collisions occurred when the pedestrian was crossing the road elsewhere (not at a pedestrian crossing)
- Pedestrian failing to look properly, driver failing to look properly, pedestrian failing to judge the vehicles speed or path were the key contributory factors

Differences between fatal and serious injury collisions:

- Locally, a higher proportion of fatal collisions occurred on private drives than serious injury collisions

3.4 Overall summary and recommendations

Overall, collisions involving older road users tend to occur during the day between 9am-6pm on A class, single carriageway roads that have speed limits of 60 or 30mph. Car occupant collisions occur mostly on rural roads, however, pedestrian collisions occur mostly on urban roads. All three road users are involved in a high number of collisions at junctions, particularly stag and T junctions. Failing to judge another persons speed or path, failing to look properly and loss of control were key contributory factors. Driver casualties were predominately male, compared to passenger casualties who were predominantly female. Pedestrian casualties had a slightly more even gender divide. It is worth noting that a lot of these higher counts may just measure older driver, passenger and pedestrian usage, i.e. more older road users on those roads at those times.

A recommendation can be made from the evidence:

- Initiatives could target older road users judgement of other vehicles speed and path, looking properly when crossing the road and driving and loss of control as these were key contributory factors in older road user collisions

4

Older road users

This next section examines the factors that may lead to older road users being vulnerable to fatal and serious injury collisions. This will help determine what initiatives could focus on to help increase older road users safety.

4.1 Aging and collision risk

The biological processes of aging impair a number of functions that are relevant to road user's behaviour. It is important to note that although findings are considered in averages, there are huge variations between people in these functions, and these variations increase with age. For example; some 80 year olds have 20/20 vision, whilst some have become blind. [10]

Age-related impairments suffered by older road users' fall into four key categories:

- Physical
- Cognitive
- Sensory
- Psychological/personality

Physical

Physical impairments include restricted mobility and joint movements, particularly of the head and neck.[1] As people age the moveable range of the neck and waist, and their grasping ability are reduced.[23] This may prevent drivers from adequately scanning and checking their surroundings in the driving environment and may cause problems in turning the steering wheel, or their heads.[1] Physical impairments may also affect the walking of older pedestrians. Older people have been found to cross the road slower than younger people. Through observations at zebra crossings it was found elderly people (over 60) took an average of 1.16m/s to cross the road, compared to 1.72m/s for young people.[24] In the USA, older adults (over 65 years) also tended to cross signal-controlled intersections more slowly than younger adults.[25] These findings also showed that older adults had a slower start up time (average of 2.48s) than younger adults (average of 1.93s). The slower speeds of older adults may be due to being less strong; however, the largest reductions in walking speed appear to be caused by illness.[26,27]

Cognitive

Cognitive age related declines refer to the difficulties experienced with processing information. As people age their reaction time tends to get slower. One study examined reaction times in young and older (60 years and over) participants using signal detection tasks. Results showed older people took longer to detect and respond to signals than younger people.[28] As complexity increases i.e. increases in selection alternatives and increases in swiftness response, the delay time of response becomes higher.[29] Older people also have greater difficulty with situations that require dividing attention between more than one task or piece of information, switching attention, complex visual search, and ignoring distracting information, particularly if it is moving.[30] Older people perform less well than younger people in complex selective attention tasks, for example having to find an item in an array of other items. When attention is diverted or attentional resources are diminished, collision risk for drivers has been found to increase significantly.[30] Useful Field of View (UFOV), the brains ability to take in and react to information at a single glance, has also been found to decrease with age.[31] Research has found a link between UFOV and collision risk in 53 older drivers. Other evidence has found UFOV explains more variance in collision risk than other measure such as visual acuity, and the relationship was stronger in collisions in which the older person was deemed to be at fault, and collisions at junctions. There is also some evidence linking pedestrian collisions to attention. Many pedestrians who are struck by cars report they looked but did not see the vehicle[32] and children who performed better on an executive function task were more likely to look at approaching traffic when crossing the road.[33] Older pedestrians have a heightened risk of being involved in collisions at junctions, and it is believed this is due to the greater complexity of junctions compared to other road situations.[34] Laboratory studies support this view that complex situations are more difficult for older people. Older pedestrians also have difficulty in selecting safe gaps to cross.[35] This appears to be a particular problem in complex environments, such as junctions,[36] and when vehicles are approaching at high speeds.[37,38] Research has found that while younger pedestrians chose constant time gaps, older people accept shorter and shorter time gaps as speed increases. Instead of basing their decisions on time gaps, as younger pedestrians do, older pedestrians seem to base their decisions primarily on the distance of the approaching vehicle.[37,38,39] This could be linked to a decline in motion perception, the ability to estimate time-of-arrival of approaching objects[40] or approaching cars.[40]

Sensory

Age-related sight and hearing problems may prevent driver's recognition of important road features, such as signage and marking. In a literature review, collision risk relating to visual function of drivers was considered. Studies examining the link between visual functions and collision risk were reviewed and if there was a lot of strong evidence showing a link between a visual function and risk than an association was suggested.[41] The table below shows the conclusions.

Function	**Relation to driving**	**Link to driving ability and collision risk**
Static acuity (the ability to see clearly when not moving and when looking at a non-moving object)	Identifying objects, reading signs, 'slows the action'	Weak association
Dynamic acuity (ability to see moving objects) Colour vision (ability to distinguish colours)	Dealing with moving objects Detecting and identifying coloured signals	Strong association No evidence for increased risk
Peripheral visual fields (ability to see objects and movement outside the direct line of vision)	Maintaining orientation and relationships among objects	Increased collision risk
Stereopsis (ability to judge depth) Night vision (ability to see when it is dark)	Depth perception under 500m, main cue in darkness Poorer acuity, night myopia, problems with glare	Weak evidence for increased risk Increased collision risk

Table 7 Relationship between visual function and driving[41]

In a UK travel survey 302 pedestrian volunteers who were registered blind or had some residual vision were questioned about their previous accidents. 24% had been involved in a collision whilst crossing the road, 93% had had an accident whilst walking and 33% had had an accident whilst climbing steps. These rates were much higher than the UK population generally. Although the general population rates may have been subject to under reporting, this evidence suggests the most severe vision problems increase pedestrian collision risk.[42] Other research has found older pedestrians with poor vision had difficulty distinguishing pedestrian signals across a wide road in New York, and detecting the boundary between the kerb and the roadway. This was found to lead to some collisions in which the pedestrian stepped off the kerb into the path of a moving vehicle. Crossing the road requires changes in perception of objects at different distances as objects, such as cars, are brought into focus.[43] Due to reduced elasticity of the eye lens, older people can not do this so readily.[44] Older people are less likely to be able to notice movement or track objects moving at a high speed. This could affect their reaction to vehicles that start to move and those moving at fast speeds. It could also affect their ability to negotiate the environment whilst moving themselves.[10] There is little direct evidence that changes in visual performance cause an increase in pedestrian collision rate. However, associations have been found with driving collisions and analysis of the tasks faced by pedestrians suggests these will also be important factors for pedestrians.

At 65 years, roughly 30% of hearing is lost.[45] The prevalence of sensorineural hearing loss, the ability to detect sounds, increases from 4% between 31 and 50 years old to 17% between 51 and 70, but rises to 62% in those over 70.[46] Hearing is used to work out where the source of the sound is coming from. Studies have found that older people are less able to identify the location of sounds.[47,48] Research suggests older people with hearing loss may have difficulty identifying the location of approaching vehicles coming from behind them,[43] or turning vehicles.[49] It may also reduce pedestrians feeling of security when crossing a road due to not having aural warning of anything approaching from a different direction unexpectedly.[50] However, the direct effect of hearing loss on pedestrian and driver risk is unclear.

Psychological/personality

Psychological problems such as anxiety may affect older road users confidence while driving or walking. Older people have reported being anxious about crossing the road. In a sample of 76 older pedestrians (over 56 years), 77% reported they were given enough time when crossing a signal-controlled junction, however, 45% reported normally experiencing anxiety about crossing in time, 55% said they frequently or always hurried across the street, and 87% increased pace further when the flashing signal was displayed.[43] There has been limited research into individual differences between older drivers and what there has been has had mixed results. Some research has found no correlation between driving performance and personality,[51,52] whereas other research has found some links. One study found high impulsivity predicted self-reported driving errors and violations in older drivers.[53] A second study measured computer based driving behaviour, self-reported driving records and personality in 152 drivers over the age of 75 years. Results showed sensation-seeking was related to driving violations and tickets, and lower temperamental control was related to risky driving behaviour, even after controlling for demographic variables.[54] Finally, 42 driver's, over the age of 60, on-road driving performance and personality were measured. Findings showed the higher a persons extraversion the poorer the driving performance. Extraversion is defined as sociability and warmth but also sensation-seeking, risk-taking and self-confidence. Researchers suggested this and age related function decline together may cause dangerous driving situations. [55]

Together, the various age related impairments can lead to a range of problems for older road users. These reduced abilities can cause inappropriate and unsafe road user behaviour.[56]

4.2 Medication

Older people commonly suffer from medical conditions that may impair performance and increase collision risk.[10] In addition, certain kinds of medication affect performance, for example, drugs can often cause drowsiness which may affect the skills used when driving and crossing the road.[57] Certain over the counter medication can also lead to unwanted sleepiness.[58] It is difficult to assess the link between each medical condition as many older people suffer from more than one illness and often take a variety of different medications.[10]

4.3 Self-regulation

It has been argued that the increase in collisions to older road users is not as high as one may expect given age-related declines.[19] It is important to examine whether older people have compensatory behaviour, specifically whether their beliefs about changing capacity are accurate, whether they alter their behaviour in response, and whether their attempts to compensate for reduced performance are successful. Some research has pointed towards older people reducing their number of trips, and distance walked.[21] This could be compensatory behaviour, however, it could also reflect different patterns of activity, for example, older people make fewer work/education trips than younger people.[59]

Research has identified that older drivers tend to self-regulate their driving in order to reduce their risk of being involved in a collision.[60] Self-regulation is an adjustment of driving behaviour due to age-related declines in ability and health.[61] Research in Britain has identified driving conditions and features of the road system that older drivers tend to avoid:

- Busy times
- Multi-storey car parks
- Town centres
- Complicated junctions
- Night driving
- Motorway
- Bad weather
- Unfamiliar vehicles
- Unfamiliar areas
- Long distances
- Driving when tired or in poor health[63,63]

Collision data in this report suggests avoiding some of these situation would be beneficial as a high number of older road user collisions occurred at junctions, however, collisions also occurred mostly during the day not at night.

Research in Australia examined reasons older drivers drive less than they used to. Table 8 identifies these and the percentage of drivers who had this reason.

Reason	Number	Per cent
General lifestyle changes	104	38
Cut back on activities/less need	*38*	*14*
Moved house	*28*	*10*
Changed family commitments	*21*	*8*
Lifestyle changes – unspecified	*13*	*5*
Financial reasons		3
Employment changes	92	34*
Retired/semi-retired	*80*	*29*
Changed job	*12*	*4*
Health/age (of self or spouse)	45	17
Use alternative transport	35	13
Driving issues	15	6
Avoidance of certain road situations	*7*	*3*
Lack of confidence in safe driving	*1*	*4*
Other	13	5

Table 8 Reasons for driving less than five years ago – Australia 2002[60]

There have been gender differences found in self regulation. Women reduce the number of car journeys they make about twenty years before their male counterparts.[1] This may be due to reduced confidence and increased willingness to change driving compared to males.[64] These findings were based on self-reported measures leaving results open to participants responding in a socially desirable way. Gender differences have also been found in driving cessation.[65] Males perceived the use of their vehicle as necessity more frequently than females, deteriorating health was the most common reason for males to give up driving, and females tend to stop driving earlier than they need to, whereas males tend to leave it too long.[66,67]

Research in Australia found that older drivers (75 years+) who rated their driving as 'not as good' were three times less likely to restrict their driving than those who rated their driving as 'better' or 'the same' as it had been 5 years ago.[60] Household structure also influences self-regulation. Individuals that live alone or were the primary driver were less likely to self-regulate. This may be due to a limitation of other travel options.[68]

There is evidence to suggest older people regulate their driving when there is a problem with cognitive functioning. For example; avoiding driving at speed and in busy traffic correlated with objectively measured impairment of vision, visual attention and general cognitive function.[69] However, older people were less likely to be aware of general cognitive decline than if there was a specific problem.

While many older drivers restrict or stop driving, many do not. This may suggest some drivers lack awareness of their limitations or willingness to change their driving appropriately. Examination of 152 drivers over the age of 65 found that those who rated themselves as 'safe' or 'at least as good as' or 'better' than others, failed a driving simulator task more often than those who rated themselves as 'average' or 'unsafe'. In depth focus groups, interviews and driver diaries by 29 older drivers suggest drivers find it difficult to conceptualise their own driving behaviour and their awareness of their limitations with regards to driving is low.[60] Drivers reported they would like more help to increase self-awareness about the driving task. In addition, the drivers reported having increasing difficulty in not having enough time to read, compute and comprehend road signs, maintaining a constant speed at the speed-limit, increased tiredness and fatigue, and increased sensitivity to glare. The findings suggest a method where driving issues are focussed on, awareness of driving limitations and discussion of these in the context of old age may be beneficial.[70]

Evidence suggests that older pedestrians are aware of their declining physical mobility.[10] One study gave older adults both a cognitive and walking task at the same time. Older people were able to maintain walking performance well but performance on the cognitive task declined, compared to younger adults who prioritised the cognitive task.[71] This suggests older pedestrians were aware of their decline in mobility and focus more of their resources on walking and not falling leaving fewer resources for the cognitive task. Other research suggests older people's belief about their performance is accurate; those over 60 years who reported they were concerned about the likelihood of falls were three times more likely than their peers to have experienced a fall at follow-up 12 months later.[72]

However, there is mixed evidence that older people are aware of decreasing perceptual function. Some research has found no difference in the level of self-reported perceptual decline between older and younger people[73], and one study even found lower self-reports of deafness among older people than younger people.[74] However, other studies have found close links between self-reported problems and problems older people would be expected to have.[75] Overall, the evidence suggests, when relevant environmental feedback is available, older people can recognise at some level that they have perceptual problems. When older people do recognise they have a decline in perceptual function evidence suggests compensatory behaviour does occur. For example; avoiding crossing busy roads at night[43], avoiding walking on roads with no pavements, and avoiding going out in bad weather.[73] Other evidence has found older pedestrians had a lack of understanding of who has right of way at give way junctions.[76] This suggests the need for on-going education of rules and rights of way between vehicles and pedestrians.

These findings suggest that changes that are obvious and have a transparent link with performance are more likely to be acted on appropriately. Explicit feedback from a professional, such as an eye specialist, can prompt behaviour change in this way[10]. However, there is little evidence to suggest the changes that are made are effective in reducing collision risk for older road users.

4.4 Summary and recommendations

The evidence available suggests the physical, cognitive, sensory and psychological declines related to aging may influence road users ability. Evidence demonstrating a direct relationship with collision risk is limited but links have been found between driver risk and Useful Field of View (UFOV), and pedestrian and driver risk with attention and vision. Research also suggests impulsivity and sensation seeking is related to risky driving behaviour in older drivers. Evidence implies older people and people who care for them may not be aware of some declines in health and the effects they may have on their driving. Older people tend to self-regulate their driving and walking by avoiding high risk situations, times and places. However, gender differences suggest males are less likely than females to regulate their driving. There is little evidence to suggest whether self-regulation is effective or ineffective in reducing collision risk.

A number of recommendations can be made from the evidence:

- Initiatives could increase older road users, and their family and friends, awareness of age related declines that could influence their safety as research suggests declines that have an obvious link with safe behaviours are more likely to be acted upon
- Initiatives could aim to increase males self-regulation as evidence suggests males are less likely to self-regulate than females

5 Interventions for older road users

This next section reviews the evidence for the effectiveness of interventions aimed at older road users including education and training, engineering and enforcement

5.1 Education and Engineering

A major problem with evaluating older road user training and education is establishing how the effectiveness of an intervention is measured. Evaluation is necessary for determining the effectiveness of an intervention on a desired change. Change can only be examined by using before and after measures, a later measure is also desirable to ascertain any sustained effects of the intervention, and a matched control group (a group of people who did not receive the intervention that have the same demographic features as the intervention group). Education is often seen as effective if objectives of the course are met and assessments are passed. However, road user education and training should ideally demonstrate benefits for road safety. This would suggest measuring collision risk and involvement before and after an intervention, however, it is difficult to show associations and many contributory factors would be involved. It is also difficult to achieve a valid control group.[56]

5.1.1 Effectiveness of older driver education and training interventions

There have been a number of interventions aimed at increasing the safety of older drivers. An early review examining these interventions rated the evidence on the quality of the evaluation, for example randomised experiments (experiments in which participants are randomly assigned to an intervention or control group) of a high quality would be given a score of 1, whilst evaluation with no experiments (i.e no control group and before and after data) would be given a score of 5. Findings showed there is limited evidence that visual and physical retraining improved older driver's skills. Educational interventions were shown to increase driving awareness and safe driving behaviour, but not reduce collision involvement of older drivers.[77]

A more recent review that rated interventions for effectiveness and level of evidence found that physical retraining alone was shown to moderately improve driving performance, and was most effective when the training focused on flexibility, coordination and speed of movement. Evidence also suggests educational interventions alone were not successful in reducing collision involvement. However, the review demonstrated that combining both on-road training and education increased driving performance and moderately improved older driver knowledge.[78] For example, one study allocated individuals to either an intervention group, consisting of 2 four hour classroom sessions based on the AAA Driver Improvement Programme and 2 one-hour on-road sessions which focused on common errors linked to older drivers, or a control group who undertook modules covering home, vehicle and environmental safety.[79] Results showed that combining the education and on-road session increased general driving knowledge and scores on on-road tests. Another study evaluated an intervention using the 55 Alive programme; a refresher programme designed to increase older drivers skills and knowledge by providing information on topics such as changes to the law and highway code, driving techniques, road layouts and fitness to drive, and a 90 minute practical training session for drivers over the age of 65. The intervention group had better on-road evaluation scores than the control group after the practical session and those that participated in the education sessions had increased knowledge scores after the programme.[80] This evidence suggests combining education sessions in the classroom and on-road practical sessions can increase older driver knowledge of safe driving and skills.

Self-reported driving behaviour of 367 drivers aged 55-94 was examined after attending the 55 Alive/Mature driving programme. 75% of participants said a year to four years later that they had increased awareness and visual skills, improved speed, space margins and vehicle manoeuvres.[81] An investigation of 86 older driver's attitudes, beliefs and perception of risk after attending an educational intervention suggested participants were more interested in maintaining their mobility rather than increasing their safe driving.[82] There were also gender differences; men were more resistant to changing their driving habits and reported driving under the influence more often than women. Women were more likely to involve their family in the decision making of driving cessation than men. This suggests training interventions may need to target men and women differently. Researchers have identified that for women, interventions should include driving skills and confidence in difficult driving situations. For men, interventions should include an individual focus on health and age-related declines.[83]

Specific types of training and education may be beneficial in increasing the safety of older drivers. Cognitive training on older adults has been shown to improve cognitive targeting abilities[80] and reduce and prevent declining cognitive performance.[84] Other research suggests participating in simple and dual computer based tasks, supported with training, were linked to improvements in performance on a driving simulator.[85] This suggests cognitive training may improve older drivers memory, attention and motor control tasks which are used when driving. A review of cognitive training for older drivers suggests the most promising cognitive training in relation to older drivers seems to be speed of processing training. Speed of processing training has been linked to improvements in cognitive ability over 2 years, to improvements in road test performance, it has been shown to delay driving cessation, it out performs memory and reasoning training, and seems to provide more general improvements in performance than simulator training.[86] Examination of an educational intervention aimed at changing older drivers perceptions about visual impairment found that drivers that received the intervention were more likely to accept that their vision may be impaired, avoid challenging driving situations and perform self-regulatory behaviour, compared to a control group. This implies education may be beneficial for visually impaired older drivers by increasing awareness and avoidance of challenging situations.[87]

The University of Plymouth and Devon County Council collaborated to evaluate the effectiveness of Driving Safer For Longer (DSFL); a programme that considers the effects of illness, medication and eyesight on driving, informs drivers of vehicle choices and modifications that are available, outlines some of the risks to drivers and sources of help, support and advice. One hundred and sixty one workshop attendees participated in the evaluation. They completed questionnaires before and after the Driving Safer for Longer workshop. It was found that workshop attendance increased driving-related knowledge and support knowledge (in particular intentions to access support).[88]

The use of workbooks as a self-assessment tool for older drivers has also been examined. The Driving Decision's Workbook provides feedback for making driver decisions based on self-awareness and feedback. It also gives information on age related declines, medical conditions and medication that can affect driving and prompts discussion with others, such as family members. [89]Evaluation of this tool on 99 drivers over the age of 65 found that 75% of the participants reported increased awareness into factors that could affect their driving. Responses were also positively correlated to on-road test scores.[90] This suggests workbooks could be used as an educational tool to increase driver's awareness.

However, there is some research that suggests driver education and training programmes may reduce safety for some older drivers. One study examined 884 older drivers who attended the 55 Alive/Mature driving programme. They investigated the self-selection bias of participating in the programme, the changes in collision rates after attending the programme, and the selection, compensation and optimisation strategies used by those attending the programme. Results showed that there was a self-selection bias in those attending the programme, in that those choosing to attend the programme were safer drivers before the intervention than a control group who didn't attend the programme. Findings also demonstrated that participating in the programme increased the number of collisions for men aged 75 and older. There was no effect on collisions of younger men and women of all ages.[91]

5.1.2 Effectiveness of older pedestrian education and training interventions

Very few education and training intervention programs for older pedestrians have been attempted.[10] In 1991, the 'Walk-With-Care' initiative by VicRoads was effective in reaching large numbers of older pedestrians with education (awareness, discussions, information on safety and hazards facing older pedestrians), advocacy and engineering improvement where necessary. However, this program has not been evaluated for any change in pedestrian behaviour or reduction in collisions. A UK programme called 'Defensive Walking' was published in 1991 and a Government Campaign was launched.[92] The programme gave information through video and flashcards on seven safety principles, such as checking whether drivers are doing what is anticipated, and planning trips in advance to reduce the number of roads crossed. There was no formal evaluation of this programme and it has been criticised for focusing on caution and possibly creating anxiety.[93] An early evaluation of a range of training methods designed to help older people understand pelican crossings, from leaflets to a half-sized model of a crossing that allowed an element of practical training, showed that there was no significant improvement in knowledge after compared to before the training.[94] A talk for older people on the different pedestrian hazards encountered on a shopping trip increased participants knowledge, however, there was no control group, leaving it difficult to draw a conclusion.[94]

Many more interventions aimed at children have been evaluated.[95] Educational programmes have been used in the classroom[96] or by parents.[97] Many of these studies have reported limited success with knowledge enhancement and have done little to improve children's skills on the roads.[98,99,100] In contrast, other methods have addressed pedestrian skills directly by training children in real life traffic environments[101] or in computer-simulators.[102,103] Results indicate significant improvement in skills which in most cases are long lasting.

It may be possible to train older pedestrians on how to cross the road more safely as roadside training with children has proven to be effective.[104] One study has examined whether a behavioural and educational intervention in a simulated traffic environment could improve 40 older pedestrian's (60 years and over) decisions to cross the road. Participants were provided with feedback on their street crossing safety, encouraged to assess the approaching vehicles speed, encouraged to observe the approaching traffic as they crossed and adjust their speed if the vehicle was approaching faster than expected. All together the program included a 30 minute discussion about what information is important to take in when crossing the road, three training modules in which the time gap varied, and two types of feedback about safety margins and time gaps. Results showed intervention participants crossed more rapidly, adopted larger safety margins and had fewer near collisions than a control group. However, there were also more missed opportunities in the interventions group and participants still failed to make use of a vehicles speed when making the decision to cross. While these are supporting findings for the use of training for older pedestrians, the differences between groups were no longer observed 6 months after the training.[105] This suggests age-related perceptual and cognitive declines cannot be improved using simulator training. Another study tested methods for improving gap judgements when crossing the road in the elderly.[106] The most promising technique required participants to judge whether the oncoming car was travelling at an atypical or normal speed, and then estimate the speed of the car. Results showed this method was successful in increasing successful judgements of speed straight after the program, however, the experiment had no follow-up phase, the task did not include an actual crossing, and the extent to which speed estimates influenced gap decisions was not tested.

An area of training that would be expected to have benefits on pedestrian safety is those that train aspects of visual attention. For example, research has suggested that UFOV can be expanded by training and this expansion lasts. However, it is unclear whether this training can result in fewer collisions in the long term.[107] One study found training on the speed of processing was successful in reducing older drivers dangerous driving manoeuvres.

A Department for Transport literature review of older pedestrians examining collision factors, age related declines in health and effectiveness of interventions and the Federal Highway Administration Pedestrian Safety Toolkit indicate pieces of advice that would be useful to older pedestrians:

- ‘Information about specific functional declines that can occur, and their potential relevance to pedestrian behaviour,
- the Federal Highway Administration Pedestrian Safety Toolkit Advice on the importance of vision and hearing checks,
- Advice that they may be able to maintain performance through functional compensation, but compensation that engages their capacity for cognitive control may eventually compromise their ability to respond quickly to unexpected events
- Information on the role of physical well being and mobility in pedestrian safety, and the benefits of walking for health
- Guidance on the ways to modify pedestrian activity to increase safety
- Advice on when to seek additional support
- Advice on the effects of alcohol, medication, and specific medical conditions.
- Make yourself conspicuous[10]

A particular issue for older people is whether they believe collisions can be prevented.[10] A large telephone survey in the USA found that older people were less likely to believe collisions were preventable.[108] This suggests increasing their perceived behavioural control (the perception of how much a person can control a situation) may be beneficial for older road users.

5.1.2.1 Driver awareness

A number of people have recommended informing or training other road users, especially drivers, on older pedestrian safety.[109,110,111,112,94] One study developed a message for drivers to help avoid particular types of collisions with older pedestrians. It encouraged drivers to ‘take a last look for pedestrians before turning’. They found a reduction in pedestrian collisions during the campaign but the effects were not long lasting[113]. Another method has been to develop a lecture to teach learner drivers about the issues raised by older pedestrians. This was delivered by driving instructors and effectiveness was measured by a questionnaire mailed to participants. However, there was no control group and no quantitative indication of how well the learners did, so it was difficult to assess this study.[94] Research suggests a specific message that could be used is that drivers who see an older pedestrian crossing from the offside ahead of them should proceed cautiously. Although they might assume the pedestrian will stop in the middle, sometimes the pedestrian will continue without reappraising the situation.[10]

5.1.3 Delivery of older road user education and training interventions

Research was undertaken to determine which methods older road users prefer for the delivery of information.[115] An interaction style was preferred over a traditional lecture style, information should be locally relevant using examples older adults find familiar, and material that can be read outside the classroom reduces the amount of information needed to be covered in the classroom and allows participants to read through it at their own pace. Another study demonstrated the importance of repeating key messages in a variety of ways to ensure it is retained by older people.[116] To increase the likelihood of behaviour change clear behavioural recommendations should be given with information on how to achieve them. The evidence should be clearly demonstrated to the audience and should come from a reliable source.[117]

Promotion of interventions is important to ensure people are informed about the programmes that are running. A telephone survey of 367 drivers who had attended the 55 Alive/Mature driver programme showed that most drivers heard about the programme through advertisements, printed material or they had been encouraged to attend by individuals who had been on the course. The instructor characteristics that were important included being approachable, knowledgeable and clear delivery. Informal interactive styles such as role play and hands on learning were also well received. Reasons for attendance were linked to motivations to learn and expectations of the benefits gained.[91] This suggests advertising interventions should focus on the benefits of attending, such as increased knowledge and awareness of driving skills.

5.1.4 Summary

Overall, education interventions appear to increase knowledge and awareness among older drivers, but not reduce collisions. In contrast, training programmes targeting specific abilities (physical, cognitive) have been shown to improve driving skills in older adults, although it has not been assessed as to whether they result in fewer collisions. The evidence for elderly pedestrians is insufficient to demonstrate which methods would be effective in increasing safety but it is clear a pedestrian intervention is needed to reduce older road user risk of injury.

5.2 Engineering measures to increase older road user's safety

The road system itself may contribute to the level of risk elderly people face on the roads and may be better adjusted to suit the needs and abilities of older persons.[118] Older road users are not considered when roadways are designed; they are often based on measures of the performance of young adults.[119] There are a number of road factors that may cause a specific problem for older road users, these are discussed below.

5.2.1 Junction design for older road users

Junctions are highly complex road environments that require greater levels of attention and information processing in comparison to other situations.[120] National and local statistics demonstrated a substantial number of older driver, passenger and pedestrian collisions occurred at junctions. Wider research also identifies an over involvement of older drivers in collisions at junctions.[121,122] The evidence suggests older drivers have difficulty making right and left hand turns, responding to traffic signals,[123] visual issues and failure to judge the speed and distance of oncoming vehicles.[120] Focus groups with older drivers suggest junctions with too many islands are confusing, raised curbs that are unpainted are difficult to see, and textured roads (such as rumble strips) are of value as a warning of upcoming changes.[124] For pedestrians the complexity of crossing a road when vehicles may be turning is high due to the pedestrian having to look right and left for oncoming traffic, and forward and backwards for turning vehicles from the intersecting roads.[117]

In 2001, the US department for transportation suggested a number of considerations to accommodate the needs of older road users at junctions:[125]

- The angle at non-restricted intersecting roads should meet 90 degrees and the angle at restricted intersecting roads should not be less than 75 degrees. Decreasing the angle of the junction makes detection of and judgments about potential conflicting vehicles on crossing roadways much more difficult. In addition, the amount of time required to manoeuvre through the junction increases, for both vehicles and pedestrians, due to the increased pavement area. There has been no research into the effectiveness of angle degrees on increasing older road user safety
- Lane width should be wide enough so older drivers don't swing too wide; this would also reduce the rotation needed on the steering wheel. A width of 3.6m was suggested. Again there has been no research into whether changes in lane width increase older road user safety.
- Raised channelizations and medians provide a better indication to motorists of proper use of lanes. The effectiveness of channelization on collisions has been documented in several

studies. An evaluation of Highway Safety Improvement Program projects showed that road improvements consisting of turning lanes and traffic channelization resulted in a 47 percent reduction in fatal collisions, a 26 percent reduction in nonfatal injury collisions, and a 27 percent reduction in combined fatal plus nonfatal injury collisions, at locations where before and after exposure data were available.[126] Raised channelizations have been found to be more effective than road markings in reducing night time collisions[127]. Another benefit in the use of channelizations is the provision of a refuge for pedestrians. Refuge islands are a design element that can aid older pedestrians who have slow walking speeds. Researchers have stated that because channelization in general serves to simplify a complex situation, the channelization of an existing junction might enhance both the safety and mobility of older persons, as well as enhance the safety of other pedestrians and drivers.[128] Research has shown a reduction in all age pedestrian-vehicle collisions after, compared to prior, the development of central refuges.[117]

- Sight-distance (the distance in which the road is visible) should be increased so there is more time for perception and reaction to accommodate the slower decision times of older drivers. A before and after analysis of junctions demonstrated a 67% reduction in collisions where obstructions that inhibited sight-distance were removed.[129]
- The luminance contrast between the marked edge of the road and the road surface should be considered to accommodate for the declining age affects on visual ability. One study examined when older and younger drivers could just detect the direction of the road curvature. Results showed older drivers required a contrast of 20% higher than the younger group to achieve the detection.[130] There has been no research into whether this increases older road user's safety.
- The radius of the curb is important as research suggests older drivers have problems at junctions when carrying out tight right-hand turns at normal speeds.[130] A recommendation of 7.5m-9m where roads intersect at 90degrees was given to facilitate vehicle turning manoeuvres, moderate the speed of turning vehicles and avoid unnecessary lengthening of pedestrian crossing distances. Again, there has been no research into whether this increases older road user's safety
- To accommodate the reduction in visual acuity associated with increasing age, signs should be clear and unambiguous.[120] A recommendation of a minimum letter height of 150mm for on post street-name signs on roads where the speed limit exceeds 25mph was given.[125] The use of overhead-mounted street-name signs with mixed-case letters is recommended at major junctions as a supplement to post-mounted street-name signs. Minimum letter heights of 200-mm (8-in) uppercase letters and 150-mm (6-in) lowercase letters are recommended at major junctions with approach speeds of 35 mph or less. At major junctions with approach speeds greater than 35mph, the minimum letter height on street-name signs should be 250-mm (10-in) uppercase and 200-mm (8-in) lowercase letters.

Research has found that collision rates for older drivers at junctions were much higher when traffic controls, such as traffic lights, were not present.[131] This would reduce approaching speeds of other drivers and the information processing requirements of older drivers. Replacing existing junctions with roundabouts has also displayed significant improvements to junction safety.[132,133] The reduced number of conflict points on a roundabout, and the unidirectional movement of the traffic mean that the frequency and severity of older driver collisions may be reduced. Evidence suggests the roundabout design should be self-explanatory for older drivers, such as advance signage, lane advice, direction of travel, priority, exit signage, and guidance on lane position. An evaluation of a variety of engineering measures in the Netherlands found that only measures related to junctions (E.g. introducing a roundabout, providing a median island) consistently reduced overall collision rates. In fact, only roundabouts reduced pedestrian injury rates.[134]

5.2.2 Other infrastructure for older drivers

Roadway curvatures

Certain types of bends, such as very sharp bends which require a significant speed reduction or those which do not have very clear perceptual information, are likely to present a risk to older drivers. However, there is no evidence that older drivers have increased collisions on bends.[120] Research suggests additional perceptual cues such as advanced warning signs, advisory speed limits and chevron markers would be helpful to all road users. Rumble strips, however, have been found to cause discomfort for a number of older drivers. Findings relating to the extent to which older drivers respond to road signage have been mixed. Some research indicates that older drivers have problems with recognising and understanding road signs[135] or may even ignore them,[136] while other research supports the conscientiousness of older drivers and shows that they are more likely to respond to signage in order to comply with the rules of the road.[137]

The width of the road prepares drivers for appropriate speeds and positioning on bends. When roads are wide the driver has less perception of speed travelled, which can have an impact on the level of deceleration when entering bends. However, narrow roads can lead to a temporary loss of visibility making it difficult to see whether another vehicle is approaching. This can lead to drivers positioning themselves in the centre of the road, which puts them at risk of collision with another vehicle. With reduced reaction time, this can have serious consequences for older drivers.[120] Widening the width of bends and therefore reducing its sharpness may be beneficial for older drivers,[138] however, the negative impact this has on increasing driver's speeds is thought to negate the overall safety gains.[139] Drivers have been found to reduce speed more significantly for bends that are perceived as being sharper and when a combination of chevron and repeater arrow signs are used with herringbone markings on the road surface, suggesting improvements in speed reductions and lane positioning can be achieved.[140]

Road markings

Road markings are important to help drivers recognise road types. When a road is well marked it can provide long-range guidance for drivers when making lane position and speed choices.[141] Research has demonstrated that adding painted material to the road surface affected drivers position on the road; drivers took a fairly central position on a non-painted road, however, adding a centre line to divide the road into two lanes encouraged drivers to remain in their lanes and thus drive closer to the edge of the road.[142] Higher contrast white lines are particularly helpful for older drivers, especially in low-light conditions.[120] One study found white lines with low contrast reduced lane tracking performance compared to higher contrast lines.[143] Merge and continuity lines can be used to keep drivers in lane when roads gain or loose a lane. This helps reduce overall speeds and overtaking rates, as well as giving older drivers more space between vehicles. [144]

In-vehicle technology

There are many new technologies which could potentially help make the driving task easier and safer for older people.[145] Technologies that assist the driver with the driving process could compensate for the kinds of cognitive limitations older drivers face and help facilitate the driving tasks older people find difficult.[145] These include technologies that provide assistance to the driving task (e.g. adaptive cruise control, ABS), help raise awareness of risk-related situations (e.g. forward collision warnings), help raise awareness of risk-related conditions of the driver (e.g. drowsiness detection systems), provide the driver with information (e.g. navigation systems, speed alerts), and interfere with actual driving (e.g. emergency braking, intelligent speed adaption). Other technology can provide a systematic record of driving incidences and a periodic report of driving patterns.[128] This can provide drivers with feedback allowing older drivers to modify their driving behaviour.

Researchers have suggested these systems could help older drivers by providing information on such things as the location of forthcoming manoeuvres, giving the driver more time to prepare for the manoeuvres. They would also help elderly drivers when they are in unfamiliar areas.[146] Evidence has found navigation aid based around landmarks is particularly useful for older people,[147] for example incorporating landmarks in turn-by-turn instructions provided by a navigation system increased older driver's confidence and significantly reduced the time spent glancing at the visual display.[146] However, navigation systems don't address collision factors specifically, for example, identifying possible dangers at junctions.[148] Adaptive collision warnings may be more beneficial for older drivers at high risk sites such as junctions to warn them of any oncoming vehicles that could pose a risk of collision. As many elderly drivers are unaware of their declining abilities, systems that provide feedback on their driving will provide opportunities for them to recognise their weaknesses and possibly adopt measures to increase their performance.[148]

It is important that any new technologies do not increase the complexity of driving by adding more information that needs to be processed at one time. This is particularly important for older people as the processing of complex information has proven difficult for older drivers.[145] One study examined the driving performance of young and older drivers during a simulator experiment. On-board display systems showing the relationship between the driver's vehicle, other vehicles and roadside objects were shown to be effective in increasing the driving performance of younger drivers but not older drivers. The failure to increase older driver performance was attributed to an implied increase in cognitive processing from using the system at the same time as driving. A second test using a heads-up display (HUD), a transparent display that shows critical and relevant information without requiring the driver to look away from the road, provided additional information on the degree to which the vehicle should be turned at each stage. This was successful in improving driving performance for both young and older drivers, without the increase in cognitive load for older drivers.[149] HUDs can also display road signs, speed limit data and traffic signs which could improve older driver's safety by enhancing the clarity of the signs.[148] This suggests that systems which provide specific feedback on a display that does not distract from the driving task would minimise the cognitive load for older drivers.

Research suggests older people are quite willing to accept in-vehicle technology that helps their driving. They also have a slight preference for those that provide feedback rather than those that reduce workload.[70] However, to date there has been no research testing the effects of in-vehicle technology on older road user safety.

Vehicle adaptations

Advances in vehicle engineering have already made driving both easier and safer for older people, these include power steering, automatic gears and adjustments to the amount of power needed to press foot pedals.[145]There are a number of other adaptations older drivers could use to increase their safety in the case of a collision:

- Seatbelts and airbags that adapt to characteristics of the vehicle and driver (e.g. speed of vehicle, driving seating height, drivers weight and age)
- Seat designs that offer improved protection to the neck in rear impact, such as special seat structure that deforms to limit neck motion at low-speed rear impacts
- Inflatable head restraints that limit rearward head motion
- Donor bags in the torso portion of the seat back that use the rearward motion of the torso to compress and transmit gas into a recipient bag in the head restraint
- Side airbags to help protect the head, thorax, and pelvis

To improve the safety of older drivers and to help them feel more confident to remain independently mobile it is important to make sure their vehicles contain the appropriate features and the users are adequately informed about them.[120] A report on 'Ageing and Transport' published by the Organisation of Economic Co-operation and Development in 2001 proposed older drivers needed not only to be informed about the implications of age-related impairments and driving cessation, but also about the choices of safer vehicles.[150]

5.2.3 Other infrastructure for older pedestrians

Pedestrian crossings

The design of pedestrian crossings need to be considered carefully; issues such as signaling, provision of central refuges, and the siting of crossings, in relation to junctions for example can affect crossing safety[151]. Research has examined whether pedestrian crossing road markings increase or decrease the risk of pedestrian collisions when pedestrian flow is accounted for. The evidence shows mixed results, some studies have found marking the crossing increases pedestrian safety[152], however, others have found marked crossings to be associated with higher risk of collisions.[153,154] One study found that where there were no traffic signals or stop signs, marked crossings increased elderly pedestrian risk by 3 times the amount of that when crossing at unmarked sites.[155] This suggests markings on the road may not be enough to increase pedestrian safety when crossing the road, lights or stop signs may be necessary. Traffic signals at junctions which stop all or part of the traffic for pedestrians to cross have been shown to significantly reduce collisions.[156,157]

Research has also considered older pedestrians walking speed. One study measured 3145 older adult's (65 years and over) walking speed and found most older adults (84% of men and 93% of women) could not walk fast enough to use a pedestrian crossing in the UK (1.2m/s).[158] Other research has suggested a walking speed of 1m/s is sufficient for elderly pedestrians.[159] It may be beneficial to have time countdown crossing signals in areas with high numbers of elderly people so they know how long they have left to cross.[117] The placement of these signs should also accommodate the elderly who may find it difficult to raise their head too high.[117]

Other research has examined how to reduce speeds at crossing to increase pedestrian safety. One study has examined whether differences in distance between speed humps and pedestrian crossing contribute differently to pedestrian safety. Results from three test sites showed vehicle speeds were lower at the pedestrian crossing when the difference between the speed hump and crossing was greater (10m compared to 5m).[160] Another study examined vehicle speeds and the number of child and elderly pedestrians given way to before and after a number of infrastructure changes were made at pedestrian crossings. Results showed not only did lower traffic speed increase safety (more pedestrians were given way to at lower speeds) but safety was further improved at sites where visibility, orientation and clarity were sufficient.[161]

Other methods that separate pedestrians from vehicles can also be effective in reducing pedestrian collisions.[162] Overpasses and underpasses have been found to substantially reduce conflicts and pedestrian collisions.[163] However, older people typically dislike such arrangements because of the extra physical difficulty of climbing up steps, or feelings of insecurity.[151]

Barriers and fences which are designed to channel pedestrians to safe crossing areas have been found to reduce mid road crossing[164] and substantially decrease collision rates for pedestrians of all ages.[165] Improving visibility by removing obstructions, extending pavements, improving lighting, adding light-reflecting high mounted traffic signs and installing a pedestrian warning system with lights have also been suggested to increase the safety of pedestrians.[166] For example, parking restrictions, such as creating diagonal parking as a replacement for parallel parking, has been shown to reduce the number of pedestrians entering the roadway from behind a parked car.[164] In addition, relocating bus stops from the near side to the far side of junctions can increase the visibility and conspicuity of pedestrians and have been shown to significantly decrease the number of pedestrians who enter the road in front of a stopped bus at signal-controlled junctions.[164]

Pedestrian refuges or islands

Central refuges through hazardous sections of two-way roads, side-road junctions and major junctions, particularly in areas with a high number of older pedestrians, has been identified as a potentially effective countermeasure for pedestrian safety.[117,129] Evidence also suggests refuge islands decrease conflicts[167] and there are significantly lower all age pedestrian collisions on two-way roads that have refuges than those that do not.[159] This may be particularly useful in areas with high numbers of elderly pedestrians because as previously noted, older pedestrians engage in potentially unsafe crossings by comparison with their younger counterparts on two-way roads because they only consider the first lane before crossing and take longer to cross.[168] A central refuge would give them the opportunity to stop and consider the second lane, breaking the road down into more simple chunks.[169,170] Curb extensions could also be used to reduce crossing distance.[171]

Reversing vehicles

Research suggests older pedestrians are over-represented in collisions with reversing vehicles,[76] particularly reversing from car parks and driveways. Locally, there were a higher number of older pedestrian collisions at private driveways than nationally. This type of collision often occurs as a result of inattention on both the driver and pedestrians behalf, and problems anticipating unexpected results by older pedestrians.[117] There have been few initiatives developed and evaluated to reduce collisions of this type. One suggestion has been to install barrier fencing where parking bays are present to encourage pedestrians not to cross in locations that may be hazardous.

Traffic speed and traffic calming

Speed increases the energy in a collision, and reducing vehicle speed should reduce the harm done by collisions.[35] As well as this, if vehicles are moving more slowly, drivers will be operating with margins for error that better match their true capacity to respond, and pedestrians will have more time to detect and respond to their presence. This should particularly help older pedestrians who have been found to react more slowly.[10] Lower traffic speeds have been shown to reduce all age pedestrian-vehicle encounters.[135] A literature review found the most effective speed reduction measure was installing roundabouts at junctions.[117] Other traffic calming measures on sections with high pedestrian activity, such as speed humps, narrowing or reducing lanes, have been recommended to increase the safety of all pedestrians; however, the effects on vehicle-pedestrian collisions are less certain.[166] Reducing traffic speeds may be even more beneficial for older pedestrians who take longer to cross the road than their younger counterparts. Research has shown older people tend to have their collisions close to home therefore areas with a high number of older people, e.g. residential areas and shopping streets, should particularly benefit older pedestrians.[110] Pedestrianisation (giving pedestrians' priority) in these areas may also be beneficial. These schemes across several European countries have been reviewed and in general these measures often reduce vehicle speeds and/or collisions.[172]

Other conflicts

A study from the University of Manchester found the poor condition of pavements to be one of the biggest problems for older pedestrians.[145] Other research has shown that 2300 older people in England fall on broken pavements everyday, suggesting this low-tech, low-cost maintenance could make a large improvement for older pedestrians, which would be particularly beneficial for older pedestrians with visual decline.[145] This should apply to the road surface at pedestrian crossings as well as the pavement.[43]

5.2.4 Summary

The evidence suggests a number of changes could be made to road infrastructure to account for older road users. Changes at junctions and other complex roads would be particularly beneficial and have been shown to reduce pedestrian and driver casualties. Reducing vehicle speeds and adding central refuges have been found to increase pedestrian safety and there are a number of in-vehicle technologies and adaptations that could increase driver safety.

5.3 Enforcement measures

The UK has a liberal licensing procedure amongst an extremely varied collection in Europe, from Sweden having no older age-related restrictions, to Finland where regular medical check ups and license renewals are compulsory. In America there is much diversity amongst the states, from Illinois where from the age of 75 license renewals must be made in person with a vision test and on-road driving test required, to Tennessee where the usual 5 year renewal period is dropped once the driver reaches the age of 65[173]. In the UK licenses must be renewed at the age of 70 and every 3 years thereafter, with self-declaration of impairment.[145] Despite some countries using screening procedures as a safety measure, research has not found any benefits of this on collision rates.[174] One study compared 7 EU countries with different screening procedures. Countries that had the most lenient screening procedures also had the lowest collision rates among older drivers.[175] Collision rates in the state of Illinois were compared before and after license renewal rules were revised. For the 69-74 year old group the rules had become more lenient, by removing mandatory on-road tests, and for the older age group, aged 80+, the rules had become stricter, by requiring more frequent checks. These changes had neither a negative effect on the safety of the younger group, or a positive effect on the safety of the older group.[186] Similar findings have also been found in other states in America,[187,188,189] Scandinavia,[190] Australia[191,192] and Holland[174] suggesting that screening does not produce the desired safety benefits for older drivers.

5.3.1 Encouraging self assessment

Research suggests it is easier for older people to accept changes to their transport choices if they make the decision themselves.[145] A study of older people and the reason they gave up driving found that those who chose to give up driving themselves were more accepting, planned their alternative transport meticulously, and generally were pleased with the outcome. In contrast, those who were forced to give up by medical professionals or family members were bitter and angry, did not gather information on alternative transport, and had a worse quality of life.[70] This suggests older people should be given the information necessary for choosing how to make themselves safer. PACTS (Parliamentary Advisory Council for Transport Safety) suggested useful information for making older people safer includes:

- The potential difficulties older people face and how to overcome them, including increased vulnerability
- How vehicles can be made safer by technology and/or adaptations
- How to renew the driving license, how to self-declare, the importance of self-declaration
- The alternative transport options
- Advice on vision and fitness to drive, particularly for those on medication or suffering from
- dementia[145]

5.3.2 Summary

The evidence suggests there are no safety benefits of compulsory screening and licence renewals for older drivers. Self-declaration seems to provide much greater benefits in terms of acceptability, quality of life and using alternative transport.

5.4 Overall summary and recommendations

Overall, there are a number of factors relating to education, training, engineering and enforcement that could be considered when targeting older road users that may increase their safety on the roads A number of recommendations can be made from the evidence:

- Driving education initiatives could emphasise the importance of attending an on-road practical driving skills session as evidence suggests a combination of in-class education and on-road training produce the highest increase in driver knowledge, awareness and safe driving skills
- Self-assessment workbooks designed for older drivers could be given out at education initiatives as evidence suggests workbooks increase knowledge and self-awareness, and self-assessment of own driving provides more benefits than compulsory screening
- The information given to both men and women in driving interventions could be tailored to their needs. Evidence suggests women need information about driving skills and increased confidence for difficult driving skills and men need information that highlight health and age related declines
- Advertising education and training initiatives could focus on the benefits of attending such as increased knowledge and awareness of skills as research suggests this is what older participants of initiatives valued most
- Road infrastructure design, particularly in areas with a high number of older people, could consider older road users needs, as research suggests road design is usually based on the abilities of younger adults. Specifically junctions which have been shown to be particularly common in older road user collisions
- Initiatives could increase awareness of available in-vehicle technologies and adaptations that could reduce road user complexity and increase safety
- Initiatives could encourage older road users to self-assess their own driving as research suggests this provides more benefits than compulsory screening.

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