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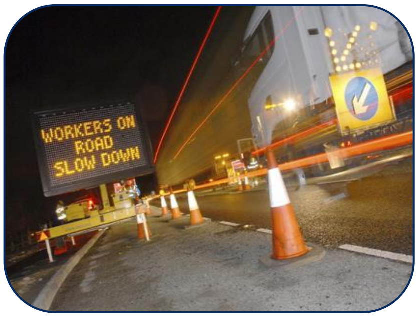

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The methodology and initial findings for the Road Accident In Depth Studies (RAIDS) Programme

RAIDS Phase 1 Report

Richard Cuerden and Mike McCarthy

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Executive Summary

This report gives an overview of Phase 1 of the Road Accident In-Depth Studies (RAIDS) programme. The project was commisioned by the UK's Department for Transport (DfT) and road collision data were collected by Loughborough University and TRL (the UK's Transport Research Laboratory). TRL was responsible for the Programme and Technical management, including provision of an on-line database. The aim of the Road Accident In-Depth Studies (RAIDS) programme is to provide detailed evidence on the causes and consequences of road collisions in order to improve road safety outcomes.

In phase 1, over 1,250 in-depth accident investigations were carried out to study the influence on crash causation and injury mechanisms of human involvement, road and environment design and vehicle safety. This ambitious work was undertaken to allow research to be conducted to investigate the causes of crashes, their subsequent injuries and the associated societal costs. It was recognised that only through a detailed knowledge of these complex causal factors will effective policies and countermeasures be developed and, ultimately, successfully applied to improve road transport safety.

This report describes the data collection methodology and provides examples of some potential research applications. This is not intended to be a comprehensive review of all the RAIDS research opportunities; rather it is designed to offer an insight into the richness and diversity of the dataset.

The report initially provides an overview of the Phase 1 data gathered. Secondly, some key findings from the first phase are presented to demonstrate the utility of the data, including:

- Road user behaviour and collision causation
- Road design
- Car user injury experience
- Characteristics of pedestrian collisions
- Vehicle technologies and collision injury prevention

From 1st April 2016, Phase 2 of the RAIDS programme started and will continue to collect data to add to the evidence base. The second phase will deliver a greater focus on advanced vehicle safety technologies and will help to assess the road safety priorities for tomorrow's roads.

1 Introduction

1.1 Background

Globally, road traffic injuries are a leading cause of preventable death and injury. In 2013, over 1.25 million people died on the world's roads and up to 50 million people sustained serious injuries and suffered the long-term adverse health consequences (WHO, 2015). Road collisions disproportionally affect young people and are the main cause of death among those aged 15–29 years.

The British Road Safety Statement (The Department for Transport, 2015) identifies that Britain has some of the lowest road casualty rates in the world. This comparison is based on the numbers of fatalities per head of the population. However, according to Reported Road Casualites Great Britain (RRCGB) in 2014, there were 1,775 road deaths and 192,702 people were injured in reported collisions on Britain's roads (The Department for Transport, 2015). The development of applicable and cost-effective policies, technologies and solutions to prevent future loss of life and injury requires a deep understanding of the mechanisms which result in road collisions and injuries. The Department for Transport (DfT) has investigated road traffic collisions for over 50 years to support strategies to make the UK's roads safer. These investigations differ from those of the police because they are designed to understand how people are injured rather than necessarily determine responsibility for the collision.

1.2 Aim

The aim of the Road Accident In-Depth Studies (RAIDS) programme is to provide detailed evidence on the causes and consequences of road collisions in order to improve road safety outcomes.

Detailed information is collected about the crash site, including highway features and environmental factors. Vehicle damage can be matched to the injuries received in the crash, allowing an understanding of how vehicle design can be improved.

The data collected will help:

- Identify the crash scenarios, including contributory factors relating to the vehicle, road and road users, which lead to collisions of varying severities;
- Identify how people are injured in road traffic collisions, the injuries they sustain, and how these correlate to vehicle characteristics and highway design features;
- Establish the extent to which a range of safety related measures have reduced the risk of injury to road users involved in collisions;
- Identify measures to reduce further the risk of collisions and injuries (in terms of vehicle design and safety, the road environment and traffic management and human factors).

1.3 Structure of the Report

Phase 1 of the DfT's RAIDS programme was initiated in 2012, with data collection between March 2013 and December 2015. Section 2 of this report describes how the RAIDS programme is managed and how data collection is structured. It also gives an overview of the RAIDS database in which RAIDS and legacy in-depth collision investigation data are stored, and summarises the ethical approvals under which the study operates. Section 3 describes the approach to data collection and Section 4 gives an overview of the data that have been collected in Phase 1 of the RAIDS programme. Sections 5 to 9 then highlight some key findings from the first phase, including findings related to road user behaviour and collision causation (Section 5), road design (Section 6), car occupant casualties (Section 7), vulnerable road user casualties (Section 8), and vehicle technologies related to driver assistance, collision prevention and injury mitigation (Section 9).

2 Introduction to RAIDS

2.1 Introduction

This section of the report gives an overview of the RAIDS programme and the principles that underpin it. This starts by explaining the organisational structure of the RAIDS programme, including the links with key external stakeholders. This is followed by an overview of the information governance and ethical standards that are a fundamental part of the RAIDS programme. Finally, the RAIDS Database itself is described.

2.2 Organisation of the RAIDS Programme

The RAIDS programme is organised into three related work packages:

- **Work Package 1 – Data Collection:** Two Data Collection teams investigate collisions in different geographical regions and work closely together to ensure that the objectives of the project are met. Principally this involves the harmonised investigation of road collisions, the collection of specified data, and accurately entering this information into the RAIDS database.

  Specialist collision investigators and injury causation experts were contracted by the DfT to collect data for RAIDS. The two teams were:

  - Transport Research Laboratory (TRL)
  - Transport Safety Research Centre at Loughborough University (TSRC)

  These organisations have considerable experience in road and vehicle safety research and collision data collection.

- **Work Package 2 – Technical Management:** The Technical Management team is responsible for the ongoing review of the data collection protocols and methods. In practice, the Technical Management team defines what data should be gathered, how this should be done with regard to investigation and reconstruction techniques, and how the data security protocols must be applied.

  A core element is the governance, maintenance, and enhancement of the RAIDS Database, with appropriate quality assurance processes applied to ensure the secure provision of validated case data to researchers. This includes the administration of users' accounts and the associated access to the database on behalf of the DfT. The Technical Management team provides training for data collectors (Data Collection Teams) and data analysts, and supplements the database with an on-line glossary. Finally, Work Package 2 is responsible for the technical reporting and analysis of the RAIDS Database.

The Technical Management Team for Phase 1 was the Transport Research Laboratory (TRL).

- **Work Package 3 – Programme Management:** The Programme Management team is appointed by the DfT and is required to ensure that the overall project is progressing to the timelines and targets set by the Department. This includes ensuring that all of the work undertaken by each contractor for the different work packages is on target. The Programme Management also has overall responsibility for the production of project reports, ensuring effective collaboration between contractors is taking place, and that the project meets the data security protocols with respect to handling and storing information.

  The Programme Management Team for Phase 1 was the Transport Research Laboratory (TRL).

Given the scope and scale of the programme of work it was necessary to establish a strong supporting infrastructure, including collaboration with other organisations. These are described as 'Key Stakeholders' in Figure 2-1. The key stakeholders include organisations involved in collision notification and on-scene data collection, organisations involved in the provision of anonymous injury information relating to casualties, and organisations involved in setting and monitoring data security, information governance and ethical standards relating to the collection and storage of RAIDS collision data.

The Programme Management team (Work Package 3) is ultimately responsible and accountable to the DfT for the successful delivery of RAIDS. WP 3 is responsible for interpreting the needs of the DfT, monitoring external trends and the wider research picture, and defining what tasks should be undertaken and when they should be completed. They are also responsible for ensuring that all contractors work together in a co-ordinated and collaborative fashion in order to complete the work to the satisfaction of the DfT and for ensuring that best practice is shared and rigorously applied, particularly in the areas of health and safety, injury data collection ethics and data security.

The Technical Management team are responsible for defining how those tasks should be completed, for example specifying the scientific techniques to be used, the data required and the equipment used to collect those data as well as then subsequently managing the data produced, monitoring and controlling data quality and the release of cases to the database.

The Data Collection teams are responsible for populating the database with the information requested by the Technical and Programme Management Teams in accordance with the defined procedures and then monitoring the quality of their own cases. They are also responsible for feeding back problems, opportunities for improvement, first-hand experiences and perspectives on collisions that may have wider safety implications, as well as for maintaining the relationships with external stakeholders that they need to be able to continue collecting the data.

Figure 2-1 illustrates the organisational structure of RAIDS.

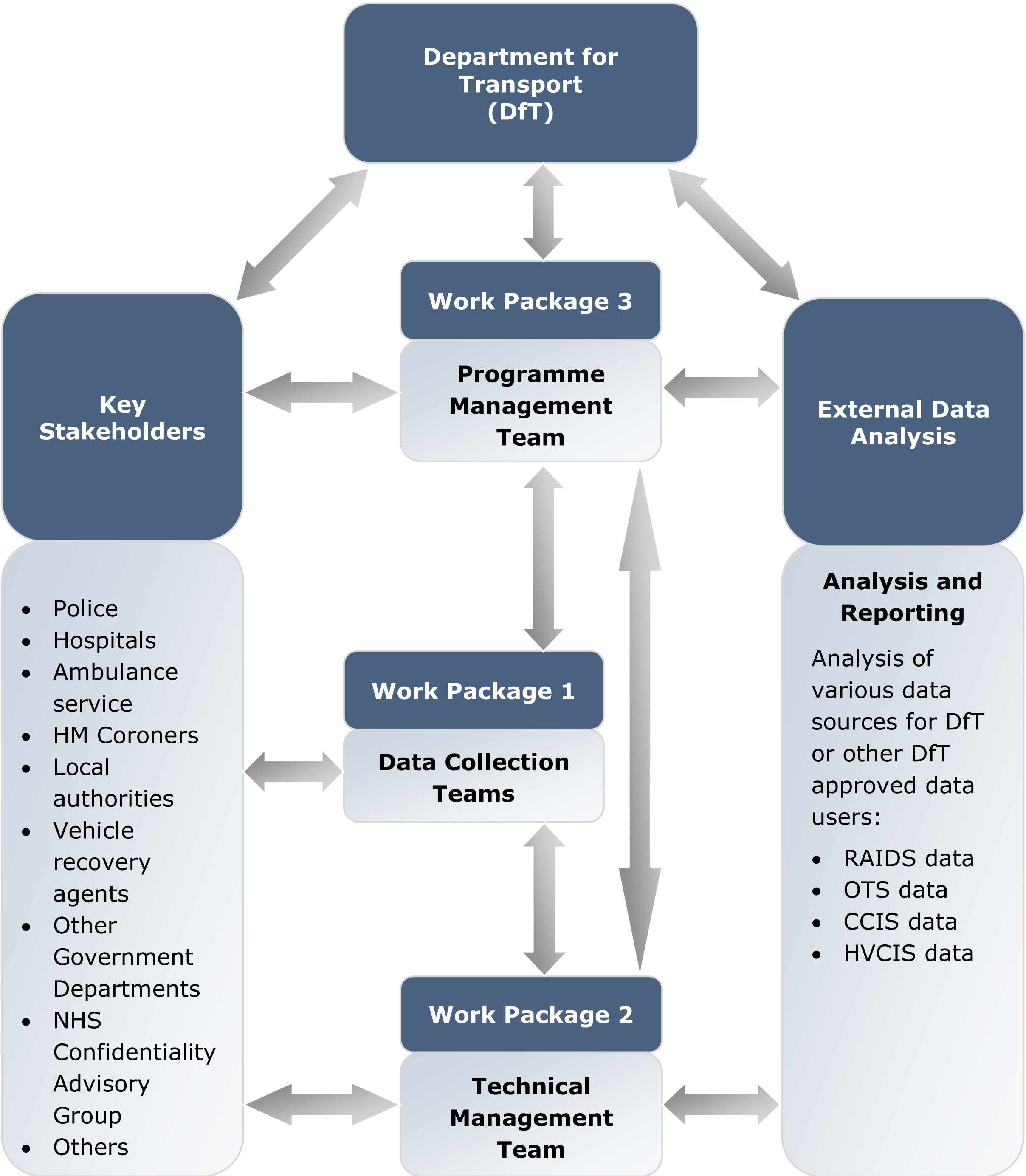

Figure 2-1: Overview of RAIDS Work Packages and relationships

2.3 Information governance and ethics

2.3.1 Data security

Data security is taken extremely seriously by the Department for Transport and the systems for data collection, handling and storage that RAIDS follows were fully assessed against the requirements of the Data Protection Act 1998 and the Mandatory Minimum Measures detailed in Cabinet Office guidance at the start of the current phase. The security requirements for the RAIDS database were established in liaison with security consultants, are reviewed regularly throughout data collection, and are regularly tested by independent auditors.

The RAIDS database does not contain reference to an individual’s name, address, date of birth or vehicle registration number. Personal details are viewed at police premises at the beginning of the investigation to allow the Work Package 1 teams to write to individuals and the medical care team. This is done on police premises and the details are not seen by the members of the investigating team who see the crash data or the anonymous injury information and provide data for inclusion in the database.

2.3.2 Anonymous injury information and ethics

Anonymised injury information is collected from hospitals and Coroners, as well as via questionnaires that are returned by collision participants. The anonymous injury information includes injury descriptions and AIS codes (see Section 3.3.1), which are critical to determining the severity and mechanism of injury. This in turn allows researchers to develop more effective injury countermeasures, such as improved (advanced) occupant restraint systems or pedestrian friendly vehicle front-ends. Indeed, this process has been fundamental to the development of safer vehicles and better safety legislation over the last few decades.

The collection of anonymised injury information has been authorised under Section 251 of the NHS Act 2006 (previously Section 251 of the Health and Social Care Act 2001). In order for the hospital staff to provide the anonymous injury information, the Department had to apply to the National Information Governance Board Ethics and Confidentiality Committee – now the Health Research Authority (HRA) Confidentiality Advisory Group (CAG) – for approval to gain access to and process the data under the NHS Act. The approval process provides the legal basis for the data collection and ensures that the combination of the anonymous injury information with the other anonymous information in the RAIDS database protects the privacy of all participants in the collisions investigated by RAIDS.

As part of the CAG application it was also necessary to:

- Apply for medical ethics approval from a Research Ethics Committee (REC);
- Develop a system level security policy and gain Impact Level 2 accreditation for the RAIDS database;
- Achieve compliance with the NHS Information Governance Toolkit for each data collection team;
- Develop a corporate level security policy for each data collection team.

2.4 The RAIDS Database

A new, custom-designed RAIDS Database was developed at the start of Phase 1 of the RAIDS programme. The Database provides a platform for the analysis and management of data from the previous DfT in-depth accident studies, and is a universal platform for the entry, processing, validation and quality assurance of future collision studies.

The Database has been hosted at TRL in a secure ISO 27001:2013 environment with no breaches of confidentiality, integrity, or availability in all years (approaching 4 years) of operation. It is also accredited by the Department for Transport and met Department of Health requirements with an accompanying Risk Management Accreditation Documentation Sets (RMADS) including a Privacy Impact Assessment and formal security risk management plan. The Database has been accessible for over 99% of the time to the end of Phase 1, including all planned maintenance and upgrade events.

The RAIDS Database is designed to facilitate access management under the control of the WP 2 programme manager, on the instruction of the DfT. All access to the Database, including for data entry, validation, and research applications is controlled. During Phase 1, 24 studies have successfully accessed and used RAIDS data.

The Database includes over 3,000 fields and all data that have been collected during Phase 1 of the RAIDS programme. In addition to the new RAIDS data, over 20,000 cases from legacy studies have been incorporated in the Database. The legacy studies whose data has been transferred to the RAIDS database are:

- **On The Spot (OTS):** This study collected crash data at the scene enabling data to be collected as soon as possible after the crash occurs, before vital evidence had been removed. Data were collected for all vehicle types and collision severities, and data collection ran from 2000 to 2010.
- **Co-operative Crash Injury Study (CCIS):** This study investigated car collisions, including retrospective vehicle examinations, in the UK to understand car occupant injury causation. Data collection ran from 1983 until 2010.
- **Heavy Vehicle Crash Injury Study (HVCIS):** This study collected detailed information on collisions involving heavy goods vehicles, light commercial vehicles, large passenger vehicles, minibuses, agricultural vehicles and 'other motor vehicles' (OMVs). The project consisted of two main elements:
    - **HVCIS fatal files:** Retrospective analysis of police fatal files for collisions involving vehicles of interest. The researchers used detailed information collected by the police to determine potential countermeasures which could have avoided or reduced the severity of the collision.
    - **Truck Crash Injury Study (TCIS):** Detailed information from investigations undertaken by the Vehicle and Operator Services Agency (VOSA) for both injury and non-injury collisions in 15 areas covering England, Scotland, and Wales.

The RAIDS database system was populated with the following data from the previous collision databases:

OTS cases	n = 4,744	Phases 1, 2 and 3 (2000-2010)
CCIS cases	n = 10,611	Phases 6, 7 and 8 (1998-2010)
TCIS cases	n = 1,476	All cases (1995-2010)
HVCIS fatal cases	n = 3,980	All cases (1995-2010)

Phase 1 of the RAIDS programme has collected information on 1,255 collisions (cases). Further information is provided in Section 4.

2.5 Summary of RAIDS and programme outcomes

In-depth studies provide an opportunity to understand how collisions and injuries occur and, from this understanding, contribute to the development of safer roads and safer vehicles.

The RAIDS programme collects detailed information about the collision site, including highway features and environmental factors. Vehicle damage can be matched to the injuries received in the collision, allowing understanding of how vehicle design can be improved.

The data collected will help:

- Identify the collision scenarios, including contributory factors relating to the vehicle, road and road users, which lead to collisions of varying severities.
- Identify how people are injured in road traffic collisions, the injuries they sustain, and how these correlate to vehicle characteristics and highway design features.
- Establish the extent to which a range of safety related measures have reduced the risk of injury to road users involved in collisions.
- Identify measures to reduce further the risk of collisions and injuries (in terms of vehicle design and safety, the road environment and traffic management and human factors).

The main deliverable and legacy from Phase 1 of the RAIDS programme is that in-depth real world road collision data have been collected in a robust and scientific manner, in sufficient detail to provide a key evidence base to help developments to mitigate future collisions and injuries.

The report outlines the data collection methodology, presents some early findings and highlights the potential uses and applications for the data.

3 Methodology

RAIDS brings together different types of investigation from earlier studies into a single programme combining existing data with new, in a common and comprehensive database.

There are two types of investigation:

- *On-scene*: A crash scene investigation done at the time of the collision while the emergency services are still present. These investigations focus on the vehicle, the road user and the highway issues and can include all injury severities, including non-injury crashes and those with relatively minor vehicle damage.
- *Retrospective*: An investigation that is typically performed the day after a collision, which examines vehicles that have had to be recovered from the crash site having suffered more serious damage and where an occupant has attended hospital due to their injuries. The retrospective vehicle investigations are further divided into two categories:
  - 'Retrospective passenger car examinations', and
  - 'Retrospective large vehicle examinations'.

For all case types, follow-up activities involve the collection and coding of anonymous injury and questionnaire data. Each collision type has targets for the number of cases collected, and on-scene cases have targets for the distribution of injury levels within those cases. The approach and protocol for these case types is described further in the following sections.

3.1 On-scene cases

On-scene data collection enables expert investigators to attend the scene of collisions at the same time as the emergency services. The 'perishable' information collected with regard to the physical evidence and eyewitness testimony, allows the incidents to be reconstructed and their causes and consequences to be understood and documented in the RAIDS database.

There are two types of on-scene cases in the RAIDS database:

- Type 1 on-scene cases, which are attended by an on-call team at the time of the collision; and
- Type 2 on-scene cases, are not attended by the on-call team at the time of the collision. These are fatal or life-threatening collisions that occurred in the on-scene area. The team work very closely with the police collision investigators, vehicle examiners and assigned investigating officer to collect data to be equivalent to a Type 1 on-scene case.

The level of detail is the same for each type of on-scene case, but the two data collection methods ensure that cases with fatal or life-threatening injuries can be captured for the periods when the teams are not on shift. Every on-scene case counts as one case, regardless of the type or number of vehicles, or casualties involved.

3.1.1 On-scene data collection protocol/guidelines

For an incident to qualify as an on-scene case, the following approach was used to populate the RAIDS database:

- The team undertake vehicle investigations of all vehicles involved, wherever possible
- The team make scene visits and record 'drive-throughs' on video to document scene evidence when involved vehicles have been removed
- The team create:
    - An anonymised scene plan (using police scene plans for Type 2 cases)
    - Anonymised scene photographs (using police scene photographs for Type 2 cases)
    - An in-depth review of the circumstances of the incident, the course of events and any important factors (using an interview with the Police collision investigator will ascertain this information for Type 2 cases). The following information is included in the review:
        - Sequence of events for collision
            - Collision location
            - Involved road users (road users, vehicle types, make and model)
            - Summary of relative direction of travel of involved road users
        - Environmental conditions
            - Weather
            - Daylight/dusk/night
            - If at night, whether street lighting was present?
        - Road layout details
            - Number of lanes?
            - Near a junction?
            - Near traffic lights?
            - Safety barriers present?
            - Any camera enforcement nearby?
            - Any road works or temporary traffic management in place?
        - Journey purpose / duration
        - Road user
            - Clothing and conspicuity
            - Motorcyclist – helmet details / protective clothing
            - Cyclist – helmet worn?
            - Any details of age/height/weight
            - Driver/rider training and experience
            - Whether the road user had any disabilities or impairments?
        - Reconstruction data
            - Summary of scene physical evidence
                - Point of impact and point of rest
                - Tyre marks on the road
                - Travelling speeds and severity of collisions

On-scene investigations require a multi-disciplinary team to gather information on the events preceding the collision, a reconstruction of the impact(s) and an in-depth assessment of the consequences. Over 2,000 data fields were typically recorded in the database for each investigation with qualitative collision descriptions and comments providing additional context.

3.1.2 On-scene investigation criteria

3.1.2.1 Response time

It is important that there are robust and efficient notification systems to provide early warning to the on-scene investigation teams, allowing collisions to be investigated as quickly as practicable. This is because the more time that elapses following an incident, the greater the chance for the evidence to be contaminated or literally to be swept or towed away, which can have adverse effects on the quality of the information and subsequent conclusions that can be documented in the database.

RAIDS investigators must arrive at 75% of collisions within 30 minutes of their notification. However, the target response time must not have any adverse effects on safety. First and foremost the teams must abide by the health and safety guidelines and obey road traffic law and the Highway Code at all times when driving.

3.1.2.2 Police injury severity

The on-scene scope covers any road collision, regardless of road user type, injury severity or property damage level, including damage only incidents. However, a minimum proportion of cases must involve a fatality or serious injury (KSI) or a slight injury (Table 3-1). The definitions of police injury severity are defined in Appendix A.

Table 3-1: Injury severity[1] profile for on-scene investigations

Injury level	% of cases
Killed or Seriously Injured	25
Slightly injured	50
No injury, damage only	25

3.1.3 On-scene geographical regions

In Phase 1 of the RAIDS project, two teams collected data using the on-scene areas used by the previous On The Spot (OTS) project. The full methodology for the OTS project was detailed in the OTS Phase I (Hill *et al*. 2005) and II (Cuerden *et al*. 2008) reports. This section provides a brief overview of the geographical areas sampled. Section 4 provides a more comprehensive summary of the collisions investigated and their characteristics.

[1] Initial police injury severity, see Appendix A

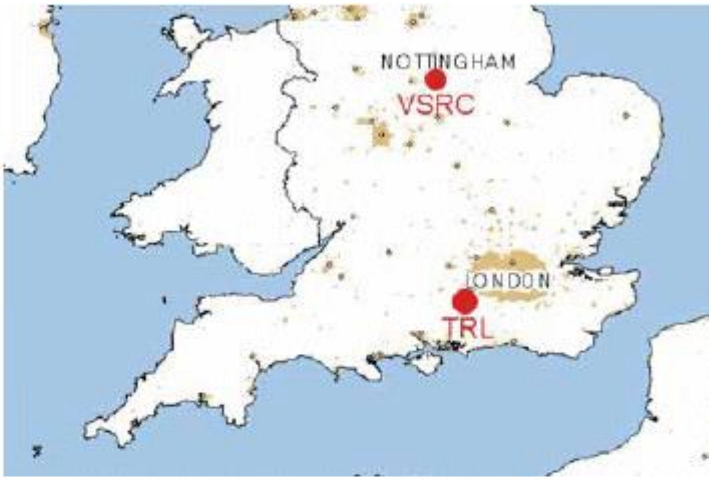

Figure 3-1: Geographical locations of the two OTS teams

The Transport Safety Research Centre (TSRC) (formerly the Vehicle Safety Research Centre, VSRC) from Loughborough University covered the South Nottinghamshire area of the East Midlands (Figure 3-2). This included the city of Nottingham with an urban population of approximately 267,000 people. The TSRC team office was located at the Nottinghamshire Police Operational Support Division close to the centre of Nottingham. It lay at the centre of a radial network of trunk roads so that most points on the perimeter of the area could be reached very quickly.

The Transport Research Laboratory (TRL) covered the Slough, Reading, Henley-on-Thames and High Wycombe areas in the South East of England (Figure 3-3). The TRL team office was located at the TRL site in Crowthorne, Berkshire, although the team were also able to work out of Three Mile Cross and Taplow police stations, which provided a more central location for team members waiting for notification of crashes. The study area around TRL was traversed in the north by the M40 and the southern edge of the region almost bordered the M3, and contained Junctions 11 and 12 of the M25. The location of any collision within the investigation area could be reached rapidly despite the often significant levels of traffic present on the roads in the region.

Both areas contained a good mix of A, B, rural and urban roads and motorway environments. However, the areas were different in terms of road-user crash involvement and associated characteristics. The TSRC area was concentrated around a large conurbation, whereas the TRL area had more balanced proportions of urban and rural environments.

A major part of the RAIDS methodology was that collisions were only investigated if they occurred within the defined geographical areas (Figure 3-2 and Figure 3-3). This was so that the sampled collisions could be directly compared to the subset of nationally-recorded collisions in those areas. This enabled a sample of crashes to be investigated from within known populations, and it allowed for a more reliable scaling of findings from the study to the national situation. The RAIDS investigation areas had fixed geographical boundaries, which were coincident with the areas covered by the local hospitals and coroners that co-operated with the study. The areas covered by the teams were completely identifiable by details from local police injury collision reports, so clear statistical links were possible.

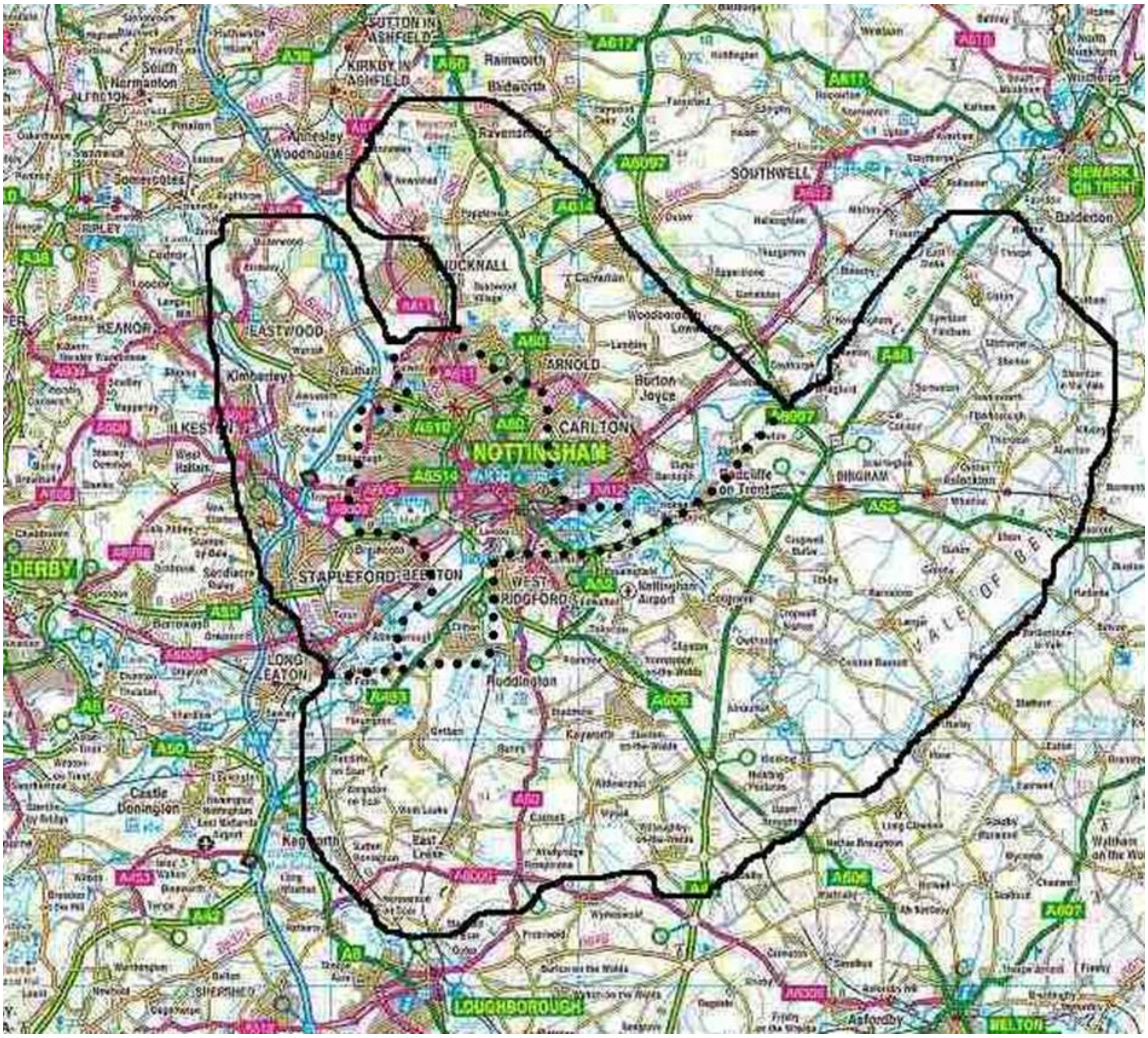

Figure 3-2: TSRC investigation area. Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationary Office © Crown Copyright AL 100021177

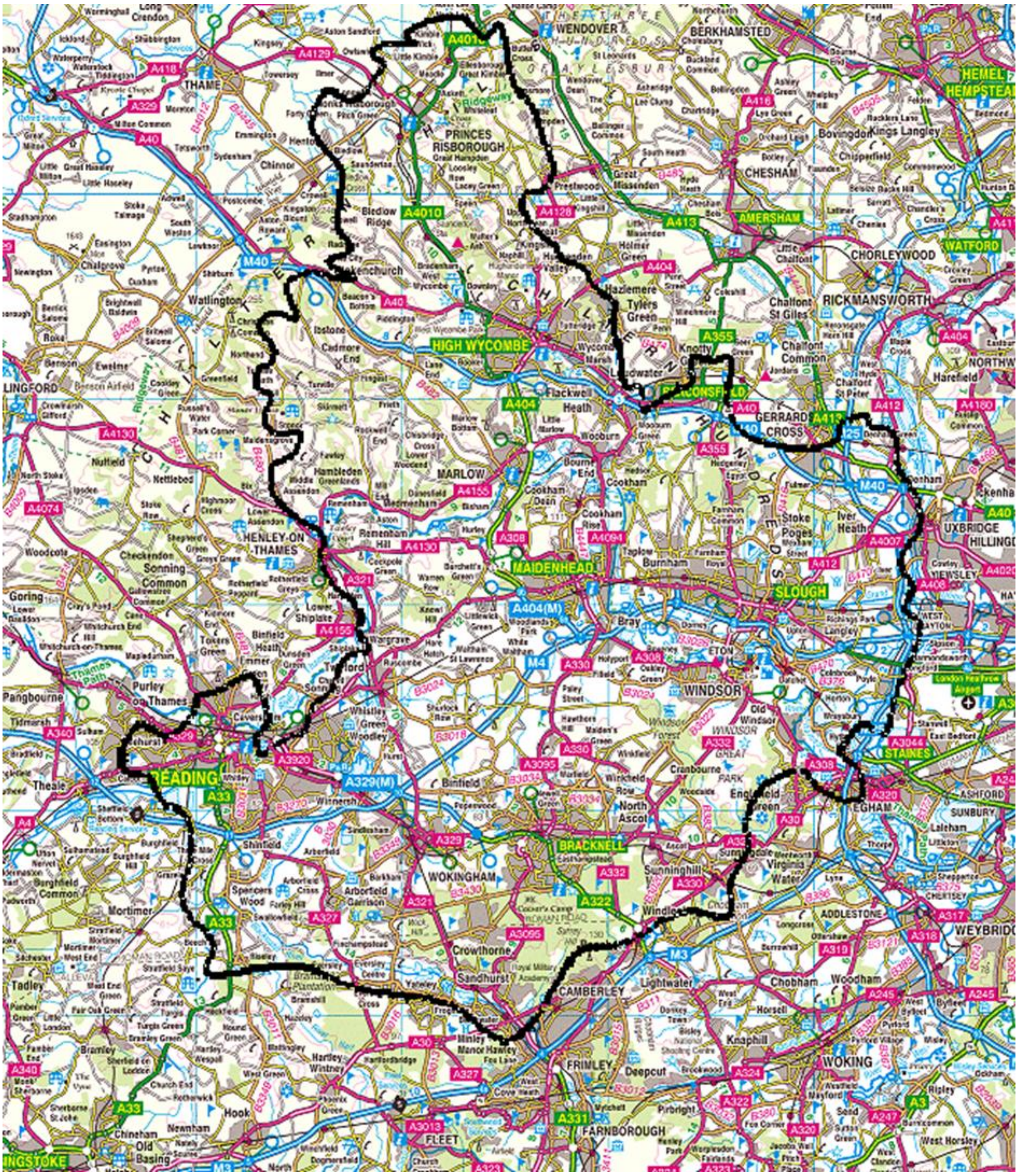

Figure 3-3: TRL investigation area. Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationary Office © Crown Copyright AL 100021177

3.2 Retrospective cases

3.2.1 Retrospective case data collection protocol/guidelines

The retrospective RAIDS cases involved a detailed examination of accident damaged vehicles a few days after the accident and not at the accident scene. This allowed a relatively large number of vehicles to be examined compared to real-time on-scene cases, and it meant that the vehicles could be given a very thorough examination. However, factors relating to the environment, the road infrastructure and driver behaviour could not be captured in the detail provided by the on-scene cases.

The examinations were normally conducted at recovery yards and were sufficiently detailed to allow estimation of impact speeds as well as identifying occupant and vulnerable road user contact points inside and outside the vehicle respectively. Injury information was acquired from hospitals or from post-mortem reports, as appropriate, and information was sought from those involved in the accidents via questionnaires (Section 3.3). The vehicle damage and injury information was correlated and mechanisms of injury documented within the reconstruction.

The objectives can be summarised as:

- Provide detailed information on the crashworthiness of vehicles
- Analyse the benefits of countermeasures (such as airbags) in reducing injury
- Provide the ability to monitor the effectiveness of new safety systems and countermeasures
- Identify the needs for improved vehicle safety as changes take place
- Provide detailed bio-mechanical information
- Help in the development of improved impact test dummies
- Support evidence led legislation for improved vehicle safety design

Vehicles were identified from the Police notification systems, and the study was biased towards fatal and serious injury accidents, with the target number of vehicle investigations reached by investigating a random sample of collisions classified as slight injury.

Over 1,000 data fields were typically recorded in the database for each investigation with qualitative accident descriptions and comments providing additional context.

There were three categories of retrospective cases in the RAIDS database:

- Retrospective passenger car
- Retrospective large vehicle
- Retrospective car and large vehicle

3.2.2 Retrospective cases investigation criteria vehicle definitions

3.2.2.1 Vehicle definitions

Retrospective passenger car examinations

Police reported road injury collisions were eligible for selection for investigation if at least one vehicle involved:

- Was a car or car derivative[2]
- Was seven years old or less at the time of the collision
- Had at least one occupant who was injured (according to the initial police injury severity assessment)
- Was towed away and was available for subsequent inspection (held at a recovery yard or repair garage identified following initial notification by the police)

If a collision involved at least one car, or car derivative that met the age, occupant injury and tow-away criteria, then wherever possible all the vehicles involved in the collision were examined. This maximises the understanding of the crash dynamics and impact severity.

If another vehicle in the collision met the large vehicle criteria, it was completed as a joint retrospective car and large vehicle case (counting to both investigation targets).

Retrospective large vehicle examinations

Police reported road injury collisions were eligible for selection for investigation, where:

- At least one vehicle involved was a:
    - heavy goods vehicle (HGV, GVW>3,500kg)
    - light goods vehicle (LGV, GVW<3,500kg), including small vans and pick-ups that don't have passenger car equivalents
    - large passenger vehicle (buses >16 passenger seats)
    - minibus (8-16 passenger seats), or
    - "other motor vehicle" (recovery vehicle, refuse collection vehicle etc)
- There is at least one injured road user in either the large vehicle or involved in the collision with the large vehicle
- The primary case vehicle is available for subsequent inspection

Once a collision was selected, all available vehicles involved in that incident were examined, regardless of whether or not they met the selection criteria. Other vehicles, such as passenger cars and motorcycles etc. did not count towards the retrospective large vehicle examination target.

If another vehicle in the collision met the passenger car criteria, it was completed as a joint retrospective car and large vehicle case (counting to both investigation targets).

3.2.2.2 Police injury severity

There were no targets with respect to the proportion of KSIs for retrospective cases. The injury severity is defined by police injury severity (Appendix A).

Cases with killed or seriously injured road users were prioritised for investigation. The target number of vehicle investigations was reached by investigating a random sample of collisions classified as slight injury. Where possible, once a case was selected, all involved vehicles were inspected.

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[2] Car Derived Vehicle (CDV)

This resulted in a stratified sampling strategy for retrospective cases favouring the more severe injury.

3.2.3 Retrospective cases geographical regions

Both data collection teams had a retrospective geographical area that included some overlap with the on-scene cases. If an eligible case was selected as an on-scene case, it was not chosen as a retrospective car case.

Retrospective passenger car examinations

The TRL team collected data from the whole of the Thames Valley police force area. The TSRC team collected data from the Leicestershire and Nottinghamshire police force areas.

Retrospective large vehicle examinations

The TRL team collected data from the whole of the Thames Valley and Hampshire police force areas. The TSRC team collected data from the whole of the Leicestershire and Nottinghamshire police force areas.

3.3 Follow-up data

3.3.1 Injury data

For all collisions investigated which met the specified criteria, the Work Package 1 teams obtained relevant anonymous injury data from hospitals attended by the injured persons, or where applicable, the post mortem from the relevant coroner's office. Anonymous injury information was obtained for all fatalities and all persons injured in the vehicles and who received trauma care at a hospital.

The injury data were coded using the Association of the Advancement of Automotive Medicine (AAAM) injury coding scale AIS 2008 (AAAM, 2008). In the AIS system, each injury description is assigned a unique six-digit numerical code in addition to the AIS severity score. The AIS severity score is a consensus-derived anatomically-based system that classifies individual injuries by body region on a six-point ordinal 'threat to life' severity scale ranging from AIS 1 (minor) to AIS 6 (maximum), shown in Table 3-2. MAIS denotes the Maximum AIS score of all injuries sustained by a particular occupant. It is a single number that attempts to describe the seriousness of the injuries suffered by that occupant.

Table 3-2: AIS 2008 Injury severity scores

AIS score	Description
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Maximum
9	Unknown

As well as being coded in the AIS system, each injury was considered in relation to the impact dynamics and probable resultant kinematics of the casualty, as revealed by the vehicle and/or scene examinations, as well as the contacts identified in the course of examining the vehicle interior and exterior structures. The outcome of this was that each injury was, wherever possible, assigned an Injury Causation Code (ICC), indicating the likely cause of the injury. This included indirect causes, for example, a pelvic fracture caused by femur loading as a result of knee contact with the facia, in addition to non-contact causes, such as a neck strain (commonly referred to as whiplash) caused purely by acceleration/deceleration forces. The precise event that was the prime cause of the injury was also identified.

3.3.2 Retrospective questionnaires

When appropriate, questionnaires were sent to those involved in collisions and, where applicable, witnesses, to gather further information about the incident. This information supplemented the injury data obtained from hospitals; indeed, for injured people who did not attend hospital, this was the only source of injury information. However, if an occupant in a case was fatally injured, sustained a life threatening head injury or were over 75 years old, no questionnaires were sent to anyone involved in the accident. In these cases, information on survivors was obtained only from the hospitals while, for the fatalities, a request was made to the relevant Coroner for a copy of the post-mortem report.

3.4 RAIDS and STATS19

In Great Britain in 2014 there were 194,477 reported road casualties (1,775 fatal and 192,702 injured) compared to 3,384 collision participants who have been investigated as part of Phase 1 of the RAIDS programme. STATS19 is Great Britain's database that records police reported traffic collisions that result in injury to at least one person. The database primarily records information on where the collision took place, when the collision occurred, the conditions at the time and location of the collision, details of the vehicles involved, and information about the casualties. Approximately 50 pieces of information are collected for each collision (Department for Transport 2007).

The severity of the casualties involved in each collision is assessed by the investigating police officer. Each casualty is recorded as being either slightly, seriously, or fatally injured. Fatal injury includes only casualties who died less than 30 days after the collision, not including suicides or death from natural causes. Serious injury includes casualties who were admitted to hospital as an in-patient. Slight injury includes minor cuts, bruises, and whiplash. The full definitions of these injury severities (and all other information recorded in STATS19) are given in the STATS20 document which accompanies the STATS19 form[3].

The RAIDS and the STATS19 data sources each have their strengths and limitations: STATS19 includes the details of a large number of personal injury collisions, as recorded by the police, but provides limited depth, while RAIDS records a relatively small number

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[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230596/stats20-2011.pdf

of collisions in much greater detail. There is overlap between RAIDS and STATS19 with some collisions being recorded in both databases as indicated in Figure 3-4.

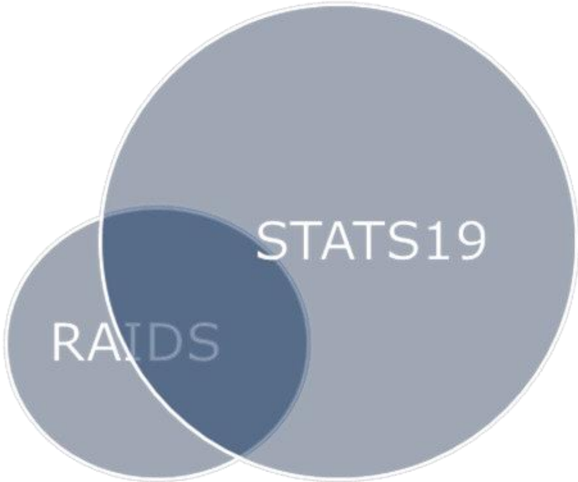

Figure 3-4: Comparing RAIDS and STATS19 cases

In Phase 1 of the RAIDS programme the TRL team collected anonymised STATS19 reports and linked these to the RAIDS database. The TSRC team were unable to collect STATS19 data directly under the conditions of their police agreement, and it is recommended that a future Phase will involve a retrospective linking exercise to match common cases in each database.

Not all RAIDS cases are recorded in STATS19, because some on-scene investigations are damage only and are not eligible and some injury collisions are not reported to the police. The RAIDS programme provides a useful comparison to help assess and understand reporting rates, as well as a validation tool to compare the information recorded for specific cases.

It is widely recognised that there is a significant degree of under-reporting of collisions in STATS19, the extent of which varies by collision and vehicle type. While fatality numbers in STATS19 are generally considered to be an accurate reflection of the true picture, UK studies (summarised by Ward *et al.*, 2006) suggested correction factors of between 1.6 and 2 were likely to be appropriate for serious and slight casualties. Since that time, the Department for Transport have made further investigations into the under-reporting issue, mainly by comparing hospital admissions and travel/crime survey data with STATS19. Their latest analysis (Department for Transport, 2010a) concludes that the approximate 95% confidence limit for serious casualties gives correction factors of between 2.0 and 4.2, and between 2.6 and 3.4 for slight injuries. For car occupants and pedestrians, the central estimates are for overall correction factors (for all casualties) of 3.1 and 2.8 respectively (the breakdowns by serious and slight are not given).

As the RAIDS programme evolves and more cases are collected, the data will provide an evidence base with regard to assessing the quantity and quality of road injury police reporting systems for a sample of forces in England.

4 Overview of Phase 1 data

4.1 Collision severity (case numbers)

The sample of collisions collected in Phase 1 of RAIDS is presented in Table 4-1 (for on-scene cases) and Table 4-2 (for retrospective car and large vehicle cases). The on-scene cases in Table 4-1 are compared with the collision severity targets set at the beginning of the programme. It can be observed that the target proportions for the most important fatal and serious injury categories were exceeded, with a commensurate small reduction in the proportion of less critical slight and damage-only collisions.

The majority of cases collected were on-scene cases. This group comprises on-scene investigations by the RAIDS WP1 teams (Type 1) and also virtual on-scene cases using data from police collision investigators (Type 2). NB: retrospective vehicle examinations that have been performed as part of a Type 2 on-scene investigation are not shown in Table 4-2, because the collision is counted only as an on-scene case; however, this enhanced retrospective information is available for researchers. Furthermore, cases that involved a collision between a car and a large vehicle have been assigned to the Type 2, large vehicle group in Table 4-2.

Table 4-1: Distribution of on-scene case type by injury severity (all cases)

RAIDS final collision severity	On-scene N	Achieved Target %	RAIDS Target %
Fatal	31	*28.6*	*25*
Serious	149		
Slight	285	*45.2*	*50*
Damage only	149	*23.7*	*25*
Unknown	16	*2.5*	*0*
Total	**630**	***100***	***100***

Table 4-2: Distribution of retrospective case type by injury severity (all cases)

RAIDS final collision severity	Retrospective car N	Retrospective large vehicle N
Fatal	34	68
Serious	148	98
Slight	169	71
Damage only	6	1
Unknown	16	14
Total	**373**	**252**

Table 4-3 enables a comparison between the samples of collisions attended by the two Work Package 1 teams within the RAIDS sample regions and the national statistics from Reported Road Casualties Great Britain (The Department for Transport, 2015), which contains details of all police-reported injury road traffic collisions. This information is presented alongside the RAIDS case information to allow the effects of the RAIDS sampling strategy to be quantified against the national picture. NB: where presented in this report, RRCGB data are not weighted to account for under-reporting. The RAIDS sample is skewed towards more serious collisions; this is directly related to the sampling strategy and the fact that slight collisions are cleared more quickly than those involving more serious injury.

If only the injurious outcomes from RAIDS cases are considered, fatal collisions are over-represented by a factor of 11.2, serious by 2.6, with slight collisions being under-represented by a factor of 0.59, compared with data from Great Britain (The Department for Transport, 2015). However, because of the different on-scene and retrospective sampling criteria, any weighting of the data will need to consider the type of investigation and more sophisticated weighting methodologies might be developed.

Table 4-3: Distribution of collision severity (all cases)

Collision severity	Initial police injury severity		RAIDS final collision severity		RRCGB (2014)	
	N	%	N	%	N	%
Fatal	130	*10.36*	133	*10.60*	1,658	*1.13*
Serious	381	*30.36*	395	*31.47*	20,676	*14.13*
Slight	570	*45.42*	525	*41.83*	123,988	*84.74*
Injury NFS[4]	14	*1.12*	-		-	-
Damage only	143	*11.39*	156	*12.43*	-	-
Unknown	17	*1.35*	46	*3.67*	-	-
Total	**1,255**	***100***	**1,255**	***100***	**146,322**	***100***

Table 4-3 also provides information on the breakdown of case injury severity for both the initial police severity (at the time of the notification to the RAIDS data collection teams) and the final RAIDS collision severity assessed at the conclusion of the case. It can be observed that a small proportion of fatal and serious injury cases are reclassified between initial notification and completion of the case.

4.1.1 Collision severity (case numbers) by road classification

RAIDS data are collected from two discrete sampling regions. Table 4-4 presents information on the distribution of the combined Phase 1 sample by RAIDS collision severity and the road type at the collision locus.

[4] NFS = Not Further Specified

Table 4-4: Number of collisions by RAIDS collision severity and road classification

Road classification	RAIDS collision severity					Totals
	Fatal	Serious	Slight	Non-injury	Unknown	
Motorway	23	30	53	25	3	**134**
Trunk road	18	59	71	17	7	**172**
A road	51	134	153	47	15	**400**
B road	18	66	76	20	7	**187**
Unclassified	22	96	148	46	9	**321**
Unknown/Others	1	10	24	1	5	**41**
Total	**133**	**395**	**525**	**156**	**46**	**1,255**

The breakdown of fatal, serious, and slight injuries by road class is compared with the distribution for GB in Table 4-5 and Table 4-6.

Table 4-5: RAIDS collision severity by road class for RAIDS Phase 1 sample

Road class	Fatal %	Serious %	Slight %	Total %
Motorways	*21.70*	*28.30*	*50.00*	*100*
A roads and trunk roads	*14.20*	*39.71*	*46.09*	*100*
B roads	*11.25*	*41.25*	*47.50*	*100*
Other roads	*7.64*	*35.22*	*57.14*	*100*
Total	***12.63***	***37.51***	***49.86***	***100***

Table 4-6: Collision severity by road class for GB collisions (Reported Road Casualties Great Britain, 2014)

Road class	Fatal %	Serious %	Slight %	Total %
Motorways	*1.51*	*10.57*	*87.92*	*100*
A roads	*1.35*	*13.71*	*84.94*	*100*
B roads	*1.20*	*15.64*	*83.16*	*100*
Other roads	*0.80*	*14.51*	*84.69*	*100*
Total	***1.13***	***14.13***	***84.74***	***100***

4.2 Vehicle numbers

Table 4-7 shows that the RAIDS sample is comparable to the national sample with respect to the distribution of vehicle types. In both cases, passenger cars predominate, representing over 70% of vehicles. Goods vehicles comprise a large proportion of vehicles in the RAIDS sample and vulnerable road users are under-represented compared with the national data in terms of the number of vehicles in the sample, both due to the sampling strategy set at the beginning of Phase 1.

Table 4-7: Vehicle type for RAIDS and national samples

Vehicle type	RAIDS N	RRCGB (2014) N	RAIDS %	RRCGB (2014) %
Agricultural vehicle (include diggers etc.)	5	579	*0.21*	*0.22*
Bus or coach (17 or more passenger seats)	32	6,103	*1.36*	*2.28*
Car	1,673	189,488	*71.25*	*70.72*
Heavy Goods	221	6,873	*9.41*	*2.57*
Light Goods	220	14,043	*9.37*	*5.24*
Minibus (8-16 passenger seats)	9	579	*0.38*	*0.22*
Motorcycle - 50cc and under	8	2,498	*0.34*	*0.93*
Motorcycle - over 50cc and up to 124cc	33	8,903	*1.41*	*3.32*
Motorcycle - over 125cc and up to 500cc	21	2,352	*0.89*	*0.88*
Motorcycle - over 500cc	41	7,407	*1.75*	*2.76*
Other motor vehicle (give details)	5	1,626	*0.21*	*0.61*
Pedal Cycle	53	21,979	*2.26*	*8.20*
Taxi/Private Hire	27	5,509	*1.15*	*2.06*

4.3 Casualty severity

Table 4-8 shows the casualty severity of road users in the RAIDS sample (both with respect to the initial police severity and the final RAIDS severity) and the Great Britain data for 2014. This highlights that more severely injured casualties are over-represented; a direct result of the RAIDS sampling strategy. NB: multiple casualties may be involved in a single case (*cf.* Table 4-3).

Table 4-8: Distribution of casualty severity (all cases)

Casualty severity	Initial police injury severity		RAIDS final injury severity		RRCGB (2014)	
	N	%	N	%	N	%
Fatal	144	*4.26*	147	*4.34*	1,775	*0.91*
Serious	525	*15.51*	559	*16.52*	22,807	*11.73*
Slight	1,172	*34.63*	1,038	*30.67*	169,895	*87.36*
Uninjured	1,440	*42.55*	1441	*42.58*	-	-
Unknown	103	*3.04*	192	*5.67*	-	-
Not answered	-	-	7	*0.21*	-	-
Total	**3,384**	***100***	**3,384**	***100***	**194,477**	***100***

Table 4-9 provides information on the severity of casualties by investigation type for the entire Phase 1 sample. Again, most casualties originated from on-scene investigations.

Table 4-9: Distribution of case type by casualty severity (all cases)

RAIDS Casualty severity	On-scene	Retrospective (car)	Retrospective (large vehicle)	Total	
	N	N	N	N	%
Fatal	36	38	73	147	*20.90*
Serious	190	229	140	559	
Slight	480	344	214	1,038	*30.74*
Uninjured	962	217	262	1,441	*42.67*
Unknown	53	86	53	192	*5.69*
Not Answered	-	-	-	-	*0.00*
Total	**1,721**	**914**	**742**	**3,377**	***100***

4.3.1 Number of casualties by collision type and type of vehicle involved

Table 4-10 shows the RAIDS Phase 1 sample in terms of the casualty type and number of vehicles involved in the collision. Casualties from cars again predominate. Table 4-10 shows that car occupants from two vehicle collisions are the modal group in the RAIDS sample, followed by car occupants in collisions involving three or more vehicles. Car occupants resulting from single vehicle collisions, without pedestrian involvement, are the next largest group.

Table 4-10: Casualties by collision type and type of vehicle involved (all casualties[5])

Casualty type	Single vehicle		2 vehicle collisions	3+ vehicle collisions	Total
	With Pedestrian	No Pedestrian			
Bus occupant	8	6	143	4	**161**
Car occupant	81	347	1,416	581	**2,434**
Cyclist	1	3	47	2	**53**
Heavy Goods Vehicle occupant	7	20	147	51	**225**
Light Goods Vehicle occupant	2	43	182	63	**291**
Motorcyclist	-	18	78	14	**110**
Not Answered	-	-	-	1	**1**
Other	1	1	9	4	**15**
Pedestrian	70	-	14[6]		**84**
Unknown	-	-	1	9	**10**
Total	**170**	**438**	**2,023**	**729**	**3,384**

Table 4-11 presents the same information but for only fatally injured casualties. This shows the expected similar pattern. Table 4-12 and Table 4-13 show the breakdown for serious and slight casualties respectively. As expected, these data exhibit a similar pattern.

[5] Includes Uninjured and Unknown casualty severities

[6] Pedestrian casualties in 2 and 3+ vehicle accidents are not included in the overall total row

Table 4-11: Casualties by collision type and type of vehicle involved (fatal casualties)

Casualty type	Single vehicle		2 vehicle collisions	3+ vehicle collisions	Total
	With Pedestrian	No Pedestrian			
Bus occupant	-	-	-	-	**-**
Car occupant	-	17	69	14	**100**
Cyclist	-	-	9	-	**9**
Heavy Goods Vehicle occupant	-	3	3	1	**7**
Light Goods Vehicle occupant	-	3	3	2	**8**
Motorcyclist	-	-	9	4	**13**
Not Answered	-	-	-	-	**-**
Other	-	-	-	-	**-**
Pedestrian	6	-	4		**10**
Unknown	-	-	-	-	**-**
Total	**6**	**23**	**93**	**21**	**147**

Table 4-12: Casualties by collision type and type of vehicle involved (serious casualties)

Casualty type	Single vehicle		2 vehicle collisions	3+ vehicle collisions	Total
	With Pedestrian	No Pedestrian			
Bus occupant	-	-	8	-	**8**
Car occupant	-	85	214	71	**371**
Cyclist	-	2	18	1	**21**
Heavy Goods Vehicle occupant	-	6	13	1	**20**
Light Goods Vehicle occupant	-	7	25	8	**40**
Motorcyclist	-	8	37	4	**49**
Not Answered	-	-	-	-	**-**
Other	-	1	-	-	**1**
Pedestrian	43	-	6		**49**
Unknown	-	-	-	-	**-**
Total	**-**	**109**	**315**	**85**	**559**

Table 4-13: Casualties by collision type and type of vehicle involved (Slight casualties)

<table>
<tr><th rowspan="2">Casualty type</th><th colspan="2">Single vehicle</th><th rowspan="2">2 vehicle collisions</th><th rowspan="2">3+ vehicle collisions</th><th rowspan="2">Total</th></tr>
<tr><th>With Pedestrian</th><th>No Pedestrian</th></tr>
<tr><td>Bus occupant</td><td>-</td><td>2</td><td>48</td><td>-</td><td>50</td></tr>
<tr><td>Car occupant</td><td>1</td><td>122</td><td>477</td><td>161</td><td>761</td></tr>
<tr><td>Cyclist</td><td></td><td>1</td><td>19</td><td>1</td><td>21</td></tr>
<tr><td>Heavy Goods Vehicle occupant</td><td>1</td><td>7</td><td>22</td><td>8</td><td>38</td></tr>
<tr><td>Light Goods Vehicle occupant</td><td>-</td><td>24</td><td>63</td><td>18</td><td>105</td></tr>
<tr><td>Motorcyclist</td><td>-</td><td>9</td><td>28</td><td>3</td><td>40</td></tr>
<tr><td>Not Answered</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Other</td><td>-</td><td>-</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Pedestrian</td><td>18</td><td>-</td><td colspan="2">3</td><td>21</td></tr>
<tr><td>Unknown</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>20</td><td>165</td><td>658</td><td>192</td><td>1,038</td></tr>
</table>

Table 4-14 presents a comparison between the RAIDS sample and GB data for the distribution of casualty type. This shows that passenger car occupants are the main group, but that the RAIDS sample has a greater percentage of casualties in cars compared to the national data. This is likely to be – at least in part – due to the fact that the national data only includes injured casualties. These data also reiterate the greater proportions of casualties from large vehicles in RAIDS and the lesser proportions of vulnerable road user casualties compared with the national data.

Table 4-14: Casualties by road user type for RAIDS and GB samples

Casualty type	RAIDS N	RRCGB (2014) N	RAIDS %	RRCGB (2014) %
Bus occupant	161	5,198	*4.79*	*2.69*
Car occupant	2,434	115,530	*72.48*	*59.74*
Cyclist	53	21,287	*1.58*	*11.01*
Heavy Goods Vehicle occupant	225	1,353	*6.70*	*0.70*
Light Goods Vehicle occupant	291	4,915	*8.67*	*2.54*
Motorcyclist	110	20,366	*3.28*	*10.53*
Pedestrian	84	24,748	*2.50*	*12.80*
Total	**3,358**	**193,397**	***100***	***100***

4.4 Collision Type

4.4.1 Cases by collision type

Table 4-15 presents the RAIDS sample broken down by the collision description, for each data collection team. This shows that the most frequently recorded collision type is 'rear end' collisions, followed by 'head-on' and 'cornering' collisions. The two RAIDS sub-samples are generally similar, but variations exist due to the differences between the sampling regions.

Table 4-15: Number of cases by collision type (all collisions)

Code	Collision description	TRL		TSRC		Total	
		N	%	N	%	N	%
A	Overtaking and lane changing	46	*7.96*	65	*9.60*	111	*8.84*
B	Head-on	78	*13.49*	67	*9.90*	145	*11.55*
C	Lost control or off road (straight roads)	78	*13.49*	107	*15.81*	185	*14.74*
D	Cornering	58	*10.03*	74	*10.93*	132	*10.52*
E	Collision with obstruction	35	*6.06*	28	*4.14*	63	*5.02*
F	Rear end	112	*19.38*	94	*13.88*	206	*16.41*
G	Turning versus same direction	18	*3.11*	26	*3.84*	44	*3.51*
H	Crossing (no turns)	31	*5.36*	50	*7.39*	81	*6.45*
J	Crossing (vehicle turning)	28	*4.84*	46	*6.79*	74	*5.90*
K	Merging	13	*2.25*	17	*2.51*	30	*2.39*
L	Right turn against	25	*4.33*	25	*3.69*	50	*3.98*
M	Manoeuvring	13	*2.25*	25	*3.69*	38	*3.03*
N	Pedestrians crossing road	29	*5.02*	32	*4.73*	61	*4.86*
P	Pedestrians other	7	*1.21*	11	*1.62*	18	*1.43*
Q	Miscellaneous	2	*0.35*	9	*1.33*	11	*0.88*
N/A	Missing	5	*0.87*	1	*0.15*	6	*0.48*
	Total	**578**	***100***	**677**	***100***	**1255**	***100***

Table 4-16 shows the same information for fatal and serious collisions only. This presents a different picture with respect to the most important collision type, with 'head-on' collisions being the largest group, followed by 'loss of control or off road' and 'rear-end'. 'Overtaking' and 'lane changing' and 'cornering' also make up significant proportions for this group of more severe collisions.

Table 4-16: Number of cases by collision type (fatal and serious collisions)

Code	Collision description	TRL		TSRC		Total	
		N	%	N	%	N	%
A	Overtaking and lane changing	25	*9.80*	29	*10.62*	54	*10.23*
B	Head-on	54	*21.18*	41	*15.02*	95	*17.99*
C	Lost control or off road (straight roads)	32	*12.55*	47	*17.22*	79	*14.96*
D	Cornering	23	*9.02*	33	*12.09*	56	*10.61*
E	Collision with obstruction	10	*3.92*	8	*2.93*	18	*3.41*
F	Rear end	31	*12.16*	31	*11.36*	62	*11.74*
G	Turning versus same direction	10	*3.92*	10	*3.66*	20	*3.79*
H	Crossing (no turns)	17	*6.67*	13	*4.76*	30	*5.68*
J	Crossing (vehicle turning)	9	*3.53*	15	*5.49*	24	*4.55*
K	Merging	7	*2.75*	1	*0.37*	8	*1.52*
L	Right turn against	7	*2.75*	7	*2.56*	14	*2.65*
M	Manoeuvring	2	*0.78*	6	*2.20*	8	*1.52*
N	Pedestrians crossing road	21	*8.24*	20	*7.33*	41	*7.77*
P	Pedestrians other	6	*2.35*	7	*2.56*	13	*2.46*
Q	Miscellaneous	1	*0.39*	5	*1.83*	6	*1.14*
	Total	**255**	***100***	**273**	***100***	**528**	***100***

4.5 Characteristics of Road Users

4.5.1 Road user gender and age by vehicle type

Table 4-17 and Figure 4-1 present RAIDS casualties by age band and road user type. This repeats the earlier theme of car occupants being dominant in the sample overall. The 25-34 year old group contains the greatest number of casualties, with the distribution of the sample skewed towards younger adult casualties.

Table 4-17: Road users by age band and road user type

Road user type	0-7	8-15	16-24	25-34	35-44	45-54	55-64	65-74	75+	Not Answered	Unknown	Total
Bus occupant	2	1	24	23	13	21	13	8	3	52	1	**161**
Car occupant	116	90	405	435	332	316	232	170	138	194	6	**2,434**
Cyclist	1	2	9	11	13	8	4	4	1	-	-	**53**
HGV occupant	-	-	6	40	38	66	45	3	-	27	-	**225**
LGV occupant	5	8	35	84	60	57	20	5	3	12	2	**291**
Motorcyclist		2	48	25	8	15	8	1	1	2		**110**
Not Answered	-	-	-	-	-	-	1	-	-	-	-	**1**
Other	-	1	4	4	-	2	1	-	-	3	-	**15**
Pedestrian	7	9	16	11	4	9	4	13	8	2	1	**84**
Unknown[7]	-	-	-	-	-	-	-	-	-	10	-	**10**
Total	**131**	**113**	**547**	**633**	**468**	**494**	**328**	**204**	**154**	**302**	**10**	**3,384**

[7] Untraced vehicle

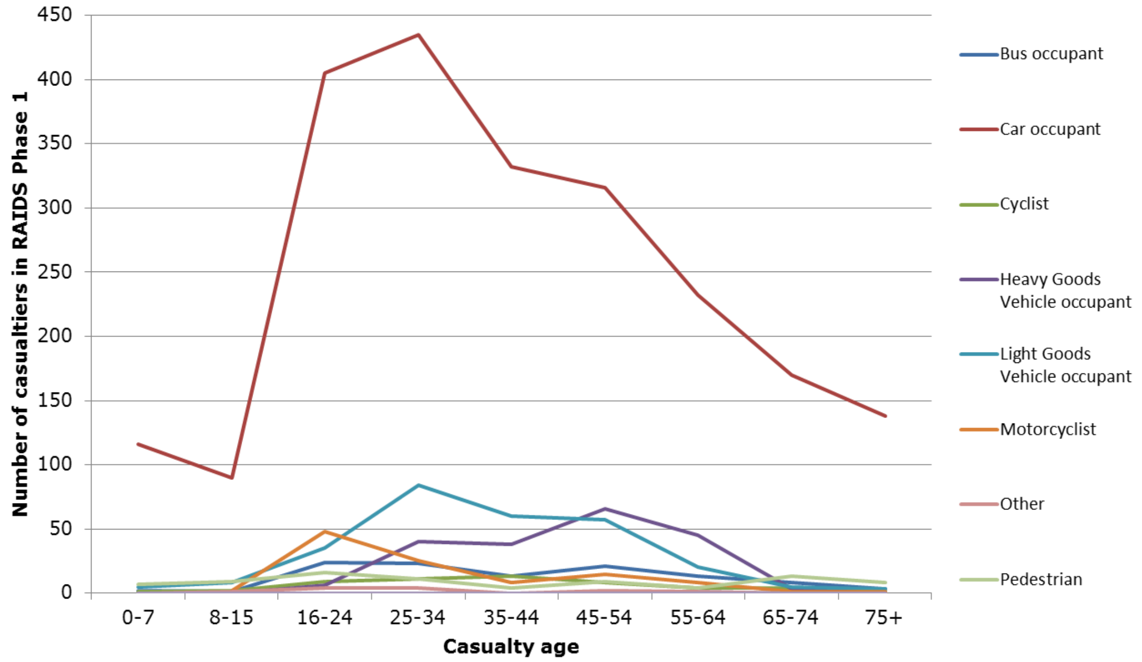

Figure 4-1: Number of casualties in RAIDS Phase 1 by road user type and age

Table **4-18** and Table 4-19 present the same information for male and female casualties respectively; these show that male casualties comprise more than 62% of the sample. Male and female casualties exhibit a similar pattern in terms of age distribution.

Table 4-18: Male road users by age band and road user type

Road user type	0-7	8-15	16-24	25-34	35-44	45-54	55-64	65-74	75+	Not Answered	Unknown	Total
Bus occupant	1	1	9	14	8	16	10	2	-	20	-	**81**
Car occupant	46	50	224	257	181	167	139	100	82	95	2	**1,343**
Cyclist	1	2	9	9	11	7	4	4	1	-	-	**48**
HGV occupant	-	-	5	40	38	65	43	3	-	19	-	**213**
LGV occupant	4	5	30	81	55	53	18	5	3	9	1	**264**
Motorcyclist	-	2	39	23	5	13	8	1	1	2	-	**94**
Not Answered	-	-	-	-	-	-	1	-	-	-	-	**1**
Other	-	1	4	3	-	2	-	-	-	1	-	**11**
Pedestrian	4	3	8	8	2	3	2	8	4	2	-	**44**

Total	**56**	**64**	**328**	**435**	**300**	**326**	**225**	**123**	**91**	**148**	**3**	**2,099**

Table 4-19: Female road users by age band and road user type

Road user type	0-7	8-15	16-24	25-34	35-44	45-54	55-64	65-74	75+	Not Answered	Unknown	Total
Bus occupant	1	-	15	9	5	5	3	6	3	5	-	**52**
Car occupant	64	39	179	177	150	146	93	70	56	51	1	**1,026**
Cyclist	-	-	-	2	2	1	-	-	-	-	-	**5**
HGV occupant	-	-	1	-	-	1	1	-	-	-	-	**3**
LGV occupant	1	1	5	3	5	4	2	-	-	1	1	**23**
Motorcyclist	-	-	9	2	3	2	-	-	-	-	-	**16**
Other	-	-	-	1	-	-	1	-	-	-	-	**2**
Pedestrian	3	6	8	3	2	6	2	5	4	-	1	**40**
Total	**69**	**46**	**217**	**197**	**167**	**165**	**102**	**81**	**63**	**57**	**3**	**1,167**

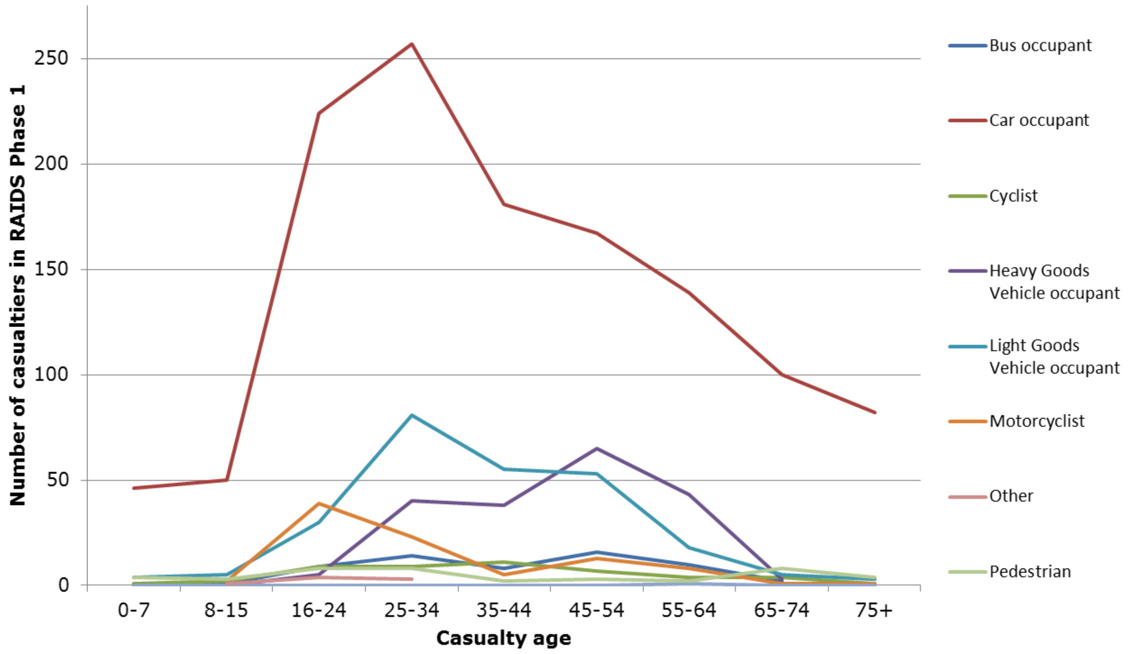

Figure 4-2: Number of male casualties in RAIDS Phase 1 by road user type and age

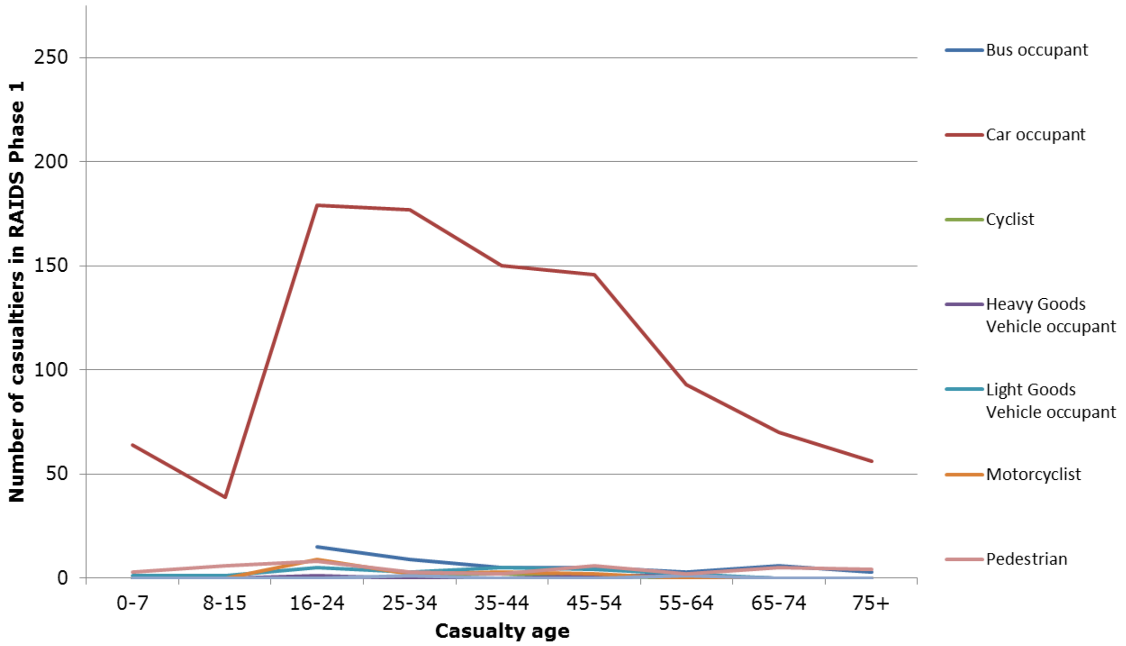

Figure 4-3: Number of female casualties in RAIDS Phase 1 by road user type and age

Figure 4-2 and Figure 4-3 highlight that male road user casualties are more prevalent than females in general. Car casualties are the dominant road user type, with fewer numbers of female road users present as other road user types.

5 Road user behaviour and collision causation

5.1 On-scene cases and contributory factors

At the time of this analysis, the RAIDS database contained 561 on-scene cases, with a total of 2,090 contributory factors. Accidents where the injury severity was known were selected and grouped as either KSI (Killed or Seriously Injured) or slight/uninjured (N=550).

Table 5-1 shows the distribution of 2,056 contributory factors for 550 RAIDS on-scene cases. The 'Driver/rider error or reaction' codes were the most commonly reported for all accident injury severities, although they were less likely to be recorded for the more severe injury accidents. However, it should be noted that the 'Pedestrian only' codes are more likely to be associated with the KSI accidents, because if a pedestrian is involved in a road collision they are more likely to suffer severe injury compared to vehicle users. This also affects the distribution.

Table 5-1: Distribution of contributory factors (N=2,056) for on-scene cases

		Contributory factor type	Killed or Seriously Injured %	Slight or uninjured %	Total %
	1	Road environment contributed	*3.9*	*5.5*	***5.0***
	2	Vehicle defects	*1.4*	*0.9*	***1.0***
Driver/rider only	3	Injudicious action	*10.4*	*12.8*	***12.1***
	4	Driver/rider error or reaction	*35.2*	*46.4*	***42.9***
	5	Impairment or distraction	*11.3*	*9.4*	***10.0***
	6	Behaviour or inexperience	*16.1*	*15.2*	***15.5***
	7	Vision affected by…	*7.3*	*6.7*	***6.9***
	8	Pedestrian only (casualty or uninjured)	*13.6*	*2.5*	***6.0***
	9	Special codes	*0.8*	*0.6*	***0.7***
		Contributory factors	**N = 645**	**N = 1,411**	**N = 2,056**
		Cases	**N = 152**	**N = 398**	**N = 550**

It is also possible to group the contributory factors for the cases by 'Vehicle', 'Environmental' or 'Human' or indeed by combinations of these. For example, if one collision has six contributory factors all relating to 'people', this will be counted once against people or 'Human'. Similarly, if an accident has three contributory factors, one for vehicle, one for road/environment, and one for people, it will be segmented under all three broad categories.

Figure 5-1 and Figure 5-2 are Venn diagrams for KSI (N=152) and slight and non-injury (398) on-scene cases respectively. The entire KSI sample of cases had at least one human contributory factor, approximately 30% of cases had an environmental factor and 11% had a vehicle factor. These proportions change only marginally for the slight and non-injury cases. For KSI cases, 62.9% had only human contributory factors compared with 66.7% of slight and non-injury cases. Therefore, if human error was eradicated from driving completely, at least 62.9% of on-scene KSI collisions could have their severity mitigated or could be avoided. All KSI collisions would be affected.

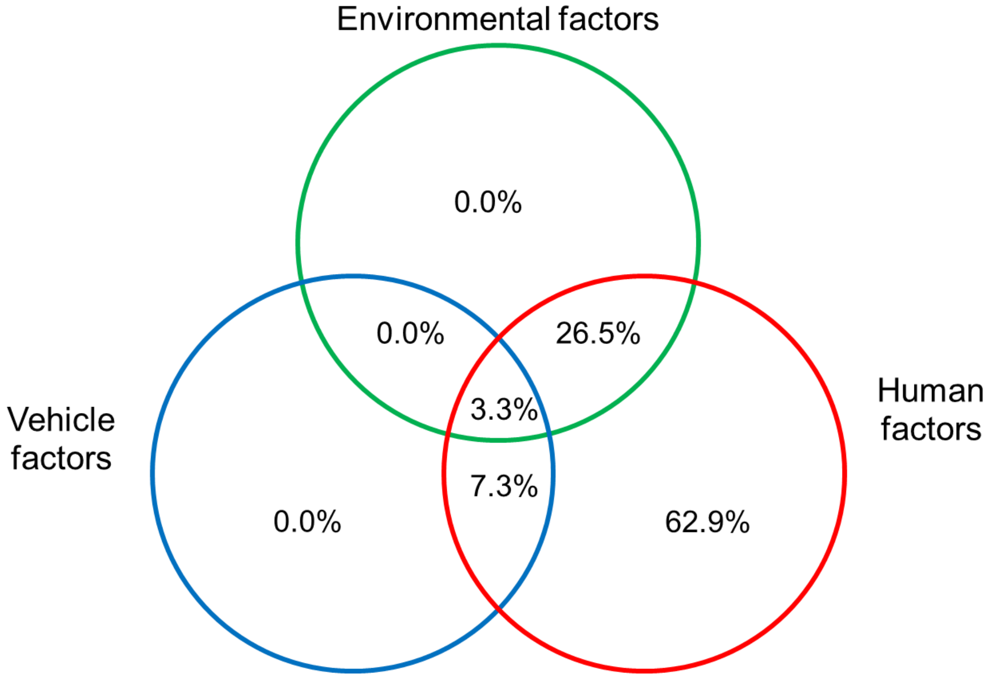

Figure 5-1: Distribution of RAIDS Contributory Factors for KSI on-scene collisions (N=152)

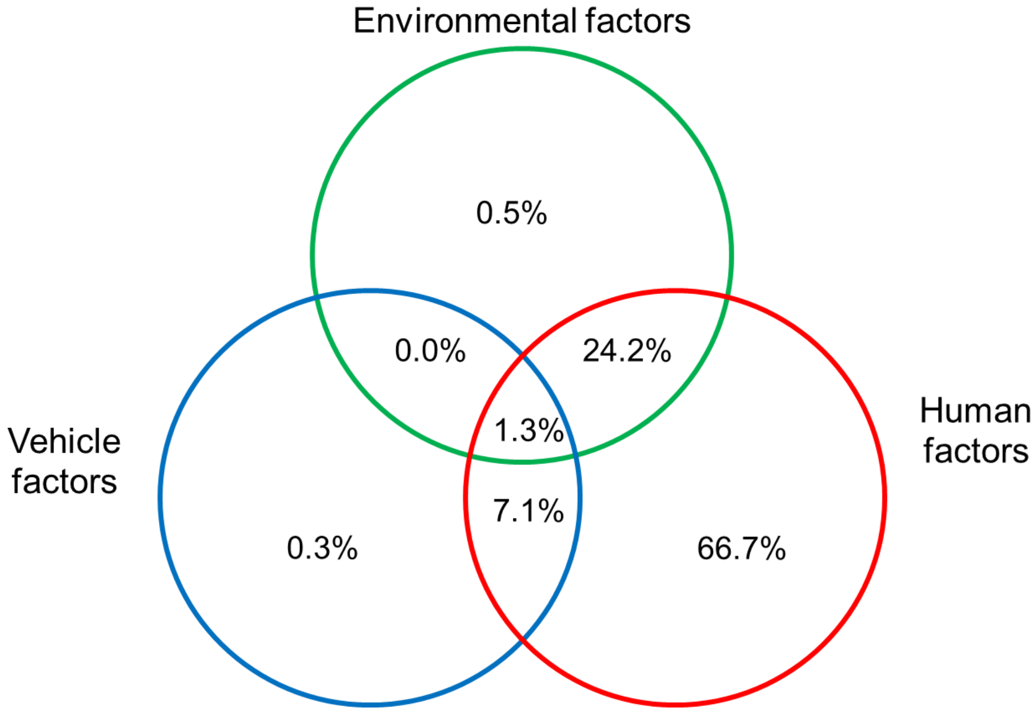

Figure 5-2: Distribution of Contributory Factors for Slight and Non-injury on-scene collisions (N=398)

5.2 Comparison of RAIDS and STATS19 contributory factors:

The linking of the RAIDS and STATS19 collisions allows comparisons to be made between the two datasets. The ultimate goal of this is to determine how representative the accidents recorded in RAIDS are of the national accident population as recorded in STATS19. This comparison is also required as the first step towards weighting RAIDS data to represent the accident population better as a whole.

Linking the in-depth RAIDS cases with their equivalent STATS19 reports also allows for a better understanding of the nuances and patterns behind the police reported collisions. It gives a valuable insight with regard to the characteristics and causes of collisions by their typology and contributory factors.

At the time of writing, only TRL cases had matched STATS19 data available. Table 5-2 highlights the 251 TRL cases, of which 136 had linked STATS19 data.

Table 5-2: Comparison of RAIDS and STATS19 contributory factors

		Contributory factor type	RAIDS %	Stats19 %
	1	Road environment contributed	*3.2*	*4.5*
	2	Vehicle defects	*0.7*	*0.6*
Driver/rider only	3	Injudicious action	*12.0*	*11.1*
	4	Driver/rider error or reaction	*43.3*	*45.0*
	5	Impairment or distraction	*11.8*	*9.9*
	6	Behaviour or inexperience	*17.2*	*12.6*
	7	Vision affected by…	*5.0*	*5.7*
	8	Pedestrian only (casualty or uninjured)	*5.7*	*8.4*
	9	Special codes	*1.1*	*2.1*
		Number of cases	**N = 251**	**N = 136**

Figure 5-3 is a Venn diagram for the 136 TRL on-scene cases where a linked STATS19 report was available. The linked STATS19 percentages are coloured red and are placed below the RAIDS ones (coloured black) in the diagram. The sample size is small, but the results are very similar at this time.

As more cases are collected and the STATS19 linking becomes more common, it will be important to track the trends regarding police reported collisions and the findings from RAIDS. This will include the opportunity to investigate common contributory factors, such as 'Looked but failed to see', and to ascertain more precisely what is meant when this is coded and how future collisions with these characteristics could be prevented. The linking will also be very valuable with regard to understanding more about under-reporting and potentially mis-coding issues in STATS19 and in RAIDS (i.e. by continuing to look for similarities and differences between the RAIDS data and RAIDS cases linked with STATS19 data).

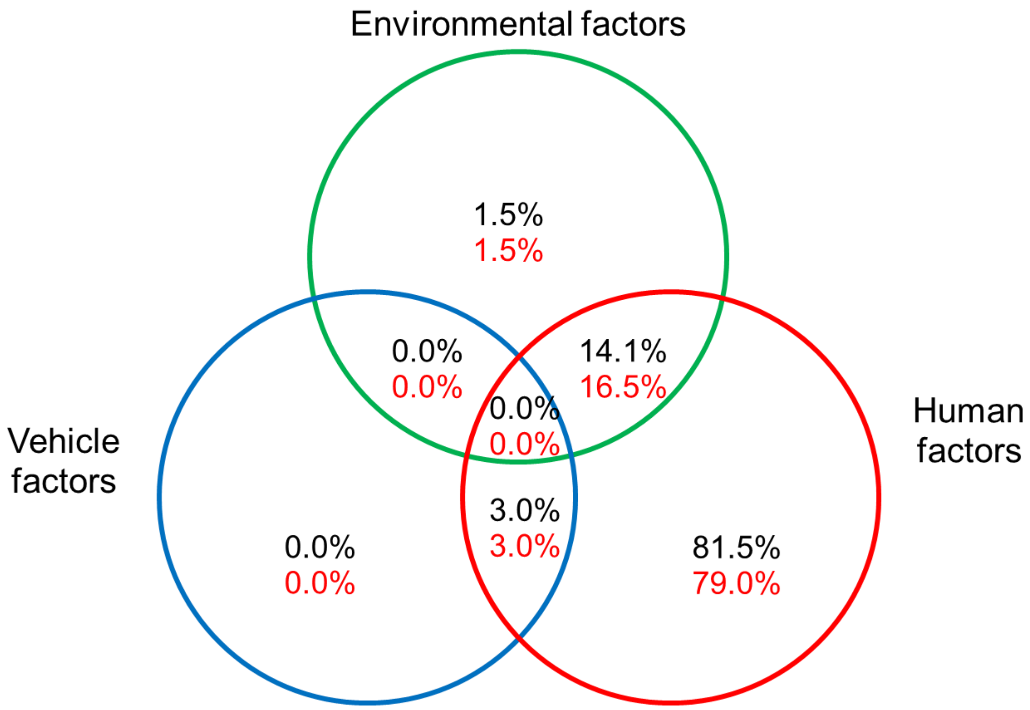

Figure 5-3: Distribution of Contributory Factors Comparison between RAIDS (TRL team) and STATS19 linked cases for cases where STATS19 is available only (N=136; black values = RAIDS, red values = STATS19)

5.3 Vehicles

Figure 5-4 shows the contributory factor types for all severity levels split between vehicle types.

It can be used to make vehicle type specific observations, for example whilst motorcyclists are more likely to have a 'Behaviour or Inexperience' contributory factor type, they are less likely to be impaired or distracted than other vehicle types, and more often affected by environmental factors than others.

HGV drivers have a higher level of driver error or reaction contributory factors than any other vehicle type; despite being the least likely to have a behaviour or inexperience related collision. HGVs also have the highest number of visibility issues of any vehicle type, this being due to greater obscuration by the vehicle structures making it more difficult to detect vulnerable road users in close proximity to the vehicle.

In this sample, LGVs and motorcycles have proportionally more 'Injudicious actions'.

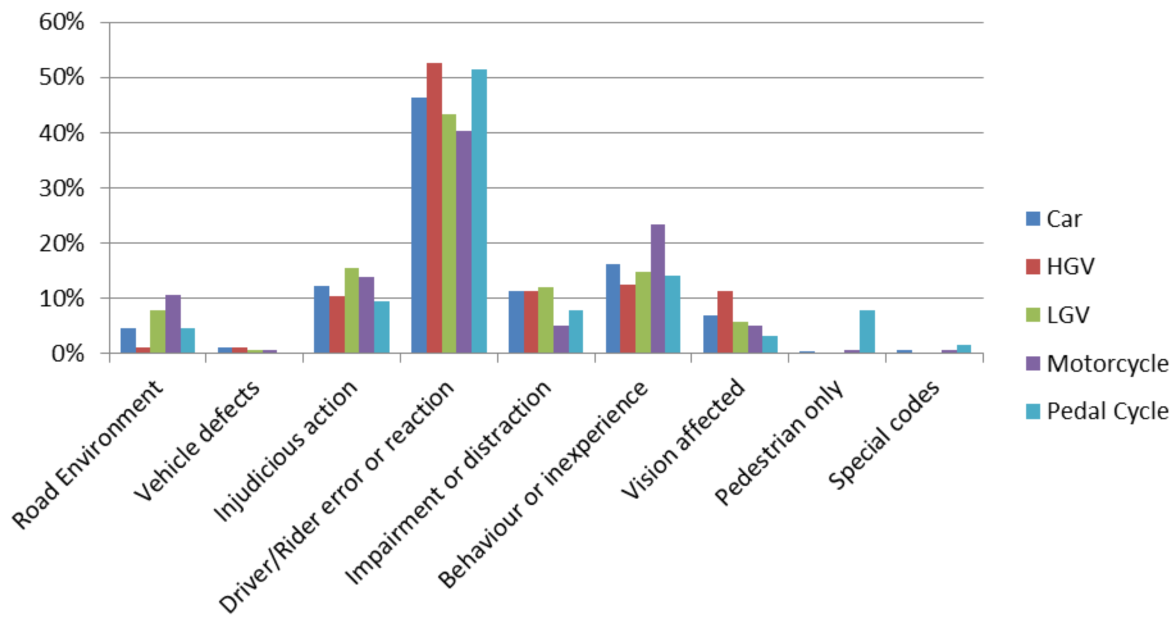

Figure 5-4: Distribution of Contributory Factor types between vehicle type.

5.4 RAIDS collision causation

5.4.1 Vehicle causation factors present

Table 5-3 shows the frequency with which vehicles are found to have vehicle-based causation factors within RAIDS, Figure 5-5 illustrates the distribution of what types of factors have been recorded for all vehicle types. The highest percentage is within the Motorcycle group. The low numbers in the HGV and LGV categories could indicate a high level of maintenance on fleet vehicles.

Table 5-3: Distribution of causative vehicle factors for vehicle types

Vehicle factors present	Yes %	No %
Car (n=752)	*6.65*	***93.35***
HGV (n=48)	*4.17*	***95.83***
LGV (n=64)	*4.69*	***95.31***
Motorcycle (n=79)	*11.39*	***88.61***
Pedal Cycle (n=35)	*8.57*	***91.43***
Total	***6.85***	***93.15***

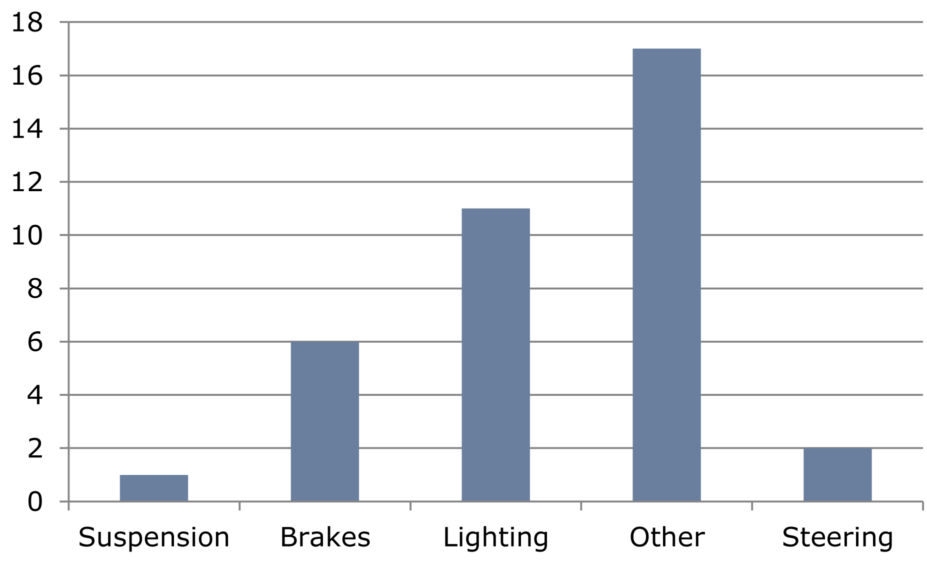

Figure 5-5: Distribution of Vehicle Causation Factors (n=37)

5.4.2 Occupant causation present

Table 5-4 shows the precipitative causation factors for the active user (the person in control of the vehicle) in different vehicle types.

The most common precipitating factor for these main vehicle groups is 'Poor Turn Or Manoeuvre' shortly followed by 'Loss Of Control Of Vehicle'. For car drivers, 'Loss Of Control Of Vehicle' is the modal group with drivers also often failing to stop, failing to give way and failing to avoid other objects in the carriageway.

In the motorcycle group; higher numbers of 'loss of control' factors may be for reasons of rider behaviour or perhaps be more indicative of the potential lack of stability/safety on a motorcycle. Similarly, many 'poor overtake' factors shows both the risks in which riders sometimes take on motorcycles (in higher speed overtaking) and the regularity in which lower speed filtering can be dangerous also if riders are not observing all the risks surrounding them.

For HGVs; 'Failed to Stop' collisions involve collisions with vehicles on motorways or main trunk roads; in terms of exposure, these road types form the main routes used by vehicles of this type. Whilst 'Poor Turn or Manoeuvre' supports the higher number of visibility related collisions mentioned, as vision obscuration is often partially causative in manoeuvring related collisions.

According to the Occupant Causation factors, pedestrians are often to blame for their impacts, with 73% of their precipitative factors identifying them as being to blame.

Table 5-4: Precipitating factor by 'active' road user type

Precipitating factor	Car	HGV	LGV	M/C	P/C	Ped	Total
Drove wrong way	3	1	1	-	-	-	**5**
Failed to avoid object or vehicle on carriageway	56	3	9	7	3	2	**80**
Failed to avoid pedestrian (pedestrian not to blame)	9	-	1	-	-	1	**11**
Failed to give way	58	1	3	2	5	1	**70**
Failed to stop	68	10	9	6	2	2	**98**
Failure to signal or gave misleading signal	3	-	-	-	2	-	**5**
Loss of control of vehicle	98	1	3	12	1	-	**115**
Other precipitation (give details)	24	-	1	3	3	4	**37**
Pedestrian entered carriageway without due care (driver no blame)	6	-	-	-	1	36	**43**
Poor overtake	11	1		14	1	-	**27**
Poor turn or manoeuvre	89	11	11	8	2	-	**121**
Sudden braking	12	1	-	3	1	-	**18**
Swerved to avoid object on carriageway	4	-	-	2	-	-	**6**
Pedestrian fell in road	-	-	-	-	-	3	**3**
Grand Total	**441**	**29**	**38**	**57**	**21**	**49**	**639**

5.4.3 Car drivers

Table 5-5 and Table 5-6 explore the differences in causation factors for male and female drivers, and age groups within gender. It is worth noting that both genders had on average 2.4 causation factors per occupant.

Within the male driver group, the highest single causation factor is 'Error Of Judgement', a broad factor which would need to be looked into further. The highest number of causation factors occurs within the 25-44 age group; where the most common causation themes were judgement, attention and carelessness factors, with these factors also being significant for all other age groups, and a similar distribution for females. As males age, similar patterns remain, but with higher proportions of uncertain and panic behaviour than at younger ages, whereas older male drivers show less recklessness, risk taking behaviour and excessive speed than younger male drivers; but had proportionately more 'looked but did not see' and 'error of judgement' collisions.

Females are less prone to aggression and excessive speed causative factors, but as mentioned above, show similar high levels of distraction and carelessness. Higher counts of 'following too close' and 'distraction within vehicle' can also be observed.

Table 5-5: Occupant causation for male car drivers (n = 469)

Collision causation	17-24	25-44	45-64	65 - 99	Total
Aggressive driving	11	15	3	3	**32**
Ignored lights at crossing	-	3	1	1	**5**
Alcohol	-	9	1	1	**11**
Error of judgement	33	60	40	29	**162**
Lack of attention	18	53	32	17	**120**
Failed to look	7	30	20	7	**64**
Bad overtake	3	3	3	2	**11**
Unauthorised passengers	-	-	-	-	**-**
Inexperience	10	2	3	3	**18**
Ignored sign	1	10	5	1	**17**
Cross from behind parked car	-	-	-	-	**-**
Risk taking behaviour	12	24	7	4	**47**
Walking in carriageway	-	-	-	-	**-**
Excess hours	-	-	1	-	**1**
Fatigue	1	3	3	-	**7**
Following too close	6	9	4	-	**19**
Distraction through listening to music (iPod etc)	2	2	1	-	**5**
Reckless	12	21	6	2	**41**
Insufficient lighting[8]	-	3	-	1	**4**
Playing	-	-	-	-	**-**
Looked but did not see	6	34	24	19	**83**
Panic behaviour	3	11	7	7	**28**
Distraction through stress or emotional state of mind	1	1	2	1	**5**
Other personal factor	-	2	1	2	**5**
Nervous or uncertain	-	1	4	7	**12**
Failure to see pedestrian in blind spot	-	7	1	1	**9**
Inconspicuous	-	-	-	-	**-**
Drugs	-	5	1	1	**7**
Illness	-	1	1	3	**5**
Excessive speed	18	24	9	4	**55**
Failure to judge others persons path or speed	20	48	28	10	**106**
Other bad manoeuvre	13	37	32	15	**97**
Carelessness, thoughtless	23	53	32	13	**121**
Disability	-	-	-	1	**1**
Distraction through physical object outside of vehicle	3	8	2	4	**17**

[8] i.e. driver did not use the lights available on the vehicle

Distraction through physical object on or in vehicle	4	13	4	-	**21**
Total	**207**	**492**	**278**	**159**	**1136**

Table 5-6: Occupant causation for female car drivers (n = 309)

Collision causation	17-24	25-44	45-64	65 - 99	Total
Aggressive driving	2	1	3	-	**6**
Ignored lights at crossing	1	-	-	-	**1**
Alcohol	3	2	2	-	**7**
Error of judgement	28	47	26	13	**114**
Lack of attention	26	40	21	8	**95**
Failed to look	10	23	12	3	**48**
Bad overtake	2	-	3	2	**7**
Unauthorised passengers	-	-	-	-	**-**
Inexperience	12	6	1	1	**20**
Ignored sign	1	2	1	-	**4**
Cross from behind parked car	-	-	-	-	**-**
Risk taking behaviour	6	5	5	3	**19**
Walking in carriageway	-	-	-	-	**-**
Excess hours	-	-	-	-	**-**
Fatigue	3	3	2	1	**9**
Following too close	4	13	5	1	**23**
Distraction through listening to music (iPod etc)	2	3	-	-	**5**
Reckless	3	4	3	2	**12**
Insufficient lighting	1	-	-	-	**1**
Playing	-	-	-	-	**-**
Looked but did not see	11	21	10	5	**47**
Panic behaviour	6	12	2	8	**28**
Distraction through stress or emotional state of mind	2	7	4	-	**13**
Other personal factor	1	5	1	2	**9**
Nervous or uncertain	1	8	1	5	**15**
Failure to see pedestrian in blind spot	-	1	2	-	**3**
Inconspicuous	-	1	-	-	**1**
Drugs	-	1	1	-	**2**
Illness	1	2	-	4	**7**
Excessive speed	12	10	5	1	**28**
Failure to judge other persons path or speed	11	28	23	4	**66**
Other bad manoeuvre	12	23	14	7	**56**
Carelessness, thoughtless	21	29	21	7	**78**
Disability	-	1	-	1	**2**
Distraction through physical object outside of vehicle	1	4	3		**8**
Distraction through physical object on or in vehicle	11	15	4	1	**31**
Total	**194**	**317**	**175**	**79**	**765**

5.4.4 Mobile phone use

By performing a case by case analysis on the 31 cases where mobile phone use was identified as causative or contributory, two trends of collision type were identified; only six cases fell outside of these two trends and into more random categories. The two types of commonly related collisions are:

Lane drifting: Generally on straight major roads (motorway, dual carriageway, A-roads) a driver operating a mobile phone drifts from their lane, generally to the offside (14 offside vs 3 nearside). The collisions then split into 3 options:

- Causing a panicked overreaction and the vehicle leaving the carriageway to the opposite side to the original drift.
- The vehicle impacts a barrier or off-carriageway object.
- The vehicle enters the opposing carriageway and collides with oncoming traffic head-on.

For example:

A driver is travelling along a motorway in lane 3 at an estimated 80 mph, he receives a text message on his dashboard-mounted mobile phone, as he looks at the text the vehicle drifts to the offside of its lane and the wheels touch the offside rumble strip, the driver panics and steers to the left harshly, causing the vehicle to lose control, the driver then harshly steers to the right, the vehicle impacts the central reservation at an angle outside of the barrier's design and crosses onto the opposing carriageway where it impacts another vehicle head-on.

Traffic rear-ends: A driver operating a mobile phone does not observe traffic ahead and impacts the rear of the vehicle in front, often occurring at sudden build-ups of traffic on faster roads.

The other collision types are varied, for example; A lady receives a phone call so stops in lane 1 of a dual carriageway and turns her engine off (no hazard lights), and is impacted from behind by another vehicle.

Some collisions are less definitive in causation but still list mobile phone use as contributory. For example an HGV driver is talking on a hands-free system when a drunken pedestrian walks out in front of his vehicle, leaving very little time for the driver to react. However, had the driver been more alert to situational risk, anticipation and quicker reaction times could have perhaps reduced the severity of the collision.

There are several vehicle technologies which are steadily becoming available and improving; from distraction detection systems which help keep the driver engaged with their surroundings, to more advanced active systems such as AEBS (Automatic Emergency Braking Systems), Lane Keep Assist, and LDWS (Lane Departure Warning Systems). Implementing these systems could reduce the likelihood or severity of these types of mobile phone related collisions. Vehicle technologies are discussed further in Chapter 9.

6 Road design

A sample of RAIDS on-scene cases have been selected to examine the influences of road design on collisions. Four road design themes have been presented to demonstrate the depth of data provided in the RAIDS database. Table 6-1 shows the total number of on-scene cases and the sample examined in the following section. The individual samples for each subsection are also shown; it is worth noting that the total of all subsections is greater than the total for Road Design as some cases appear in more than one subsection.

Table 6-1 RAIDS case samples by factor

Overall sample	Subsection sample	Number of cases
RAIDS on-scene cases	-	630
Road Design	-	221
6.1	Vehicle speed and road type	93
6.2	Sightlines	6
6.3	Road departure collisions	138
6.4	Signage issues	18

6.1 Vehicle speed and road type

Cases which had a RAIDS-assessed contributory factor of 306 (excessive speed) or 307 (travelling too fast for the conditions) were selected. The vehicles to which the factors applied were selected and their travel speeds compared to the speed limit of the road on which the collision occurred. For cases which did not record a travel speed, the speed at the start of the first phase was used as a proxy measure (i.e. it was assumed that the speed at the start of the phase was equivalent to the intial travel speed). This resulted in a sample of 93 cases from RAIDS Phase 1.

This sample was examined to determine the road type on which the excessive speed or inappropriate speed took place. Figure 6-1 shows that 41% of these occurred under the speed limit, primarily in urban 30 mph roads and on 70 mph rural roads. Collisions also occurred while the vehicle was travelling at the posted speed limit, as well as 20% of all cases occurring below the speed limit on 60 mph roads in rural areas.

In these cases, the vehicle was travelling too fast for the conditions. The frequency of vehicles travelling within or below the speed limit (67%) indicates that for these cases, the vehicle speed with respect to the conditions is more important than the speed relative to the speed limit.

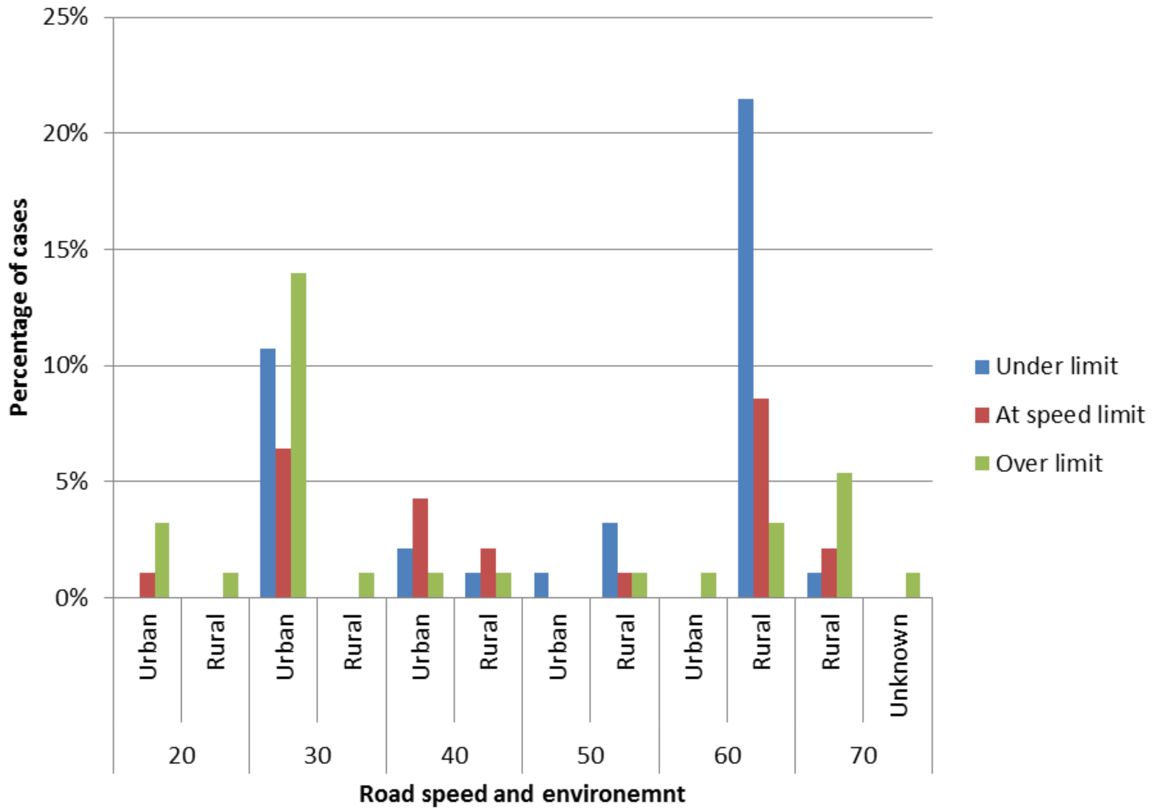

Figure 6-1: Excessive and inappropriate speed by road speed limit and environment (all collision severities, N=93 cases)

Figure 6-2 shows the same analysis for fatal and serious collisions. Here the same trend remains in relation to the vehicles exceeding the speed limit and road environment. In contrast, however, almost 50% of fatal or serious collisions involve vehicles travelling over the speed limit. Therefore, whilst exceeding the speed limit is not a good predictor of collision involvement, it is associated with more severe injury outcomes.

There is a clear propensity for collisions to occur in urban 30 mph and rural 60 mph roads, shown in Figure 6-1 and Figure 6-2. It is worth noting that despite the greater distance driven on 70 mph roads, including motorways and dual carriageway A-roads, collisions are comparatively underrepresented in RAIDS. This is because of the segregation of traffic which leads to less opportunity for conflicts between traffic crossing or interacting directly with the main direction of travel. Further work could explore the representation of these road types in the on-scene sample areas.

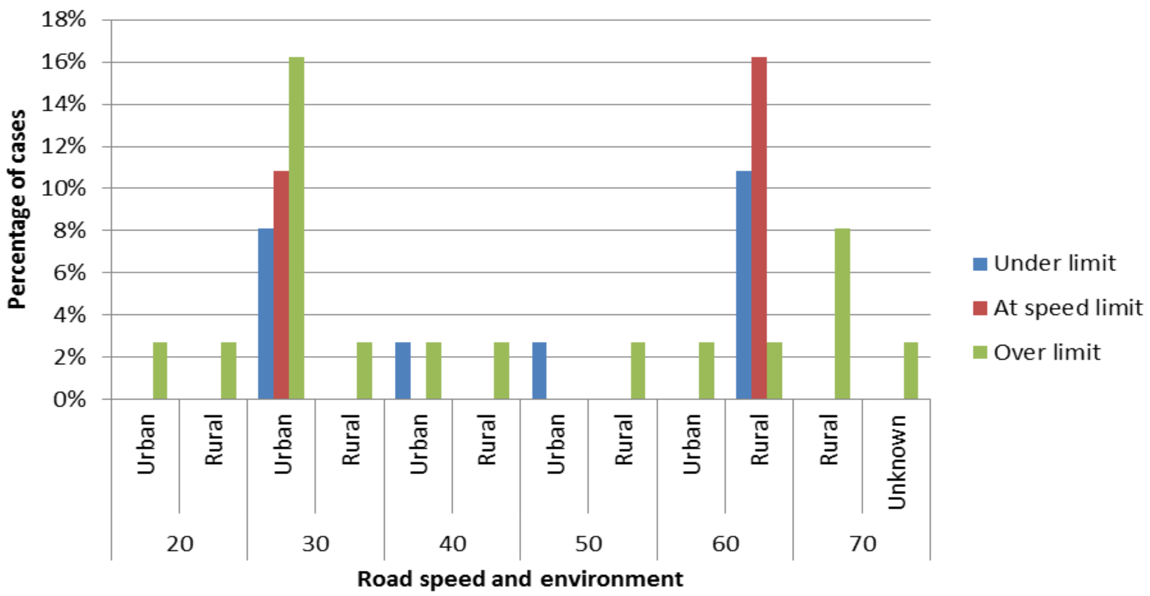

Figure 6-2: Excessive and inappropriate speed by road speed limit and environment (Fatal and Serious collisions, N=37 cases)

Examining the data by road class and speed limit (see Figure 6-3) reveals that speeding is evenly spread between 20 mph unclassified, 30 mph roads of all classes and motorways. Collisions involving vehicles travelling under the speed limit are most frequent on low and high speed C-class / unclassified roads (30 and 60 mph) and 60 mph B-class roads. It is possible that B-class road speed limits are closer to the appropriate vehicle control speeds for the road layout and conditions than other road classes.

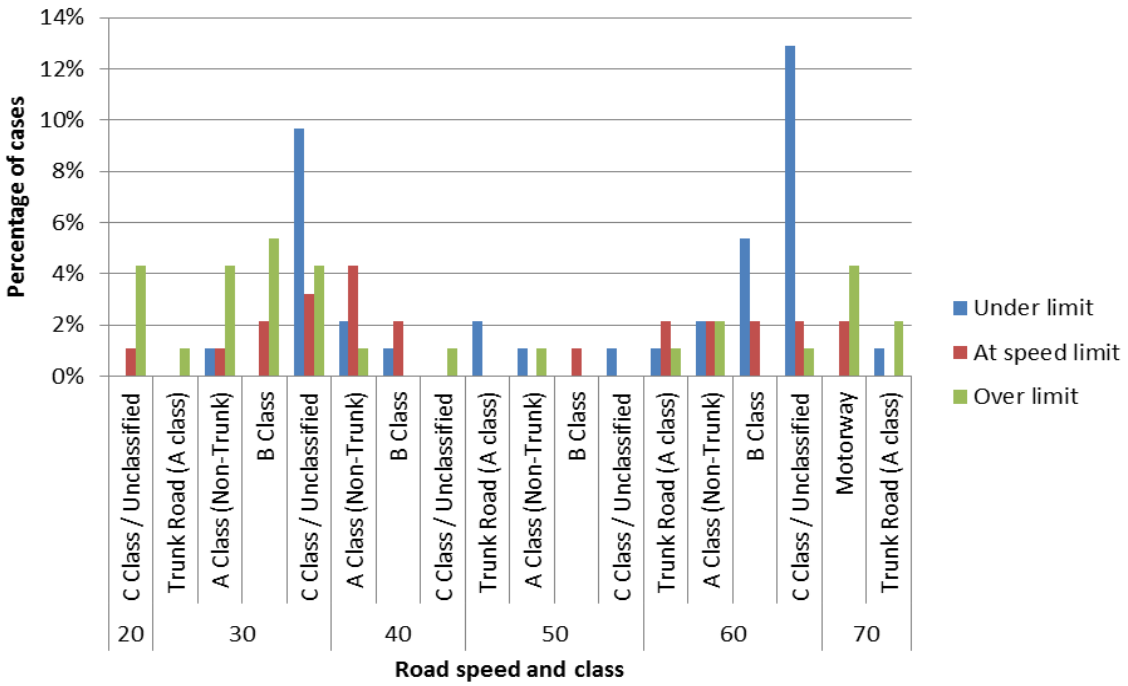

Figure 6-3: Excessive and inappropriate speed by road speed limit and road class (All collisions, N=93 cases)

However, considering only fatal and serious collisions in Figure 6-4, 30 mph B-class roads predominate, followed by motorways, 70 mph A-class trunk roads, 30 mph C-class roads and 20 mph C-class or unclassified roads.

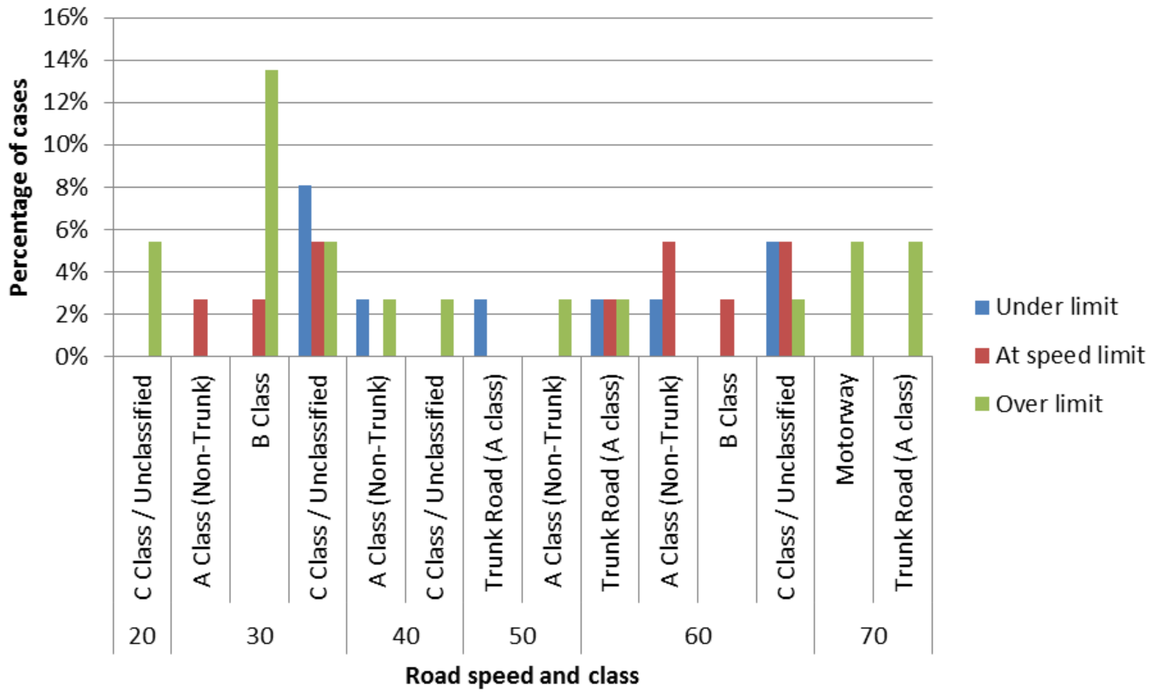

Figure 6-4: Excessive and inappropriate speed by road speed limit and road class (Fatal and Serious collisions, N=37 cases)

Examining the road surface conditions in Figure 6-5 shows that the majority of collisions involving speed as a contributory factor, but which were under the speed limit, occur when there are low surface friction conditions. In contrast, more than double the proportion of collisions where the travel speed was in excess of the speed limit occur in dry surface conditions. C-class or unclassified roads remain the most frequent roads with collisions involving excessive speed, regardless of the surface conditions. This suggests that road safety could be improved by lowering the speed limit during low friction conditions and by increasing speed limit compliance during normal (dry) surface friction conditions.

Two cases have been excluded from the sample as the road surface conditions at the exact time of the collision were inconclusive. This can occur with rapidly changing weather conditions, for example sunlight can dry out a damp or wet road surface at a collision locus in minutes and before the on-scene team arrive.

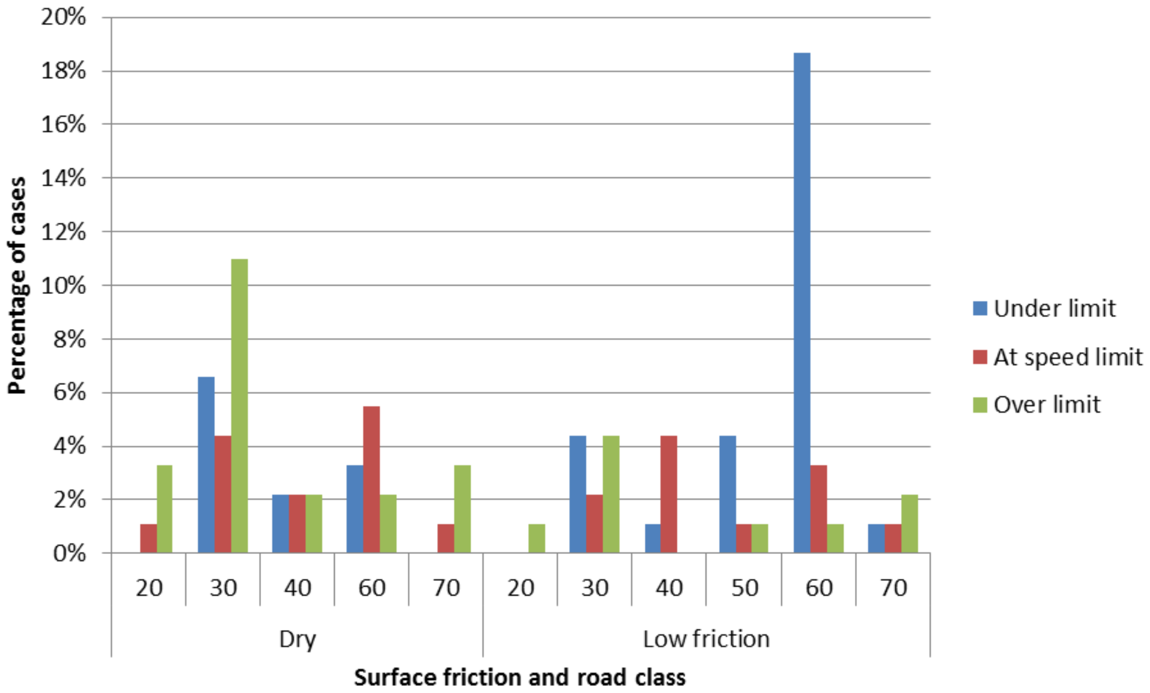

Figure 6-5: Excessive and inappropriate speed by road class and surface friction (All collisions, N=91 cases)

More than 70% of killed or seriously injured collisions occur under dry road surface conditions, as shown in Figure 6-6, and almost half of these collisions occur over the speed limit.

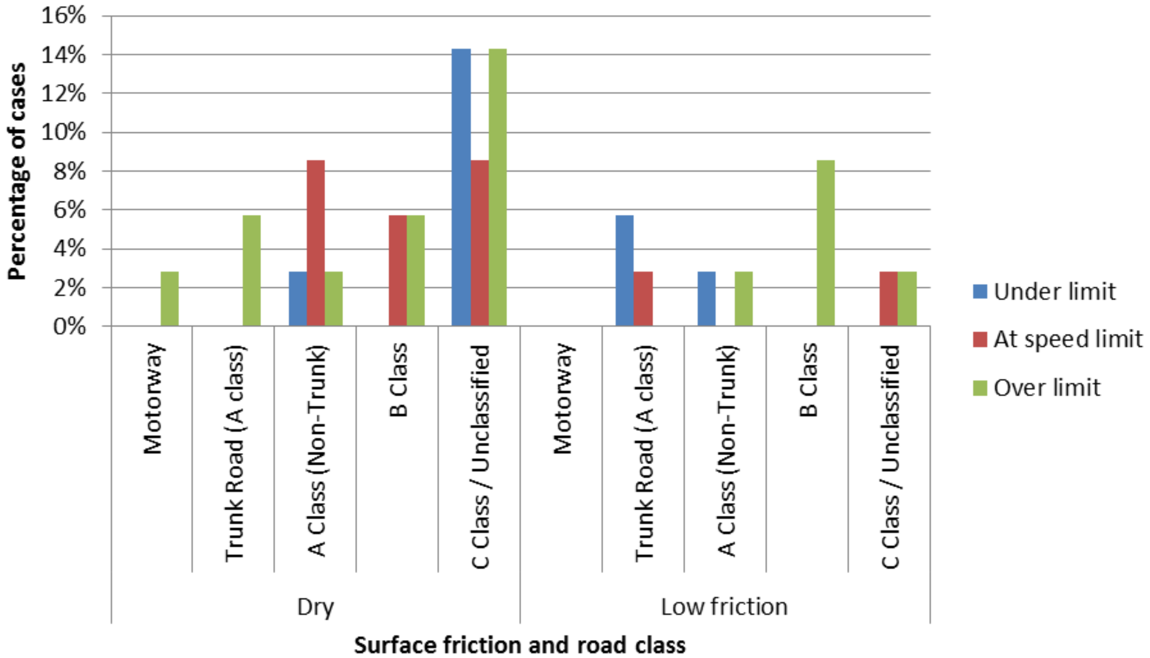

Figure 6-6: Excessive and inappropriate speed by road class and surface friction (Killed and Serious collisions, N=35 cases)

6.2 Sightlines

The design of the road in terms of the available sightlines can have an influence on collisions because these, depending on the speed of the vehicle, limit the time available for the driver to take appropriate avoidance of braking manoeuvres.

In order to examine this issue in greater depth, RAIDS cases were examined for cases where sightline obstructions were flagged as being present in the collision environment. This identified 89 cases. Of these cases, only 6 were judged, upon review, to have sightline issues that were relevant to the collision. These related to bends in the road limiting the forward view and parked vehicles impeding the view of the driver, but the sample of cases where the sightlines were judged to be relevant to the collision was too small to draw any meaningful conclusions.

6.3 Road departure collisions

In the following section a specific collision type has been examined to explore the influence of highway design and environment on collisions. Collisions which involved a departure from the carriageway were selected, resulting in a sample of 149 vehicles in 138 separate collisions.

Figure 6-7 shows the distribution of vehicles that left the carriageway by the class of road and the maximum injury severity of the occupants within the vehicle. It is evident that the majority of vehicles that leave the carriageway are on A-class roads. Furthermore, the most frequent injury outcome for vehicles that leave A-class carriageways is fatal or seriously injured, with over 12% of all road departure collisions occurring under these circumstances.

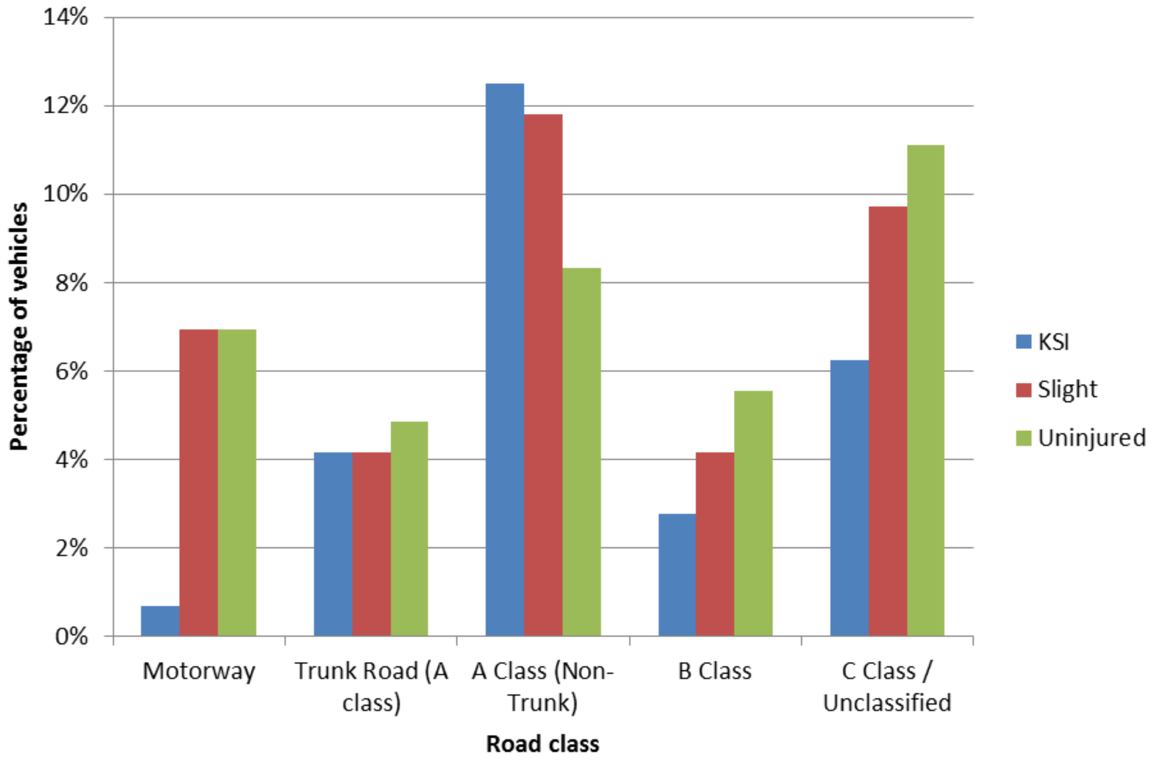

Figure 6-7: Vehicles that departed the road by road class and maximum occupant severity (N=144)

Figure 6-8 shows the distribution of these vehicles by their type and clearly shows that the most frequent vehicles to leave the carriageway are passenger cars. When a passenger car leaves the carriageway, both damage only and slight injury outcomes make up 30%. Just fewer than 15% result in fatal injury and this is a relatively high proportion compared to the proportion of slight and uninjured. However, motorcycles have the highest proportion of killed or seriously injured when a carriageway departure occurs and almost all motorcyclists are injured when they leave the carriageway.

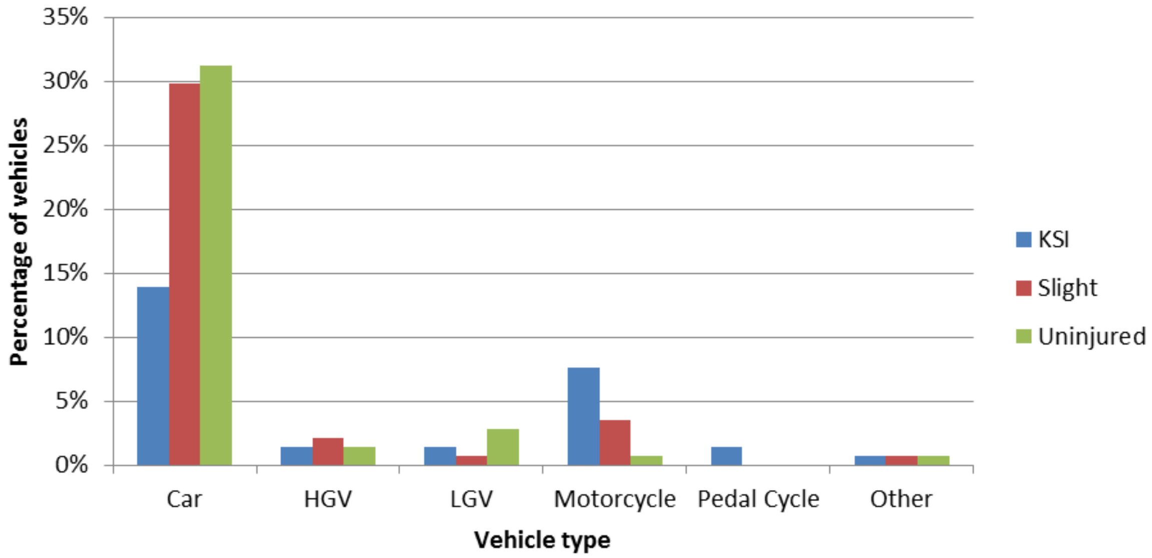

Figure 6-8: Vehicles that departed the road by vehicle type and maximum occupant severity (N=144)

Figure 6-9 focuses on what the passenger cars that left the carriageway impacted during the collision (a vehicle can strike multiple objects; hence the 144 vehicles impacted 279 objects for Figure 6-9). It reveals that the most frequently struck objects are other vehicles and roadside furniture for all injury severities. Striking a tree was the next most common occurrence for cars leaving the carriageway, but those collisions only accounted for 4% of the slight injury outcomes and 3% of the killed or seriously injured.

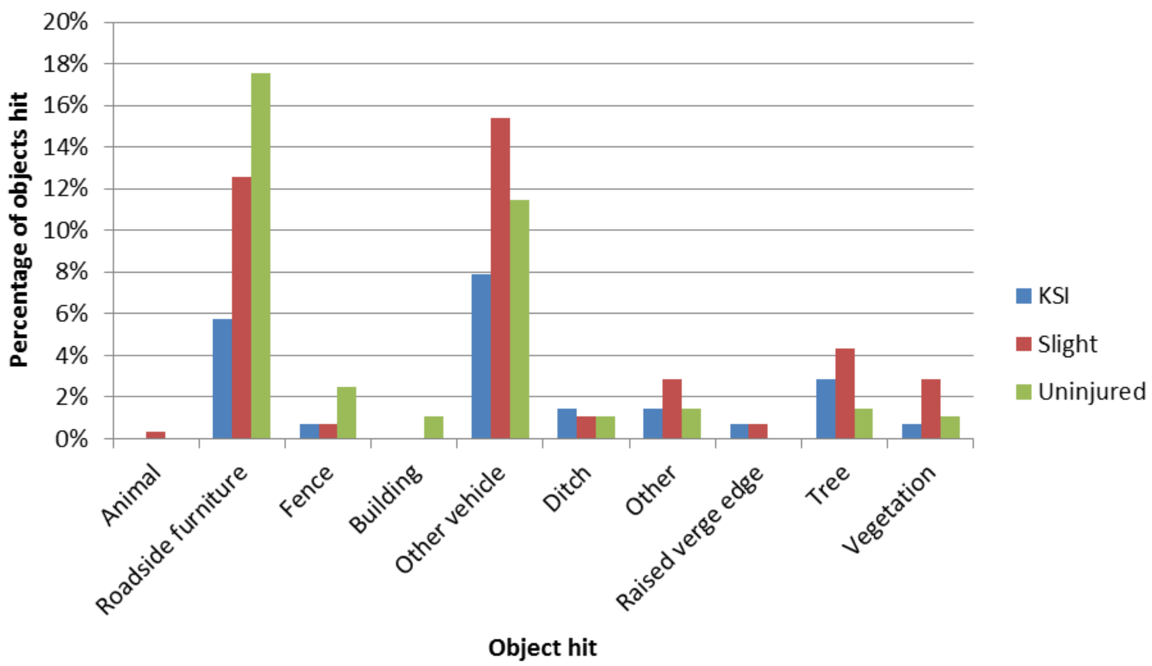

Figure 6-9: Objects struck by passenger cars that departed the road by maximum occupant severity (N=279)

Breaking down the two most common types of objects hit in further detail in Figure 6-10, it is possible to see that barriers are the most frequently struck road side furniture, but have the smallest proportion of killed or serious injury outcome. The distribution of vehicles with killed or seriously injured occupants is reasonably even across the different types of roadside furniture. However, passenger car collisions that involve impacting other passenger cars or car derived vans result in the highest proportion of vehicles with killed or seriously injured occupants.

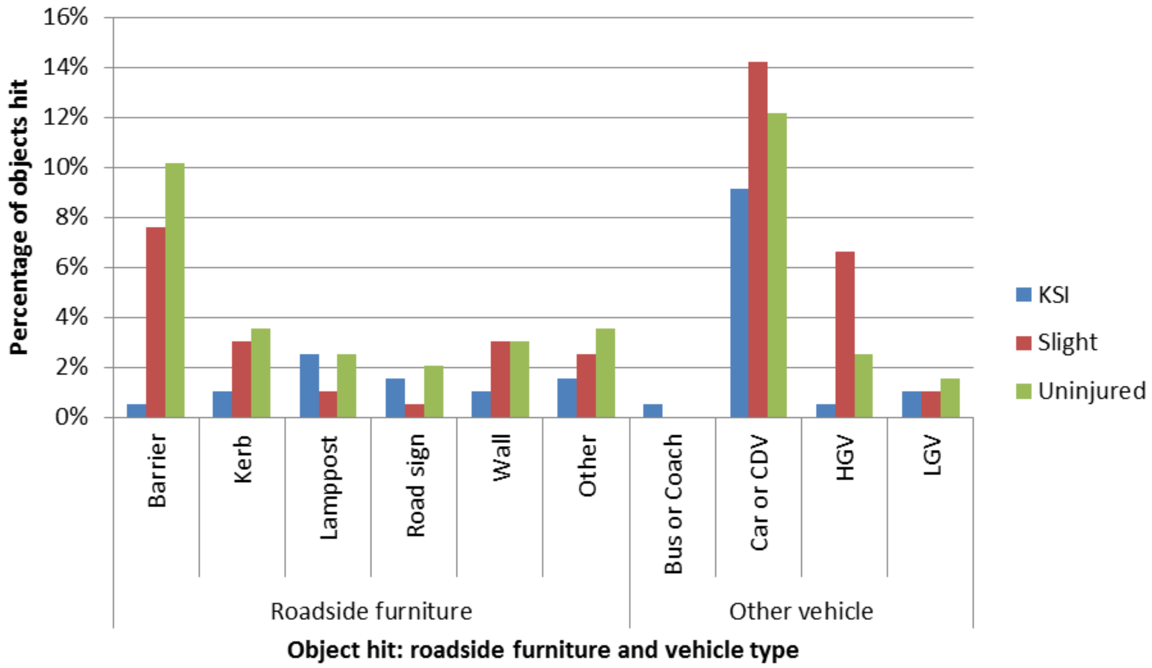

Figure 6-10: Roadside objects and vehicles struck by passenger cars that departed the carriageway (N=197)

6.4 Signage issues

As part of on-scene investigations, the RAIDS investigation teams will inspect and analyse the influence of road and highway design on the collision causation. However, the interactions between road users and highway features such as road signs can be complicated. The data presented below demonstrates how the investigation teams can capture incidents when signage has an effect on the collision and how these issues interact with road users.

Figure 6-11 shows the number of paths (N=21) in the 18 cases where issues with the signage at the collision locus were identified by the on-scene investigation team by the injury severity of the collision. It also highlights the proportion of these cases where the signage issues directly contributed to the collision’s occurrence or outcome.

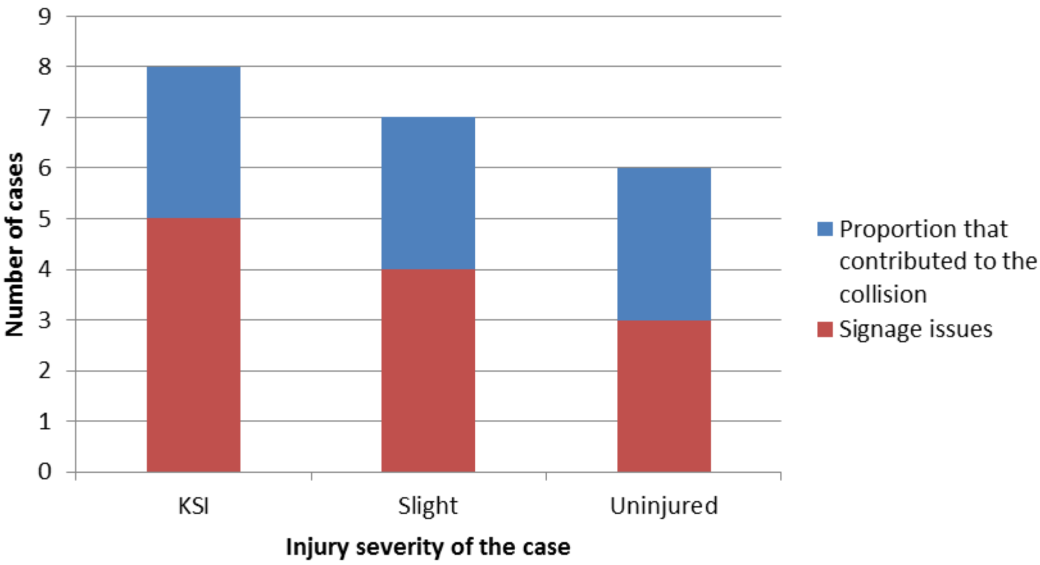

Figure 6-11: Number of paths where signage issues were identified at the scene of the collision (N=21) and the proportion where they contributed to the collision (N=9)

Examining the 9 cases where the signage contributed to the collision in further detail in Table 6-2, it is possible to see exactly what issues were identified by the investigation teams. This shows that the sample size is very small and that more data is required before any consistent issues can be identified.

Table 6-2: Number of cases with specific signage issues by case severity

Signage issues	KSI	Slight / uninjured	Total
Electronic sign not functioning correctly	1	0	**1**
Information overload	0	1	**1**
Sign positioning problem	0	1	**1**
Signage distracting	0	1	**1**
Signs missing	2	3	**5**

7 Car user injury experience

RAIDS cases involving at least one car were selected to analyse:

- Seat belt use
- Collision characteristics
- Injury characteristics

The data set contained 824 occupants in 557 vehicles.

7.1 Seat belt use

The seat belt usage shown is for occupants in the accident data set. It will likely be lower than the seat belt usage observed on the roadside because of a bias of risk taking individuals to be involved in accidents.

Percentage of seat belt use (where known) by gender and age is shown in Figure 7-1. Sample size male occupants: 336; female occupants: 274; tabulated data is shown in Appendix E. This indicates a lower seat belt usage for younger persons (aged 17-24), and for males aged 17-44.

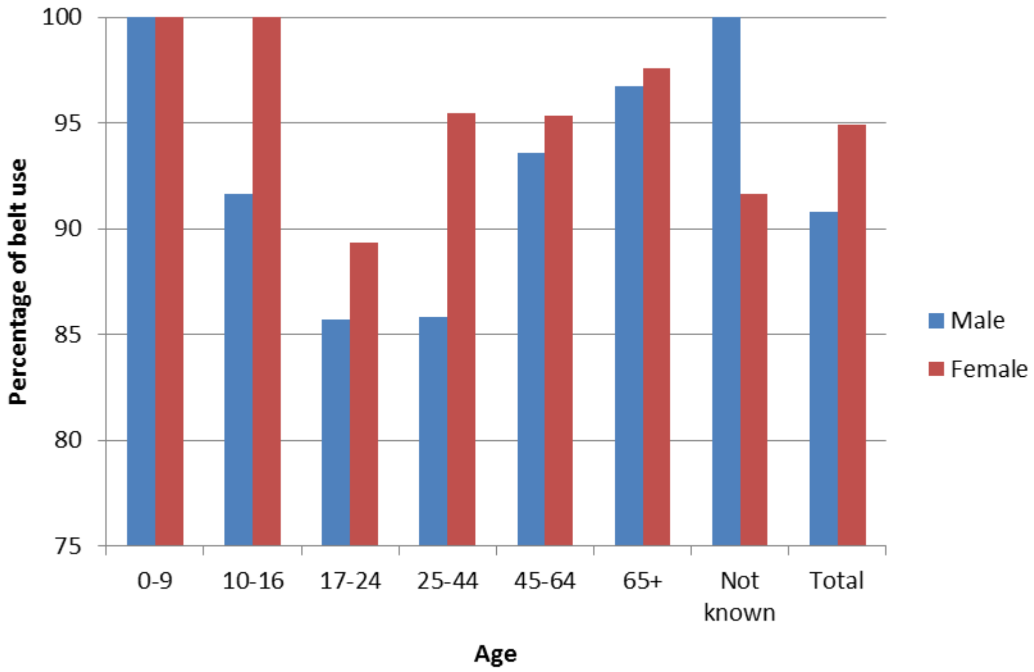

Figure 7-1: Percentage of seat belt use by gender and age

Examination of seat belt usage by seating position shows a lower usage in the rear than other positions for both males and females (Figure 7-2).

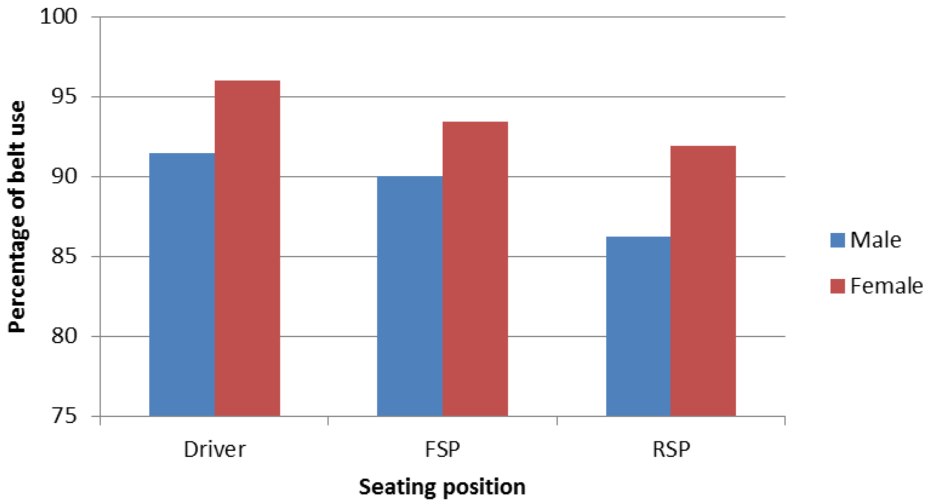

Figure 7-2: Percentage of seat belt use by seating position

Examination of seat belt usage by time of week and day shows lowest usage Monday to Thursday and from 18:00 to midnight. The highest usage is on Sunday, when perhaps families travel more or the journey types and purposes are likely to be different.

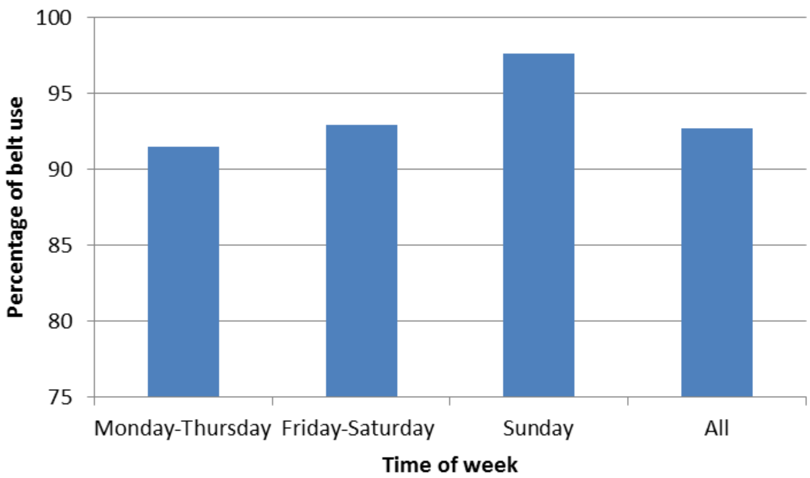

Figure 7-3: Percentage of seat belt use by time of week

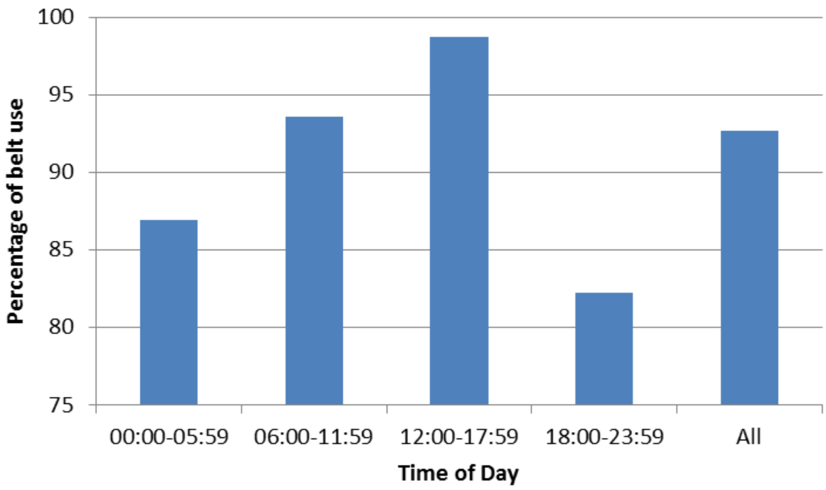

Figure 7-4: Percentage of seat belt use by time of day

7.2 Collision characteristics

The collision type is shown for all and MAIS 2+ injured occupants (approximately equivalent to Killed and Seriously Injured). For both groups the most common type of impact is frontal at circa 40-45%. The main differences between the groups are an increase in the percentage of rollover and a decrease in the percentage of rear for MAIS 2+ injured occupants. This is because the risk of an AIS 2+ injury in a rollover is high compared to a rear impact. For rear impact there are many low speed, low AIS 2+ injury risk events. Note that neck strain, commonly referred to as 'whiplash', is classified as an AIS 1 injury.

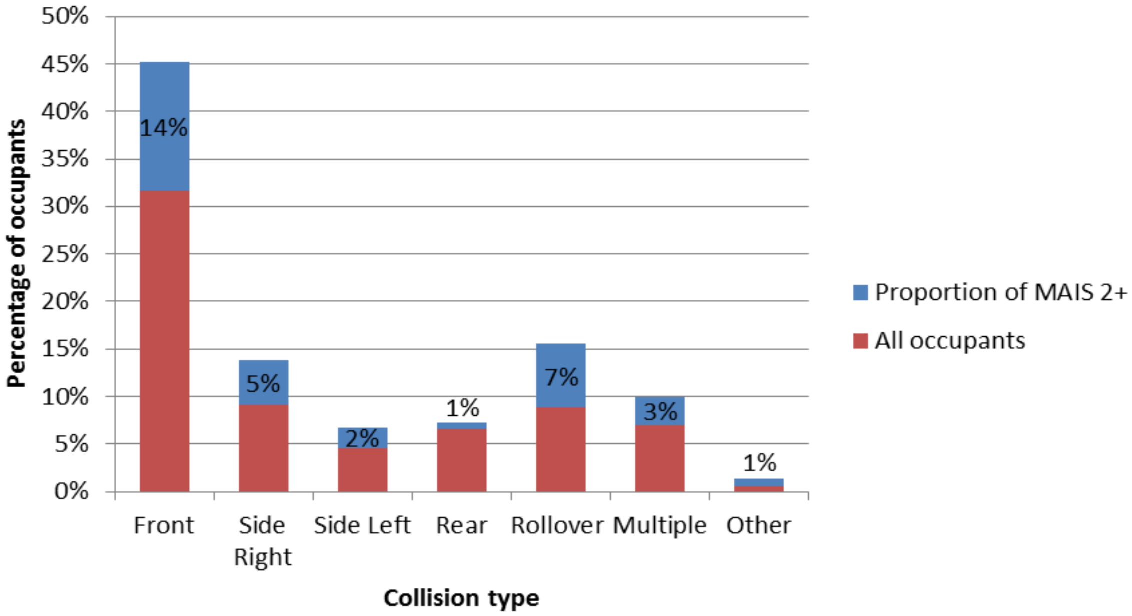

Figure 7-5: Collision type for all injured occupants and the proportion of MAIS2+ occupants.

Examination of collision type by driver age shows different distributions for older and younger drivers (Figure 7-6), where younger drivers have a greater percentage of rollover and multiple impacts. Further work is needed to determine the reasons for this. However, a difference in driving behaviours is likely to explain this.

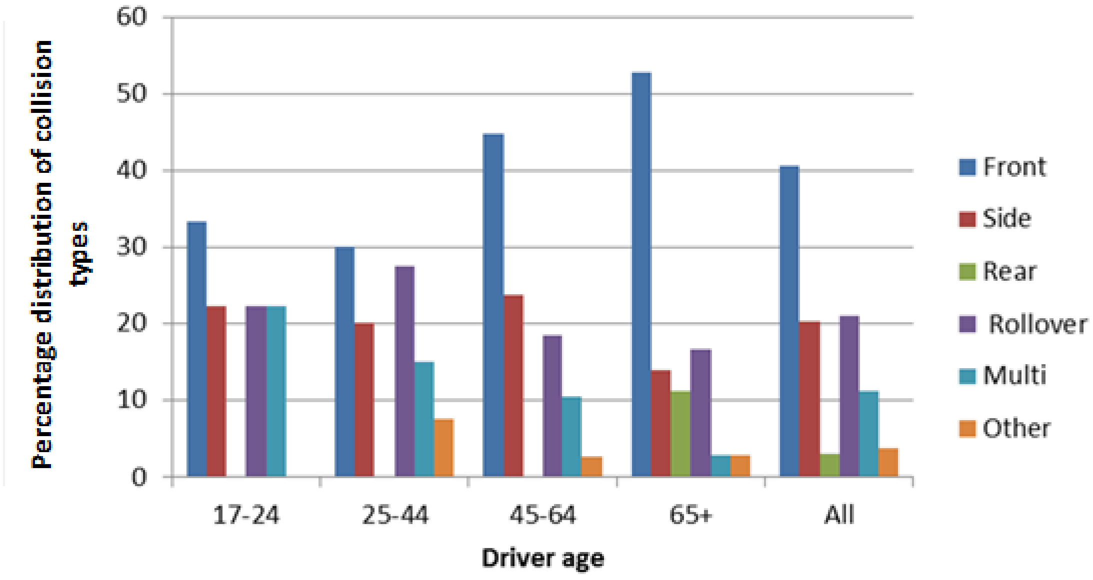

Figure 7-6: Percentage distribution of collision type by driver age

For the most frequent impact type, frontal impacts, Figure 7-7 shows the impact partner. It is seen that the most frequent impact partner is another car (44%), the second most frequent a Heavy Goods Vehicle (HGV) (22%) or an object (wide 18% plus narrow 4% = 22%).

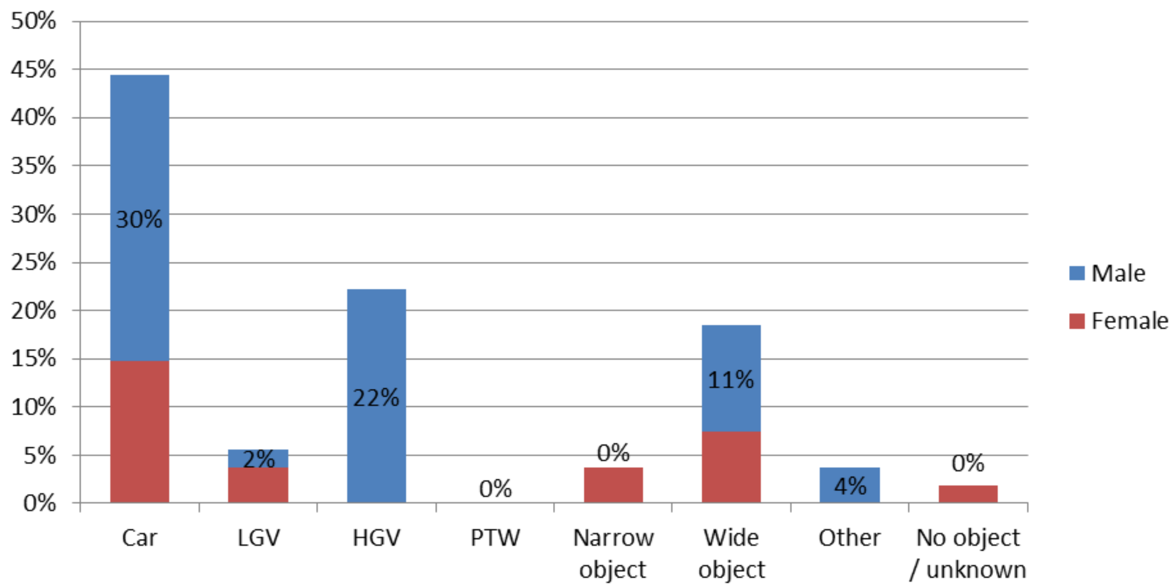

Figure 7-7: Impact partners for belted and unbelted drivers in frontal collisions

Figures 7-8, 7-9 and 7-10 begin to highlight the frequency and relative proportion of different types of collision for all car occupants with respect to injury severity. Figure 7-8 compares the collision types by seating position, with each injury severity group (MAIS 2+ and MAIS ≤ 1) summed to represent 100% of casualties (drivers and passengers).

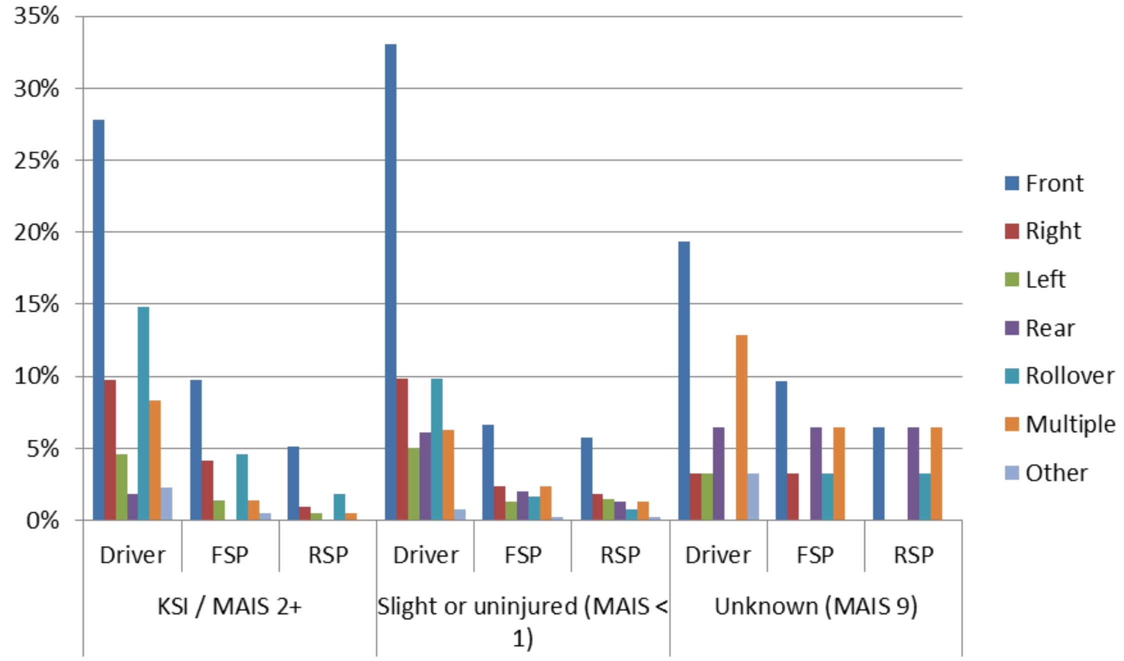

Figure 7-8: Collision type for all belted and non-belted occupants (n=788) by injury severity (100%) and seating position

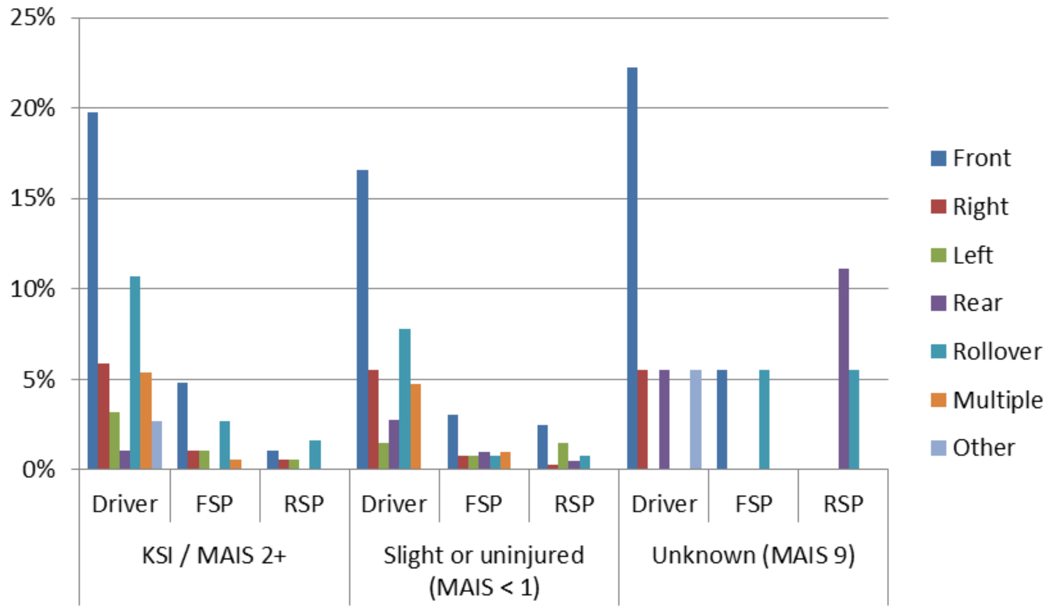

Figure 7-9: Collision type for all MALE belted and non-belted occupants (n=335) by injury severity and seating position, as a percentage of all occupants with known gender (100%)

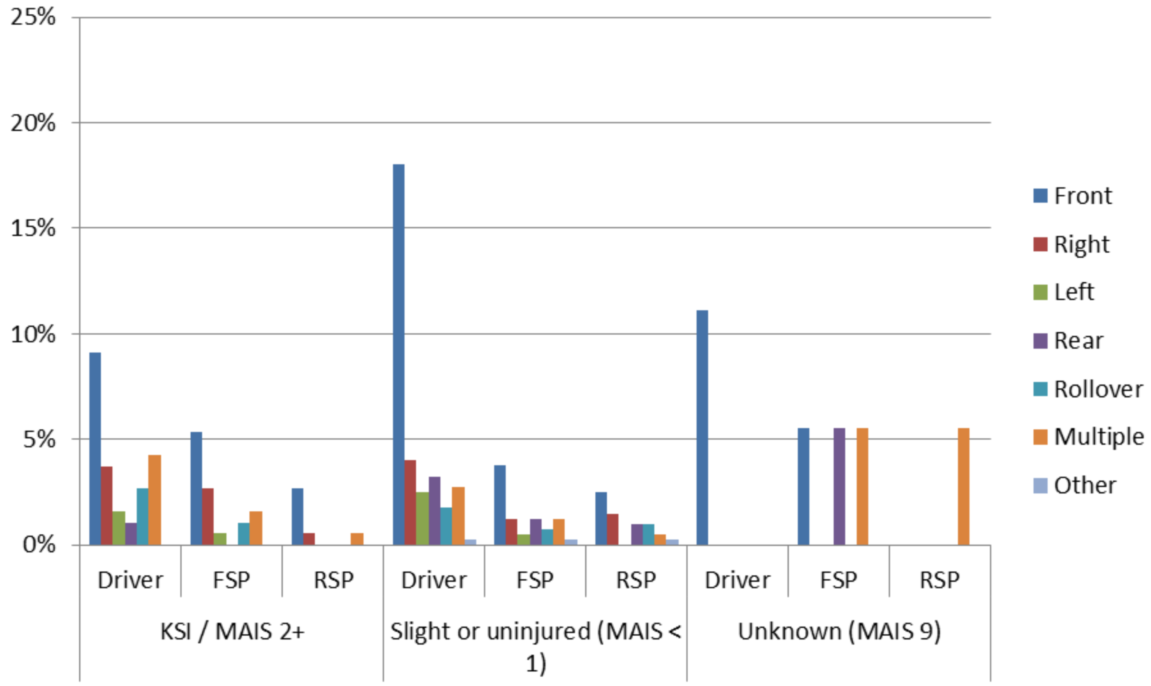

Figure 7-10: Collision type for all FEMALE belted and non-belted occupants (n=269) by injury severity and seating position, as a percentage of all occupants with known gender (100%)

For all car drivers, front impacts are the most common, but the risk of injury is greater for rollovers and multiple impacts. However, for male car drivers who experienced front impacts, the proportion of MAIS 2+ is greater and the reverse is true for female drivers (proportion of MAIS 2+ is less compared with MAIS $\leq$ 1). This is possibly explained by male drivers being, on average, involved in more severe collisions.

Figures 7-11 and 7-12 highlight that male car drivers aged 17-24 experience proportionally more frontal and rollover collisions than female drivers in the same age group.

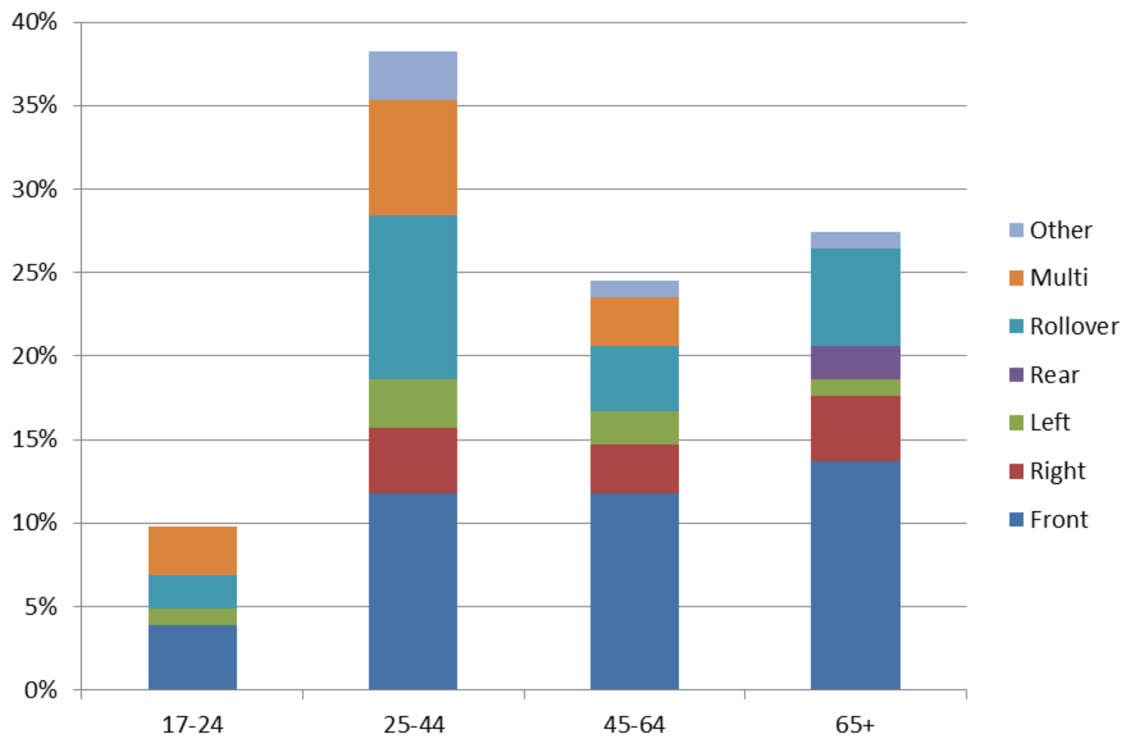

Figure 7-11: Collision types for male drivers (n=103) by driver age and all injury severities

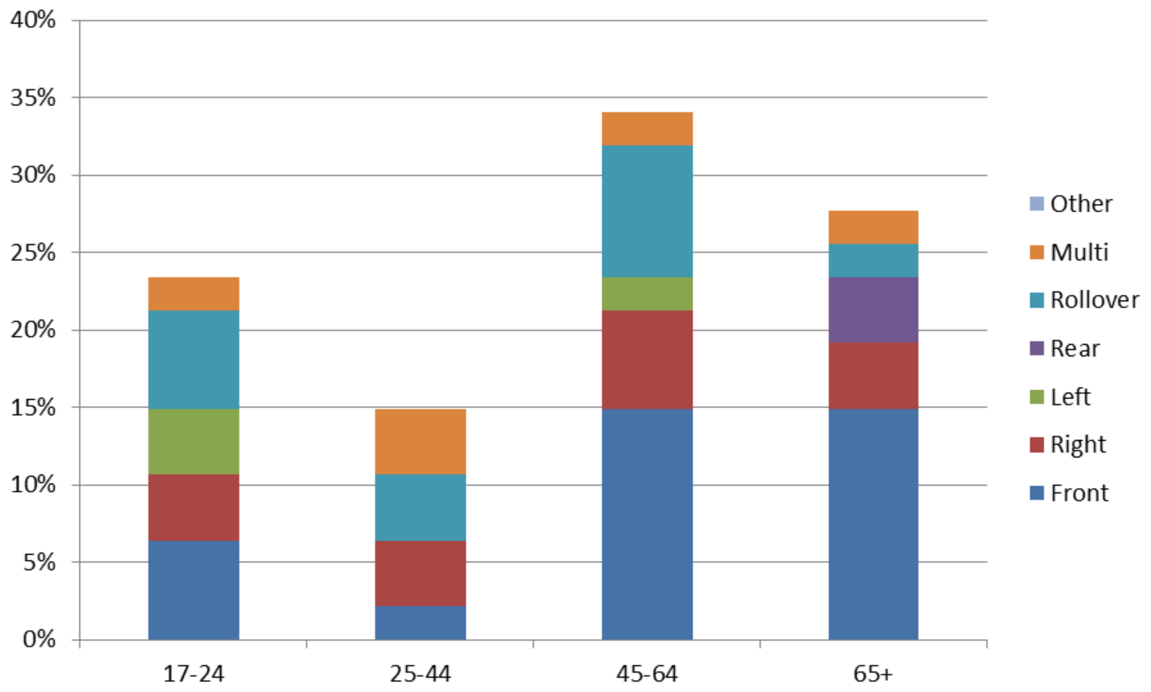

Figure 7-12: Collision types for female drivers (n=47) by driver age and all injury severities

7.3 Injury characteristics

For casualties who used a seat belt, the body regions most frequently injured at the AIS 2+ level are the thorax and pelvis followed by the abdomen (Figure 7-13).

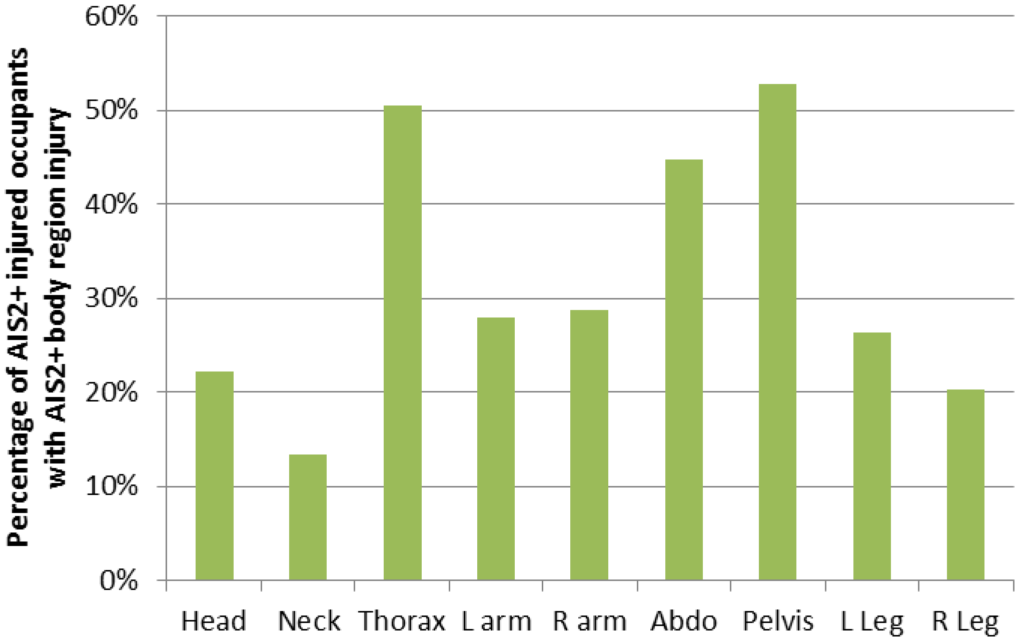

Figure 7-13: Percentage of AIS 2+ injured occupants with AIS 2+ body region injury

Breakdown by vehicle age shows that pelvic and abdominal injuries are more frequent in newer cars (Figure 7-14). Further work is needed to understand the reasons for this observation.

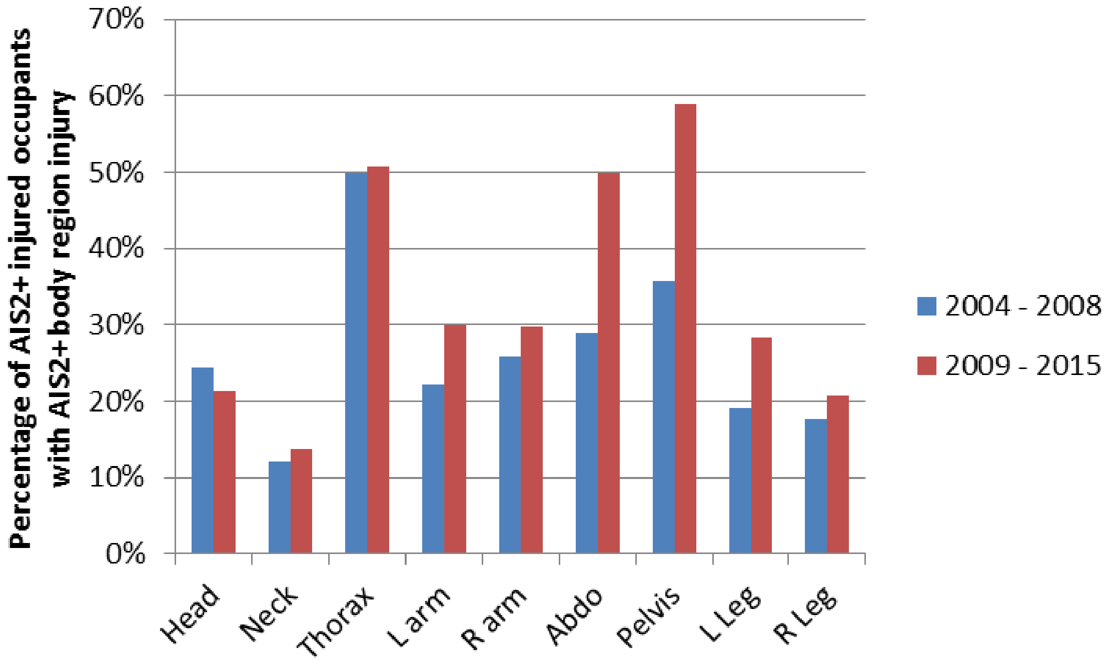

Figure 7-14: Change in AIS 2+ body region injury distribution by car age

8 Characteristics of pedestrian collisions

8.1 Pedestrian collision typology

At the time of analysis there were 74 on-scene Phase 1 pedestrian collisions. The distribution of these cases, their outcome, and the type of collision involved is shown in Figure 8-1. The x-axis, provides information on the collision code, a key for which is presented in Table 8-1. The most common type of collision involved a pedestrian crossing a road from the left hand side in front of the vehicle (N1 collision code). This type of collision did not have any associated fatalities; however there were a substantial number of serious injuries recorded. The second most common type of collision (representing a similar number of cases) consisted of a pedestrian crossing the road from the right hand side of the vehicle (N2 collision code). Of these collisions, there were 2 fatalities and 15 serious injuries recorded for pedestrians.

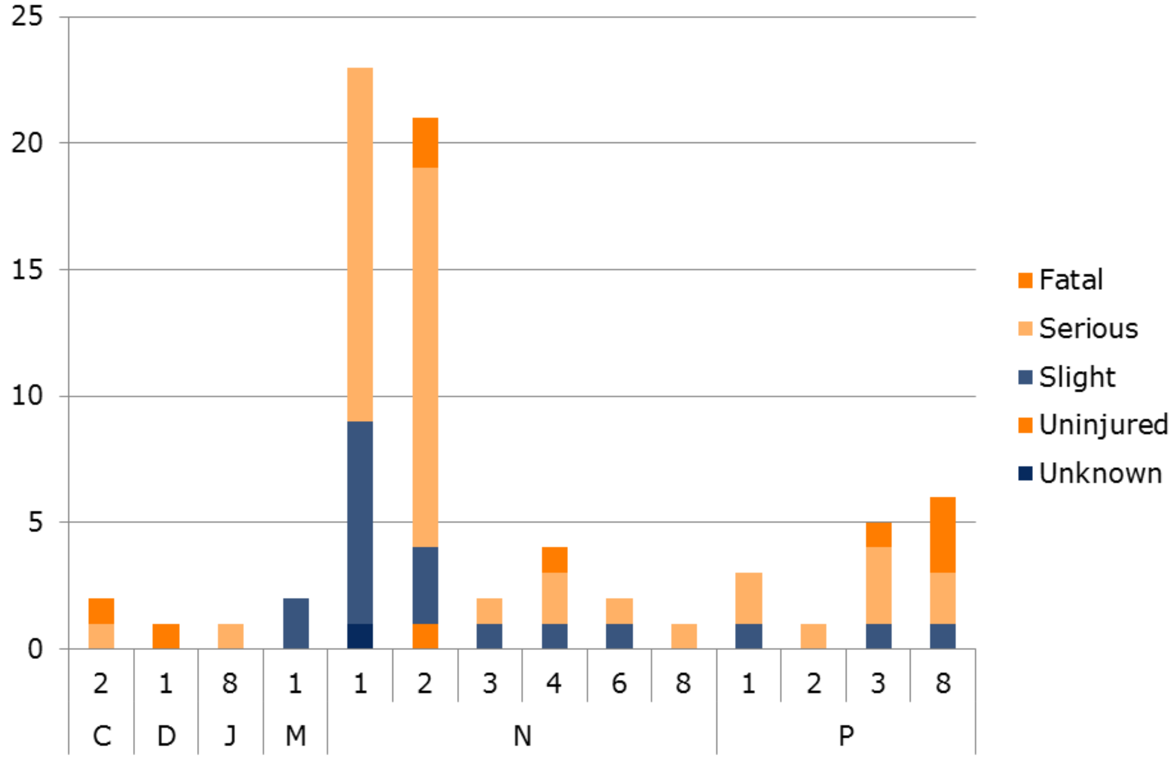

Figure 8-1: Pedestrian collision typology

Table 8-1: Collision code definitions.

Collision code	Definition
C2	Lost Control/Off Road (Straight Roads) • Off roadway to left
D1	Cornering • Lost control turning right
J8	Crossing (vehicle Turning) • Other
M1	Manoeuvring • Parking or leaving
	Pedestrians Crossing Road
N1	• Left side
N2	• Right side
N3	• Left turn left side
N4	• Right turn right side
N6	• Right turn left side
N8	• Other
	Pedestrians Other
P1	• Walking with traffic
P2	• Walking facing traffic
P3	• Walking on footpath
P8	• Other

Figure 8-2 and Figure 8-3 highlight that the majority of pedestrian collisions occur on single carriageways with 30 mph speed limits. Pedestrians who are struck as a result of crossing a road from the right are twice as likely to have been crossing a dual carriageway as those who were crossing from the left. Pedestrians crossing from the left are most likely to be crossing a single carriageway than any other road type.

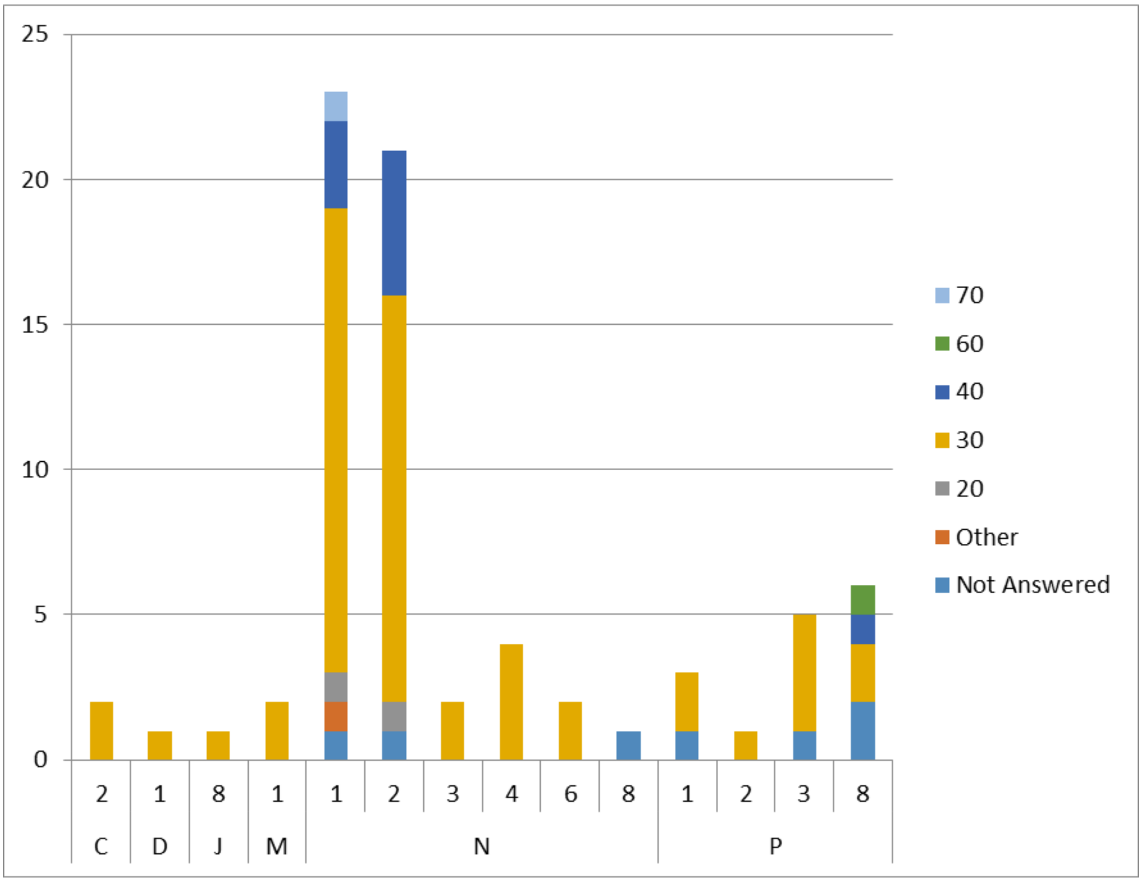

Figure 8-2: Pedestrian collision typology by the road speed limit

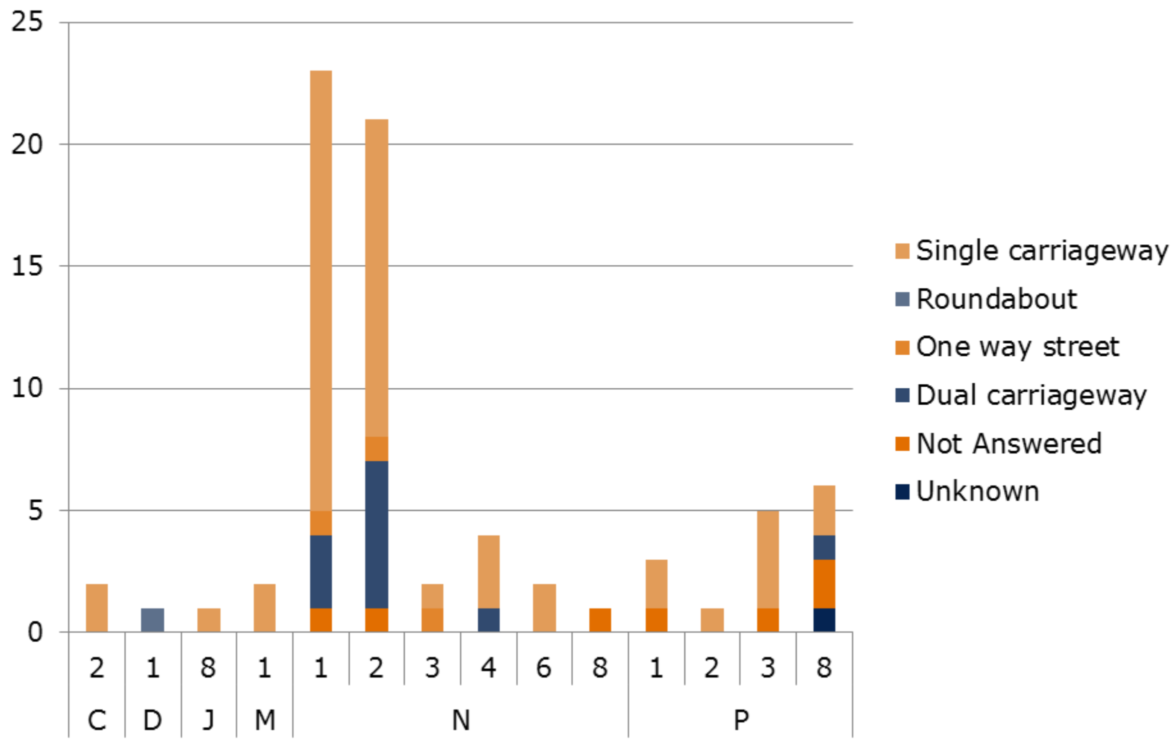

Figure 8-3: Pedestrian collision typology by the type of road

Figure 8-4 outlines the types of pedestrian facilities that are present in collisions involving pedestrians. As noted in Figure 8-1, the majority of collisions occur when a pedestrian is crossing a road from the left, followed by crossing from the right. There is no pedestrian facility present for the majority of incidents (n=8) that involved a pedestrian crossing from the left. For collisions where the pedestrian crossed from the right, there is an equal amount of ‘pelican, puffin, toucan or similar non-junction pedestrian light crossings’ (n=8) and the absence of any facility (n=8).

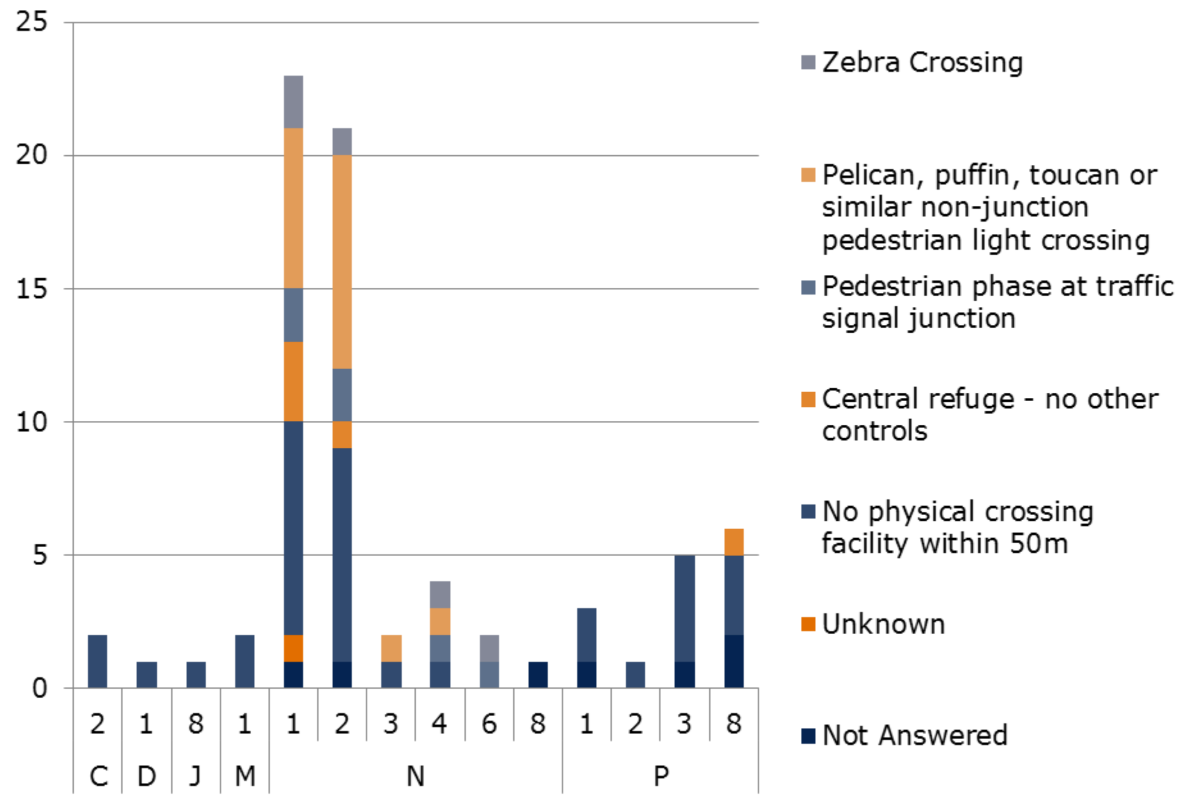

Figure 8-4: Pedestrian collision typology by presence of crossing facilities

The most common impact partner in a pedestrian collision is a car (Figure 8-5). Of the 74 collisions, 59 have involved a pedestrian and a car. This is followed by buses or coaches and heavy goods vehicles (>7.5 tonnes). Pedestrians who were impacted by a car were most likely to sustain MAIS 2 injuries, followed by MAIS 1 and then MAIS 3.

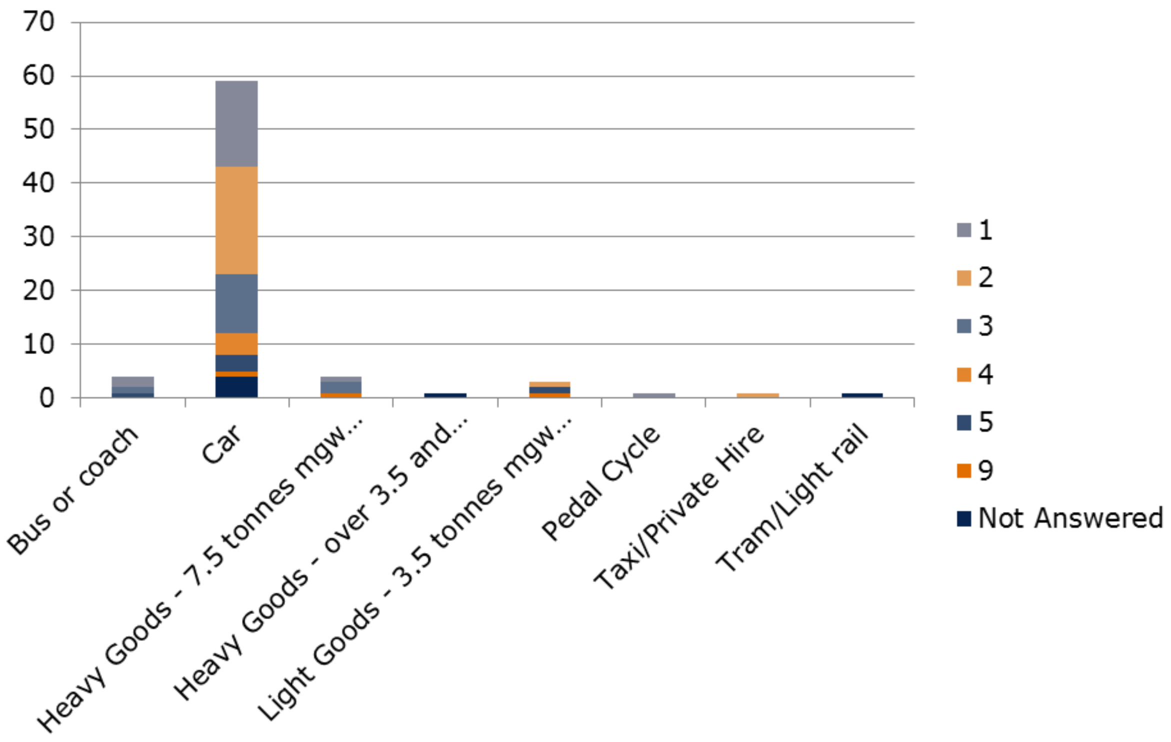

Figure 8-5: Distribution of MAIS by type of vehicles involved in pedestrian collisions

Figure 8-6 shows the movement of the vehicle before the collision with the pedestrian in relation to the vehicle's speed. This highlights that collisions with pedestrians occurred most frequently when the vehicle was travelling between 0 and 9 mph. In only four of the 74 pedestrian cases was the speed known to be 40 mph or more. At the moderate speeds involved for most cases, it should be anticipated that safety technology (primary and secondary) could have a substantial influence on the outcomes from these collisions. The most popular manoeuvre in all speed groups was 'Going ahead other'. Again, indicating that complexity of the collision path is unlikely to be a barrier to technological advances in safety for the majority of equivalent cases.

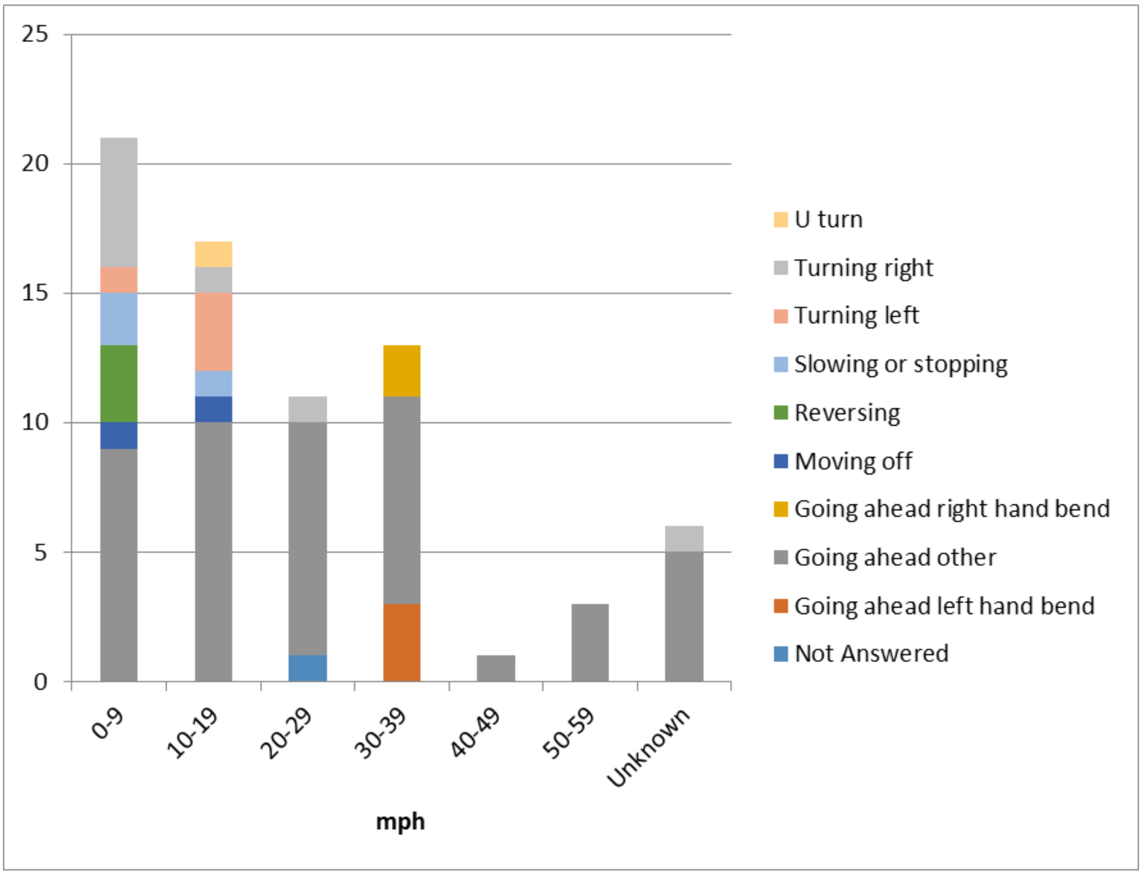

Figure 8-6: Vehicle speed by type of manoeuvre

Table 8-2 shows the controllable actions and estimated speeds of vehicles who were involved in collisions with pedestrians. The most common controllable actions include travelling at a steady speed, followed by emergency braking. Where the vehicle was under emergency braking, then (depending on the specific conditions) it could be imagined that the driver was doing as much as they could, in practice, to avoid the collision. Conversely, in 26 of the 74 cases, the vehicle was travelling at a steady speed; therefore no substantive avoiding action was taken. These two circumstances are quite different when thinking about the potential influence of collision mitigation countermeasures. The second group lend themselves to technology which can alert the driver, or react on their behalf, to the impending collision. In addition, the cases where the driver was accelerating towards the pedestrian also suggest that a warning regarding the potential collision could have some benefit.

Table 8-2: Controllable vehicle actions by estimated speeds (mph) prior to collision with a pedestrian

Controllable Action	0-9	10-19	20-29	30-39	40-49	50-59	UNK	Total
Accelerating	5	2	-	-	-	-	-	**7**
Accelerating and cornering	-	1	1	-	-	-	-	**2**
Cornering	4	1	-	1	-	1	-	**7**
Emergency braking	5	3	2	2	-	-	-	**12**
Emergency braking and cornering	-	1	1	1	-	1	-	**4**
Other braking	1	2	-	-	-	-	1	**4**
Other braking and cornering	2	-	-	-	-	-	1	**3**
Reversing	1	-	-	-	-	-	-	**1**
Steady-speed	3	6	7	8	1	1	-	**26**
Unknown		1	-	1	-	-	6	**8**
Total	**21**	**17**	**11**	**13**	**1**	**3**	**8**	**74**

Most of the pedestrian collisions occurred when a pedestrian crossed the road from the left of the opposing vehicle. The most injured age and gender group in this type of collision is '12 - 15 years – Female' (n=4). This is closely followed by '25 – 34 years – Female' (n=3). In collisions where the pedestrian was hit as a result of them crossing the road from the right of the opposing vehicle, the most injured age and gender group was '25 – 34 years – Male' (n=4).

The involvement of pedestrians in the age group of 25 – 34 years suggests that this could be an area for further investigation, but at present the sample size is too small to draw any meaningful conclusions. It might be that this group should be targeted to improve their awareness of the risks associated with being a pedestrian trying to cross a road. Equally, the older children involved in pedestrian collisions may be indicative of a failure in perception regarding the care and attention required to cross a road safely.

Note that there is little evidence to support a large over-representation of older pedestrians in these data. It was noted in RRCGB that between the years 2013 and 2014 there was an increase in pedestrian fatalities (The Department for Transport, 2015). This rise was attributed to pedestrians aged 60 and over. This finding is not reciprocated in this data, although it should be remembered that RAIDS is collected from two sampling areas only.

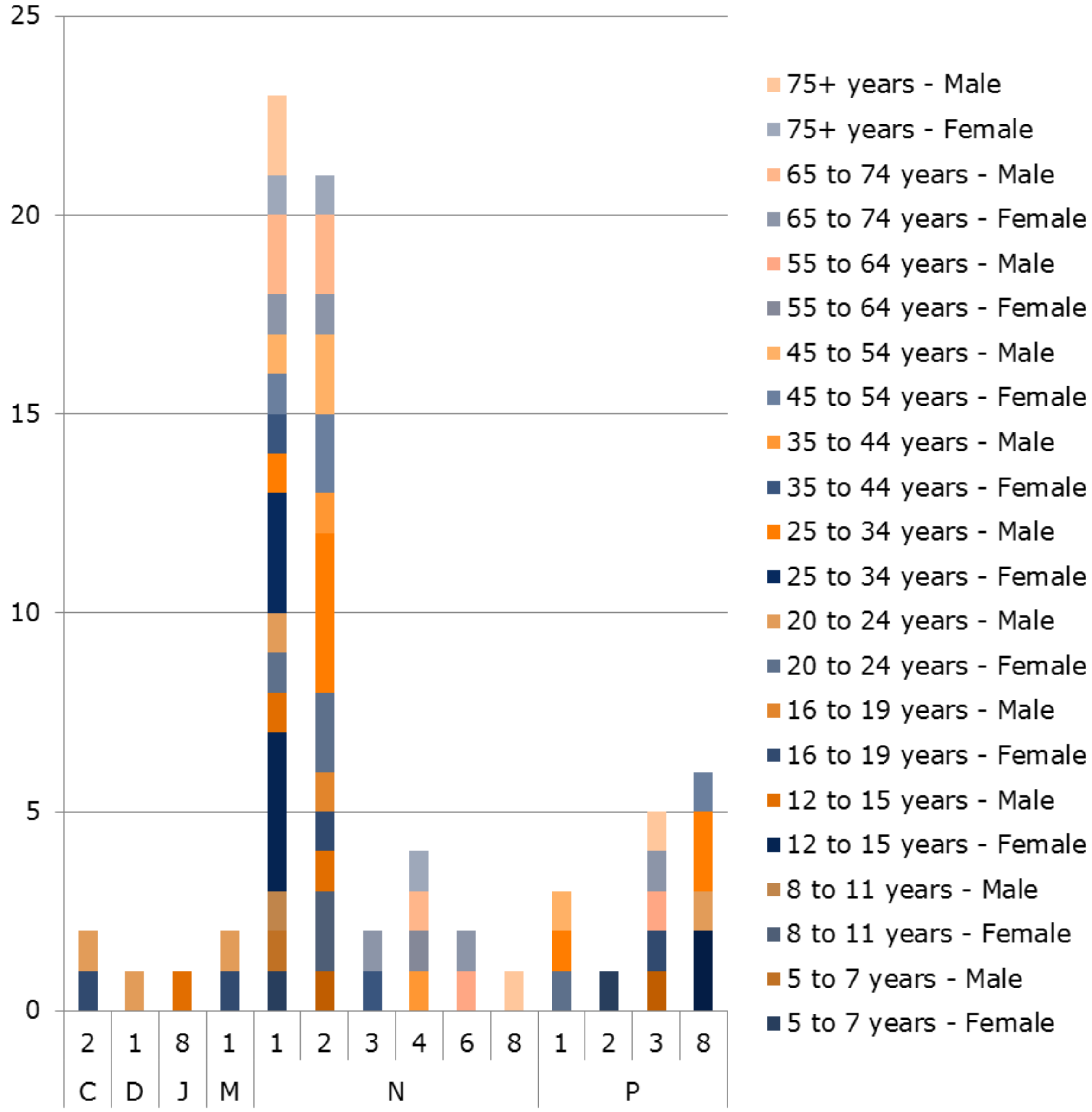

Figure 8-7: Pedestrian collision typology in relation to pedestrian age and gender

8.2 Risk of pedestrian risk by impact speed

Table 8-3 provides a summary of the impact speed for the vehicles which collided with the 74 pedestrians. This involved all vehicle types as described in Table 8-5. In general, the higher the impact speed the more severe the injury outcome. Some collisions involved slow moving vehicles pulling away or reversing.

Table 8-3: Estimated impact speed of all vehicles by pedestrian injury severity

Estimated impact speed (mph)	Fatal	Serious	Slight	Uninjured	Unknown	Total
< 5	2	5	6	1	-	**14**
5	-	2	2	-	-	**4**
7	-	1	-	-	-	**1**
8	-	-	1	-	-	**1**
9	-	-	1	-	-	**1**
10	-	5	2	-	-	**7**
12	-	-	1	-	-	**1**
15	-	6	2	-	-	**8**
17	-	-	1	-	-	**1**
20	-	3	2	-	-	**5**
24	-	1	-	-	-	**1**
25	-	4	-	-	-	**4**
28	-	1	-	-	-	**1**
30	2	4	-	-	1	**7**
33	-	1	-	-	-	**1**
34	1	-	-	-	-	**1**
35	1	3	-	-	-	**4**
40	-	1	-	-	-	**1**
50	-	1	-	-	-	**1**
53	-	1	-	-	-	**1**
55	1	-	-	-	-	**1**
Unknown	2	5	1	-	-	**8**
Total	**9**	**44**	**19**	**1**	**1**	**74**

Currently there are not enough RAIDS cases to calculate the pedestrian injury risk curves. However, the RAIDS database also contains data from the legacy studies (OTS and a sample of Police fatal files) and this has been used to demonstrate how risk curves can be calculated using the data.

Data on pedestrian casualties recorded in the On The Spot (OTS) study and Police fatal files were used to estimate the relationship between impact speed and pedestrian injury severity. Police fatal file collision reports contain information arising from Police investigations into fatal traffic collisions, and provide detailed information on the events leading up to a collision, as well as giving details of driver errors and/or vehicle defects which may have contributed to the collision and to the injuries that resulted in the fatality. They provide a unique insight into how and why fatal collisions occur.

From the pedestrian collisions in OTS and the Police fatal files, a sample of 197 pedestrian casualties was obtained, including 66 fatalities. These pedestrians were hit by the front of cars, in collisions occurring from 2000-2009. Collisions where the pedestrian was lying down or where the vehicle "sideswiped" the pedestrian were excluded. All ages of pedestrian casualty were included in the sample, including those of unknown age.

Figure 8-8 shows the cumulative impact speed of the pedestrians in the OTS and Police fatal file dataset. This shows that approximately half of fatally injured pedestrians in the dataset were hit at an impact speed of 30 mph or less. In order to perform the logistic regression, the number of slight, serious, and fatal casualties in this dataset was weighted to match the number of pedestrian casualties in the national statistics (which is shown in Table 8-4).

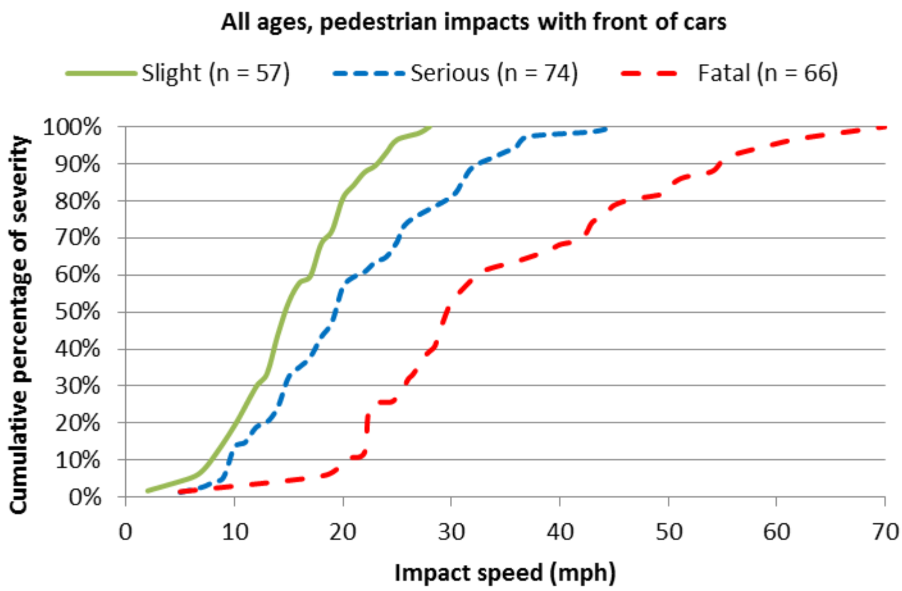

Figure 8-8: Cumulative impact speed for pedestrian casualties in the OTS and Police fatal file dataset

Table 8-4 gives details of the sample size and weighting performed on the pedestrian cases in the OTS and Police fatal file sample. The weighting was particularly important for this sample because of the large proportion of fatalities (many of these cases came from the Police fatal files, which provided fatally injured pedestrians only). As the sample only included pedestrians hit by the front of cars, it was weighted using the number of pedestrians reported to have been hit by the front of cars nationally.

Table 8-4: Sample size and weighting for OTS and Police fatal file data

Pedestrian casualties with the front of cars in Great Britain 2005-2007 mean			Pedestrian casualties in sample	Weighting factors
Injury severity	**Number**	**Proportion %**		
Fatal	347	*2.4*	66	5.26
Serious	3171	*21.7*	74	42.9
Slight	11116	*76.0*	57	195.0

It should be noted that there are some slight and serious collisions which are not reported to the Police, and are therefore not present in the national statistics (Department for Transport, 2009). This means that once the results are weighted, they are likely to give an over-estimate of the risk of fatality. Figure 8-9 estimates the risk of fatal, serious and slight injury for pedestrians struck by passenger cars by impact speed. As RAIDS Phase 2 collects more data it will be important to assess how the risk of injury changes with more modern vehicles.

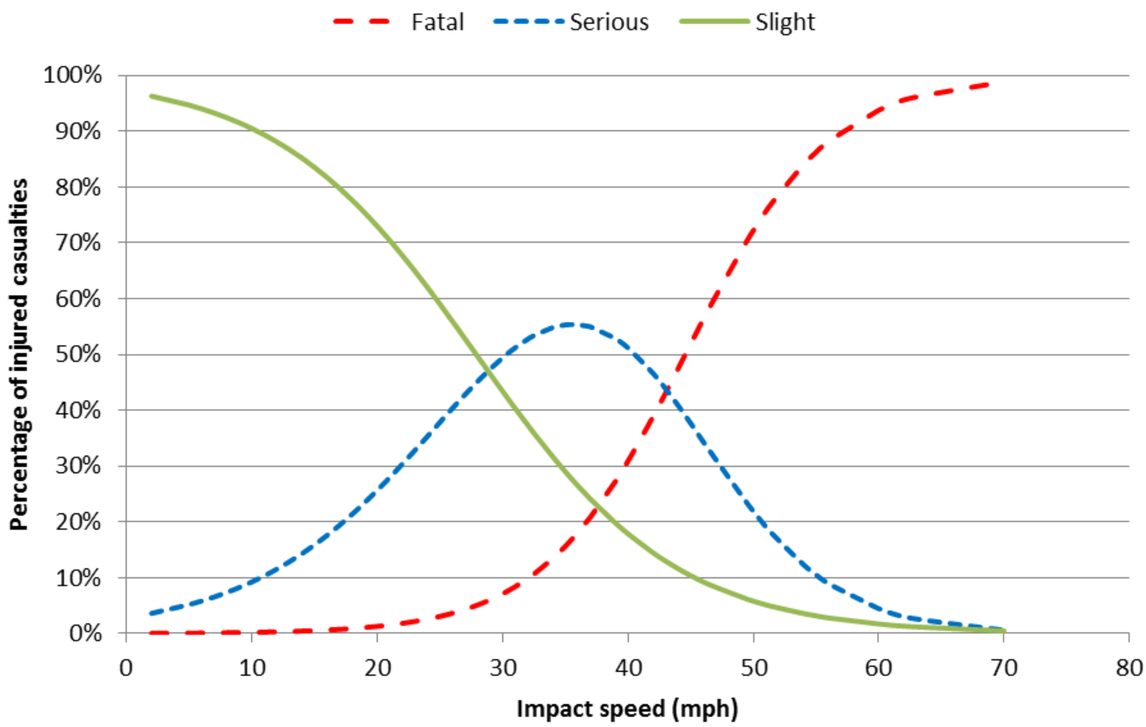

Figure 8-9: Risk of pedestrian injury by car impact speed (OTS data)

8.3 Pedestrian Injuries

The graph shows the injury severity of pedestrians by age group. The most injuries were sustained by the '25 to 34 years' group (n=11). The majority of injury severities for this group were 'Serious'. This age group was also noted as being the group most commonly involved in 'N1' and 'N2' collisions (Figure 8-10). Fatalities mostly occurred in the '20 to 24 years' age group. This age group was also mostly involved in 'N2' collisions.

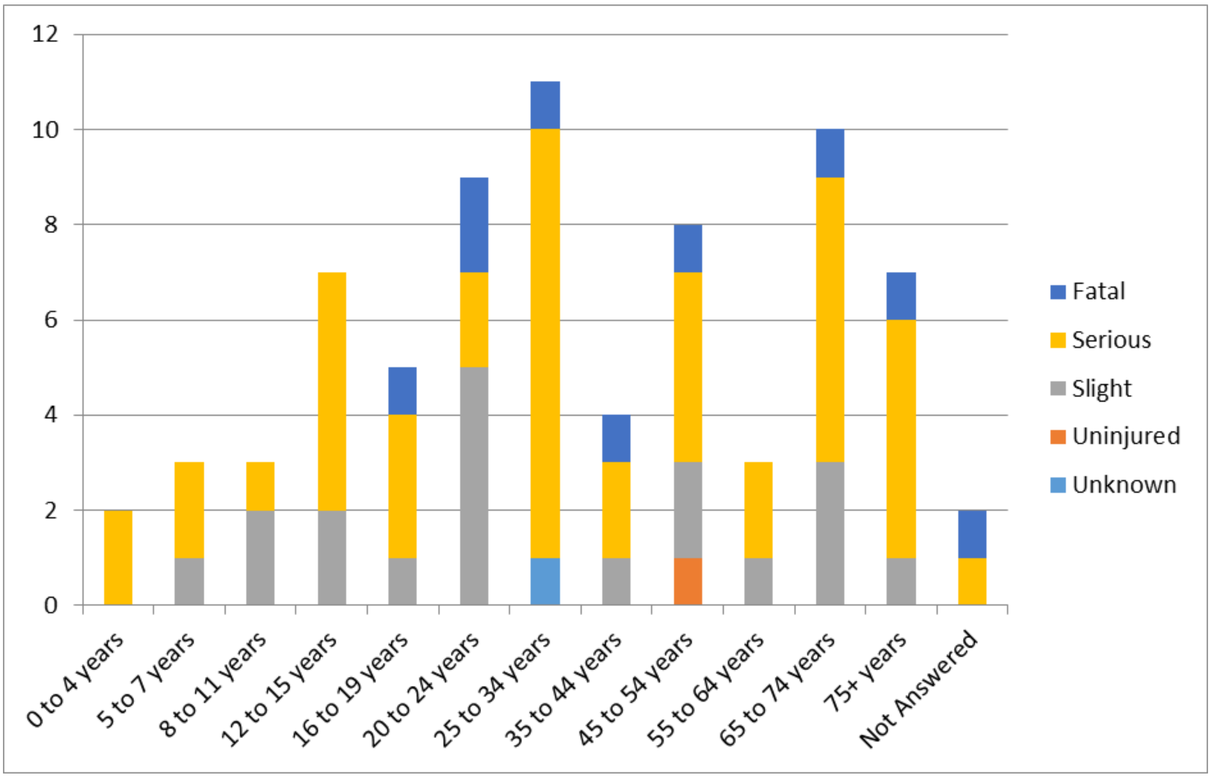

Figure 8-10: Pedestrian injury severity by age group

In Europe the mandatory level of protection for pedestrians and other vulnerable road users required of motor vehicles is dictated by Regulation (EC) No 78/2009 or the equivalent UN Regulation No. 127. These regulations specify tests of the bumper to limit the potential injury risk to the knee and lower leg and also of the bonnet to limit the potential injury risk to the head.

The distribution of injured body region by severity of injury for the pedestrians involved in collisions with all other types of vehicle is shown in Table 8-5. This shows that the head (including the face) is the body region most frequently injured at the MAIS ≥ 3 severity level. The second body region most frequently injured at this severity is the thorax or chest. Whilst the head is also injured frequently at the AIS 1 and 2 levels, it is the extremities which account for a large proportion of the body regions injured with a MAIS of 1 or 2.

Table 8-5: Distribution of injured body region by severity for pedestrians involved in collisions with all vehicles

Region	MAIS 3+	MAIS=2	MAIS=1	MAIS=0	Unknown	Total
Head (inc Face)	18	4	21	28	3	**74**
Neck	2	1	2	66	3	**74**
Thorax	8	4	3	56	3	**74**
L Arm	-	6	7	58	3	**74**
R Arm	-	9	11	51	3	**74**
Abdomen	1	9	8	53	3	**74**
Pelvis	6	5	1	59	3	**74**
L Leg	1	12	13	45	3	**74**
R Leg	1	6	12	52	3	**74**

Pedestrian collisions with cars account for all of the most severe pelvis injuries sustained by pedestrians. In respect to collisions with cars, the pelvis becomes the second most frequently injured body region at the MAIS ≥ 3 level after the head (and face). This is potentially important given that there is no longer an upper legform test included in the worldwide pedestrian safety legislation and monitoring of the performance in this test has ceased in Europe.

Table 8-6: Distribution of injured body region by severity for pedestrians involved in collisions with passenger cars

Region	MAIS 3+	MAIS=2	MAIS=1	MAIS=0	Unknown	Total
Head (inc Face)	14	2	17	25	1	**74**
Neck	1	1	2	54	1	**74**
Thorax	5	4	3	46	1	**74**
L Arm	-	5	4	49	1	**74**
R Arm	-	6	9	43	1	**74**
Abdomen	-	6	6	46	1	**74**
Pelvis	6	3	1	48	1	**74**
L Leg	1	12	12	33	1	**74**
R Leg	1	6	9	42	1	**74**

The distribution of injury causing contact points for the most severe pedestrian head injuries in the cases where the head and face were injured and from collisions with all vehicle types is shown in Figure 8-11.

From this information, it can be seen that, of the 46 MAIS injuries, only one was attributed to the bonnet and that was only an AIS 1 injury.

Beyond two AIS 1 injuries, there were no injury causing contacts with the A-pillars. This is interesting as they are known to be a stiff region of the vehicle front and are untested by the legislative or consumer information tests.

However, the largest source for injurious contacts was the windscreen. 15 of the 46 MAIS injuries were from this source and importantly, 10 of the 18 MAIS ≥ 3 injuries were attributed to a windscreen contact. The windscreen is not included in the pedestrian testing regulations. It is assumed to be both unfeasible to change and to make safe. Equally, Euro NCAP does not test the windscreen of cars, again assuming the windscreen results to be the best available performance level. The contacts shown below illustrate how the assumption that the windscreen is a safe region of the vehicle is not a robust one.

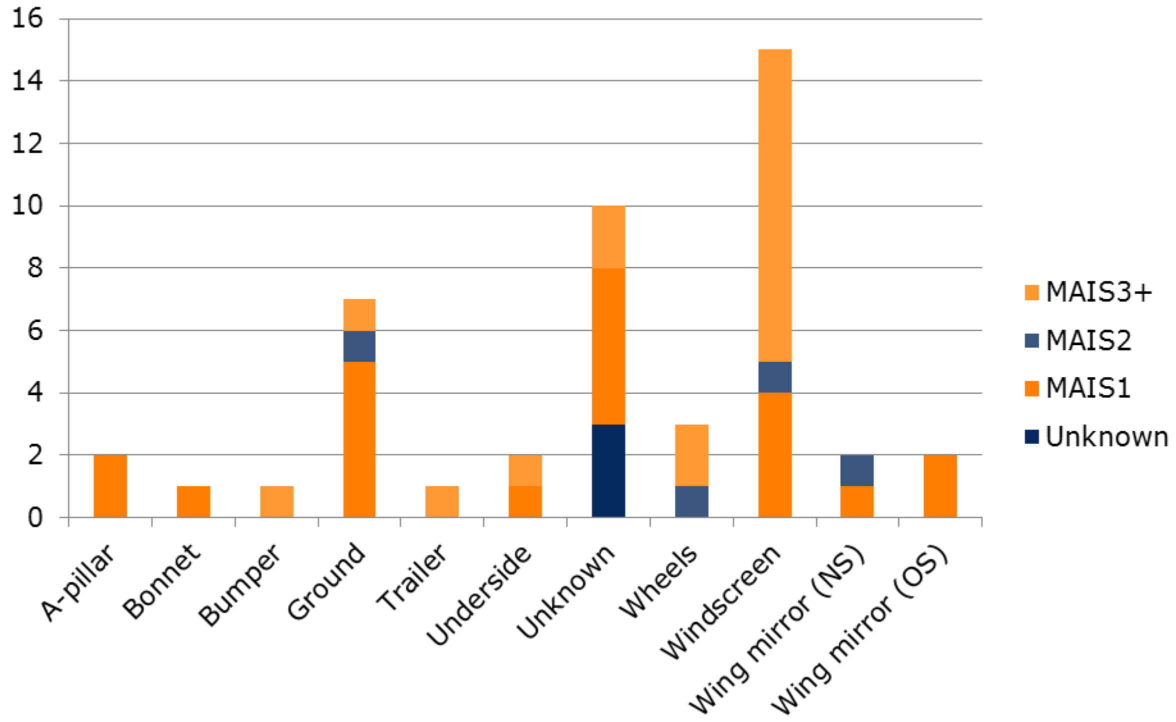

Figure 8-11: Injury causing contact for the pedestrian head injuries (all vehicles)

Details of the pedestrian head to windscreen contact points were reviewed in more detail with an inspection of the photographs from each of the 15 cases. The vehicle type, head injury MAIS and region of the windscreen struck were recorded and are provided in Table 8-7.

Only four of the 15 cases had a contact point in the centre of the screen, where the windscreen should provide the least resistance before fracturing and the least risk of injury for the pedestrian. However, there were still two MAIS 3 cases among these four. Note that one of these four cases involved a Bus/Coach.

Otherwise the contact point was distributed around the periphery of the windscreen where it would be expected that some additional stiffness was provided by the A-pillars or scuttle region.

Table 8-7: Windscreen contact points for pedestrian head strikes.

Vehicle contacted	Head MAIS	Damage to windscreen
Car	4	Next to nearside A-pillar - damage covers whole height of windscreen.
Bus/Coach	3	Centre of windscreen - large windscreen as vehicle is a bus.
Car	3	Damage to centre of windscreen - large inward dent.
Taxi/Private Hire	1	Damage at base of windscreen in the centre.
Car	3	Damage to lower nearside of windscreen.
Car	5	Damage to lower nearside of windscreen.
Car	3	Damage to lower nearside of windscreen.
Car	5	Damage to mid-height nearside of windscreen.
Car	1	Damage to mid-height nearside of windscreen.
Car	3	Damage to centre of windscreen.
Car	2	Damage to base centre of windscreen.
Car	3	Damage to lower nearside of windscreen.
Car	5	Damage from the centre of windscreen to nearside A-pillar. Damage to entire height of windscreen.
Car	1	Damage to centre of windscreen.
Car	1	Damage to mid-height offside of the windscreen.

Collisions involving pedestrians mainly occur when a pedestrian is crossing a road from the left. The findings suggest that these collisions usually occur on single carriageways with a speed limit of 30 mph, and that the driver of the vehicle is 'Going ahead other'. The second most popular collision type is when a pedestrian crosses the road from the right. Although these also occur mainly on single carriageways, they are also likely to happen on dual carriageways. Pedestrian to car collisions are most popular compared to any other type of vehicle (Figure 8-5). The majority of pedestrians struck by a car sustained a MAIS 2 injury, followed by MAIS 1.

From these data it is apparent that the majority of pedestrians involved in collisions are aged between 25 and 34 years. The age group which was most likely to sustain a fatal injury was 20 to 24 years. These findings do not fully coincide with those reported in the RRCGB 2014. However, Figure 8-10 shows that the second most popular group to be involved in a pedestrian collision were those aged 65 and 74 years. It is apparent that the safety of those aged between 20 and 34 years needs to be focused on.

Figure 8-11 highlights the amount of MAIS 3+ injuries sustained by pedestrians who were contacted by a car. Injuries to the head, thorax and pelvis occur much more frequently than injuries to other body regions at the MAIS 3+ severity. Injuries to the head are most commonly caused by a head strike to the windscreen. Therefore, improvements to the windscreen area are important when head protection is concerned and in the mitigation of serious injuries to pedestrians.

9 Vehicle technologies and collision and injury prevention

9.1 Introduction

Historically, many of the major road safety advances have been achieved by improving secondary safety; for example by the improvement of vehicle crashworthiness and improvements in occupant restraint systems. This area has been driven by regulation as well as consumer testing schemes. It is generally thought that primary and active vehicle technologies are the safety systems that will deliver further significant safety improvements.

These systems typically act before the collision to either mitigate or avoid the collision and make a decision to activate based on data collected from sensors that monitor the vehicle state as well as the road environment. Examples of these systems include: Automatic Emergency Braking Systems (AEBS) and Lane Departure Warning Systems (LDWS), as well as a multitude of other, related systems. Such systems are increasingly being fitted to new vehicles, although in general their prevalence in the fleet is one reason why these vehicles are not being detected in the RAIDS collision sample.

As well as the fact that most systems (with some notable exceptions: Volvo for example) of this type are offered as optional extras and so may only be fitted to a small proportion of cars, meaning that their penetration into the fleet takes an extended period of time, there are other explanations. For example, if the system in question is effective, the collision will not occur, and therefore will not be seen at all in the collision sample. Over time, it is expected that more vehicles with collision prevention technologies will be seen in RAIDS, but it is difficult to determine how the fitment of such systems is affecting collision occurrence without reference to exposure data: how many equipped vehicles are in the fleet. Even with such information, assumptions are required on the mileage travelled by equipped vehicles and whether the system was active at the time of the collision because most assistance systems can be manually deactivated by the driver.

So what can RAIDS tell us about the safety effect of these systems? While the data contained in RAIDS after Phase 1 is only sufficient for case by case analysis, with a larger sample, comparisons could be made on collision occurrence and collision severity between equipped and similar unequipped vehicles. RAIDS could also flag cases where systems which might be expected to function, or provide a certain level of safety did not do so, therefore providing an early warning of in-use issues.

Since robust retrospective analysis requires large quantities of data to allow statistical comparisons, TRL has proposed a new approach in Phase 2 which will see the introduction of countermeasure assessments. This will allow the engineering judgement of the investigator to be applied to each case at the time of case coding where the most information and the narrative of the collision is available. In conjunction with clear guidance on system capability and performance, this will allow predictive assessments to be made on the likely effect on collision and injury outcome, had specific systems been fitted. This approach is considered the best method to identify and track collision and casualty prevention potential until such time as sufficient collision data exists for a more robust retrospective analysis.

As the number of vehicles equipped with assistance systems is not large enough to provide any statistical analysis, a case by case review has been made on those accidents collected that included an active system; these are presented and discussed in the following sections.

9.2 Automatic Emergency Braking System (AEBS)

AEBS combines sensing of the environment ahead of the vehicle with the automatic activation of the brakes (without driver input) in order to mitigate or avoid an accident. The level of automatic braking varies, but may be up to full ABS braking capability.

In Phase 1 of RAIDS there were 11 cases that involved a vehicle equipped with AEBS. In 7 of these cases the fitment of the system had no relevance to the accident.

Case 1

Description: Vehicle 1 (equipped with AEBS (Urban and Pedestrian functionality) turned right and was struck by vehicle 2 travelling in opposite direction.

Contribution to accident: It is unknown if the AEBS would have worked in this situation because the timing of key events was unknown. The system may not have had time to react because of the turning manoeuvre or may have been traveling at speed in excess of the functionality of urban AEBS. Had it been functional, it may have reduced the severity of the impact.

Case 2

Description: Vehicle 1, equipped with AEBS (Urban functionality) drifts out of lane on 40 mph single carriageway road and collides head on with Vehicle 2.

Contribution to accident: It is likely that Vehicle 1 was travelling at speeds in excess of the operating functionality of the urban AEBS. Inter-urban AEBS or LDWS (or other lane keeping system) would have been relevant here had they been fitted.

Case 3

Description: Vehicle 1, equipped with AEBS travelling at high speed (90-100 mph) on a curved slip road between two motorways, does not react to Vehicle 2 (travelling at 40 mph) and strikes rear of Vehicle 2.

Contribution to accident: It is likely that Vehicle 1 was travelling at speeds in excess of the operating functionality of the AEBS and the sensor line of sight may have given the system less time to react. The system may not have had the time to warn the driver, or the driver may have deactivated this functionality.

Case 4

Description: Vehicle 1 (equipped with AEBS) travelling on motorway in rush hour stops successfully behind the car in front which carried out emergency braking, Vehicle 2 travelling behind Vehicle 1 failed to stop in time and impacted rear of Vehicle 1.

Contribution to accident: The AEBS system may have allowed Vehicle 1 to brake and successfully avoid striking the leading vehicle. Vehicle 2 may have also avoided the collision had it been equipped with AEBS.

9.3 Lane support systems

9.3.1 Lane Departure Warning System (LDWS)

A lane departure warning system (LDWS) monitors the lane boundaries and provides a warning to the driver of an unintended lane departure (determined by lack of indicator use, steering angle and the relative position of the vehicle to the lane boundary markings).

Phase 1 of RAIDS contained seven cases with vehicles equipped with LDWS; none of these involved accidents which were relevant to system fitment.

9.3.2 Lane Change Assist (LCA)

Lane change assistance systems warn the driver when it is unsafe to change lanes. The system will not take any direct action to prevent a possible collision.

Phase 1 of RAIDS contained two cases with vehicles equipped with LCA but neither of these involved accidents which were relevant to system fitment.

9.4 Adaptive Cruise Control (ACC)

ACC is an extension to the speed management capability of conventional cruise control systems, which maintains a desired vehicle speed if the road ahead is unobstructed and there is a constant time gap from a moving vehicle ahead.

Phase 1 of RAIDS contained six cases with vehicles equipped with ACC but none of these involved accidents which were relevant to system fitment.

9.5 Pedestrian blind-spot detection

These systems provide a warning for the driver if a pedestrian is in close proximity to the vehicle.

In RAIDS Phase 1 there were 18 cases which listed ‘Failure to see pedestrian in blind spot’ as a known or suspected occupant causation factor. After a review of these cases, nine were relevant to blind-spot pedestrian accidents. These involved low speed manoeuvres (approximately 20 mph and below) such as turning at junctions, performing U-turns on the carriageway, turning from side roads onto main roads and vice versa, and navigating roundabouts and parking manoeuvres. These are situations which require the highest levels of observation all around the vehicle and in which blind-spot warning may have alerted the driver to the presence of the pedestrian and prevented the accident.

9.6 Additional systems

9.6.1 Active pedestrian bonnet

An active pedestrian bonnet or ‘pop-up’ bonnet deploys if pedestrian contact is detected to provide greater deformation potential to protect against bonnet head strikes.

In Phase 1 of RAIDS, 14 cases involved the fitment of this system, only one of which was relevant to the accident.

Case 1

Description: Vehicle 1, equipped with an active pedestrian bonnet and travelling on a 40 mph speed limit road struck a pedestrian on its front nearside corner. The active pedestrian bonnet did not deploy.

Contribution to accident: In this case, the pedestrian's head struck the A-pillar inflicting fatal injuries. The pop-up bonnet may not have influenced the injury outcome in this case, but the system should have activated. This accident occurred shortly before a recalibration of the system because the triggering was found to be not sensitive enough.

9.6.2 *Curve warning system*

This is a system which provides the driver with a warning of an upcoming bend. In one case in RAIDS Phase 1 a vehicle was equipped with a curve warning system. In this case, it is unknown if the radius of the bend was too great for the system to work, or whether the vehicle was travelling at speeds outside the system functionality.

9.7 Summary

Collision avoidance and mitigation technologies are being equipped to new vehicles in the fleet, but are not prevalent in the RAIDS Phase 1 sample, therefore preventing any conclusions regarding ADAS. The small numbers of equipped vehicles in RAIDS is most likely because of the low penetration rate of the systems into the fleet because systems are generally fitted as optional extras. Vehicles with standard fit systems are beginning to appear in the accident sample and greater numbers are anticipated in the next Phase of RAIDS.

It is inherently difficult to determine the effectiveness of systems from the accident sample alone. Information on the population sample (system fitment and exposure to accident risk) is required to carry out a comparison of accidents or injuries between vehicles with and without any system in question. RAIDS will continue to collect information on the accident sample to enable later retrospective analysis should exposure data become available, and will allow comparison of accident rates between similar vehicles once sufficient data is gathered. RAIDS will also flag accidents in which systems did not function as they were designed to do. An example of this was found in Phase 1 where an active pedestrian bonnet did not deploy in a pedestrian accident.

TRL have proposed the inclusion of countermeasure coding for the next phase of RAIDS. While this is a predictive technique and therefore less robust than retrospective statistical analysis, it allows a 'what if' approach to be applied to all accidents – not just those involving an equipped vehicle – therefore quickly building a picture of systems that have the greatest influence on accidents and casualties. This approach is complimentary to the retrospective approach and provides evidence on likely system benefits when the systems are rare in the fleet. Updates on this topic will be provided in the next RAIDS phase.

10 Conclusions

This report provides an overview of the RAIDS programme and describes the aims of the in-depth data collection, the sampling strategy, and a high level overview of the data collected during the first phase. It should be recognised that RAIDS is an evidence base – a resource that can be used to investigate and answer a wide range of research questions. The RAIDS database is already being successfully used by a range of research projects, each with specific research questions. As data collection continues into a second phase, sample sizes will increase, enabling research questions to be answered more robustly and allowing improvements that ensure that the data collected are able to address tomorrow's research questions.

The main conclusions of this high level review of Phase 1 of the RAIDS programme can be summarised as:

- Phase 1 of the RAIDS programme resulted in the collection of 1,255 cases (630 on-scene, 373 retrospective car, and 252 retrospective large vehicle) being collected from two discrete sampling regions.
- If only the injurious RAIDS cases are considered, fatal collisions are over-represented by a factor of 11.2, serious by 2.6, with slight collisions being under-represented by a factor of 0.59, compared with data from RRCGB 2014 (The Department for Transport, 2015).
- The RAIDS sample is comparable to the national sample with respect to the distribution of vehicle types. In both cases, passenger cars predominate, representing over 70% of vehicles. However, RAIDS contains greater proportions of goods vehicles and lesser proportions of Vulnerable Road Users compared to the national data.
- Cars dominate the RAIDS sample (over 71% of vehicles). For all KSI collisions, head-on (17.99%), loss of control (14.96%) and rear end (11.74%) are the most frequently occurring collision types.
- Car casualties dominate the RAIDS sample, with 25-34 year olds, followed by 16-24 and 35-44 being the most frequent casualty age groups. Other vehicle types exhibit different age patterns which most likely reflect exposure, although the sample size is small. Overall, male casualties comprise more than 62% of the sample.
- The 'driver/rider error or reaction' codes were the most commonly reported for all accident injury severities, although they were slightly less likely to be recorded for the more severe injury accidents.
- 100% of KSI cases had at least one human contributory factor, approximately 30% of cases had an environmental factor and 11% had a vehicle factor. For KSI cases, 62.9% had only human contributory factors, compared with 66.7% of slight and non-injury cases.
- For TRL cases (which were the only ones that had matched STATS19 data), contributory factors were found to be generally consistent to those recorded in

STATS19. However, RAIDS identified more contributory factors relating to impairment or distraction and behaviour or inexperience.

- Vehicle causation factors were more frequently noted for motorcycles (11.4%) than other groups. Goods vehicles had a lower percentage (4.2% HGV and 4.7% LGV) than cars (6.7%), possibly resulting from better maintenance.
- For occupant causation factors 'error of judgement' was the most frequent for both male and female car drivers. The most frequent precipitating factors were overall 'poor turn or manoeuvre' followed by 'loss of control'.
- The greatest number of causation factors occurred in the 25-44 age group; the most common causation themes were judgement, attention, and carelessness factors, with these factors also being significant for all other age groups. Older male drivers show less recklessness, risk taking behaviour and excessive speed than younger male drivers; but had proportionately more 'looked but did not see' and 'error of judgement' collisions.
- Female car drivers were found to be less prone to aggression and excessive speed causative factors, but showed similar high levels of distraction and carelessness/thoughtless causation factors to male drivers. Higher counts of 'following too close' and 'distraction within vehicle' were observed.
- Mobile phone is difficult to detect retrospectively. A case by case analysis (n=31) found two main trends: drifting out of lane causing collision or loss of control due to a panic corrective action and failing to perceive a stationary or slower moving hazard ahead.
- For 93 cases which had a contributory factor of excessive speed, 67% were travelling within or below the speed limit. However, exceeding the speed limit was found to be associated with more severe injury outcomes.
- Although seat belt use was generally high (>85%), use was lowest for males and females aged 17-24 and males aged 25-44. Overall seat belt wearing for males was lower than females. Examination of seat belt usage by time of week and day shows lowest usage Monday to Thursday and from 18:00 to midnight.
- For casualties who used a seat belt, the body regions most frequently injured at the AIS 2+ level were the thorax and pelvis followed by the abdomen.
- Analysis by vehicle age shows that pelvic and abdominal injuries are more frequent in newer cars; this should be investigated in Phase 2.
- Of the 74 pedestrian collisions, 59 involved a pedestrian and a car. This is followed by buses or coaches and heavy goods vehicles (>7.5 tonnes). The modal age group for pedestrian collisions was 25-34.
- 76% of pedestrians (56) were stuck by vehicles with estimated pre-crash travel speed of 30 mile/h or less. In only four of the 74 pedestrian cases was the speed known to be 40 mile/h or more. Therefore it should be anticipated that safety technology (primary and secondary) could have a substantial influence on the outcomes of these collisions.
- The head (including the face) was the body region most frequently injured at the MAIS $\geq$ 3 severity level, followed by the thorax. Whilst the head is also injured

frequently at the AIS 1 and 2 levels, it is the extremities which account for a large proportion of the body regions injured with a MAIS of 1 or 2.

- However, the largest source for injurious contacts was the windscreen. 15 of the 46 MAIS injuries were from this source and importantly, 10 of the 18 MAIS ≥ 3 injuries were attributed to a windscreen contact. The windscreen is not included in the pedestrian testing regulations.
- In respect to collisions with cars, the pelvis becomes the second most frequently injured body region at the MAIS ≥ 3 level after the head (and face). This is potentially important given that there is no longer an upper legform test included in the worldwide pedestrian safety legislation and monitoring of the performance in this test has ceased in Europe.
- Collision avoidance and mitigation technologies are being equipped to new vehicles in the fleet, but are not prevalent in the RAIDS Phase 1 sample, therefore preventing any conclusions regarding ADAS. The small numbers of equipped vehicles in RAIDS is most likely because of the low penetration rate of the systems into the fleet because systems are generally fitted as optional extras.

11 Recommendations

1. As more cases are collected and the number of cases with STATS19 linking increases, it will be important to track the trends regarding police reported collisions and the findings from RAIDS. Common contributory factors, such as 'Error of judgement' and 'Looked but failed to see', should be investigated further to ascertain more precisely what is meant when this is coded and how future collisions with these characteristics could be prevented.

2. Analysis of body region of injury by car age showed that pelvic and abdominal injuries are more frequent in newer cars. Further monitoring and more detailed analysis should be carried out on this specific topic in Phase 2.

3. For pedestrians struck by cars, the following aspects should be monitored using RAIDS data in Phase 2:

   - The pelvis was the second most frequently injured MAIS ≥ 3 body region after the head (and face). This is potentially important given that there is no longer an upper legform test in worldwide pedestrian safety legislation.
   - The largest source for injurious contacts was the windscreen. 15 of the 46 MAIS injuries were from this source, and 10 of the 18 MAIS ≥ 3 injuries were attributed to a windscreen contact. The windscreen is not included in pedestrian testing regulations.
   - Collisions involving pedestrians aged 25-34 should be assessed to understand how future accidents involving this age group could be prevented.

4. Assessment of countermeasures should be introduced to assess advanced safety systems and other safety solutions. This will allow the engineering judgement of the investigator to be applied to each case at the time of case coding where the most information and the narrative of the collision is available. In conjunction with guidance on system capability and performance, this will allow predictive assessments to be made on the likely effect on collision and injury outcome. This approach could identify and track collision and casualty prevention potential until such time as sufficient collision data exists to allow more robust retrospective analysis comparing outcomes for equipped and unequipped vehicles. Future data collection should focus on:

   - Advanced Driver Assistance Systems (ADAS): Develop the RAIDS methodology to evaluate the real world effectiveness and performance limits of the state of the art collision avoidance and injury mitigation technologies fitted to cars today.
   - Connected and Autonomous Vehicles (CAV): There is a revolution with regard to vehicle systems. RAIDS must evolve to be able to capture the pertinent data for these technologies.
   - Event Data Recorders: The valuable data stored on most vehicles in the event of a collision will provide a greater opportunity to learn more about how the safety technologies operated and afford accidentologists more insight into the specific nature of collisions. This will help to improve the quality of reconstructions, which in turn will allow researchers to assess

how future collisions can be prevented, often based on smaller samples of cases than was previously possible, because of higher confidence in the collision and injury mechanisms (e.g. travel speeds, changes of velocity etc.). This will mean the evidence to improve road safety will be available in shorter timescales for similar investigation sample sizes.

5. The RAIDS sample contains proportionally less Vulnerable Road Users compared to the national reported road casualty statistics. VRUs account for approximately half of all killed and seriously injured road casualties in Great Britain and consideration should be given to adopting the sample strategy to capture more cases involving motorcyclists, pedal cyclists and pedestrians.

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- Thames Valley and Hampshire Police forces
- HM Coroners for Berkshire, Buckinghamshire, Hampshire and Oxfordshire
- South Central Ambulance Service and John Radcliffe Hospital
- University Hospital Southampton
- Frimley Park Hospital
- Royal Berkshire Hospital
- Portsmouth Queen Alexandra Hospital
- Leicestershire Police
- Nottinghamshire Police
- HM Coroners for Nottinghamshire, Leicester City and South Leicestershire District, and Rutland and North Leicestershire District
- Leicester Royal Infirmary
- Queen's Medical Centre, Nottingham
- Kingsmill Hospital, Mansfield
- Royal Derby Hospital

More information on the study can be found at https://www.gov.uk/government/publications/road-accident-investigation-road-accident-in-depth-studies.

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Appendices

Appendix A Definition of police injury severity

Police injury severity is defined using the STATS20 guidelines: Any persons killed or injured in a road accident involving human death or personal injury occurring on the Highway and notified to the police within 30 days of occurrence, and in which one or more vehicles are involved.

This includes:

a) A person who moves quickly to avoid being involved in an accident, is successful in that, but in doing so incurs an injury (e.g. twists an ankle). Also includes occupant of vehicle which manoeuvres or brakes suddenly to avoid an impact, but in so doing sustains an injury;

b) A pedestrian who injures himself on a parked vehicle;

c) A person who is injured after falling from a vehicle;

d) A person who is injured boarding or alighting a bus or coach;

e) A person injured whilst aboard a bus or coach as a result of braking, a sudden manoeuvre or a collision, whether or not another vehicle is involved;

f) A person who is injured away from the carriageway as a result of an accident which commenced on the public highway;

g) All casualties in accidents arising from deliberate acts of violence involving a vehicle;

Excluding:

h) Death/injury to babies unborn up to the time of the accident;

i) A person injured in a road accident as a result of illness (e.g. fit) immediately prior to the accident, where the only injury sustained is deemed to be a result of the illness rather than the road accident. All other casualties involved in the accident should be included;

j) A person who dies in a road accident from natural causes (e.g. heart attack) and whose death is not ascribed by the Coroner's Court (Procurator Fiscal in Scotland) to have been a result of the accident. Other casualties in these accidents should be reported;

k) Confirmed suicides. Other casualties in these accidents should be reported. Injured persons suspected of having attempted suicide should be reported;

l) Any person who witnesses an accident and suffers shock but who is not directly involved.

The injury definitions are:

A. **'Fatal'** injury includes only those cases where death occurs in less than 30 days as a result of the accident. 'Fatal' does not include death from natural causes or suicide (see (h) to (l) above).

Where a person is injured in a road accident and dies subsequently, but death is not deemed to be directly related to the injuries sustained in the accident, casualty severity should be based on the injuries initially sustained (e.g. casualties admitted to hospital following an accident but then contracting MSRA virus).

B. Examples of **'Serious'** injury are:

Broken neck or back
Severe head injury, unconscious
Severe chest injury, any difficulty breathing
Internal injuries
Multiple severe injuries, unconscious
Loss of arm or leg (or part)
Other chest injury, not bruising
Deep penetrating wound
Fracture
Deep cuts/lacerations
Other head injury
Crushing Burns (excluding friction burns)
Concussion
Severe general shock requiring hospital treatment
Detention in hospital as an in-patient, either immediately or later
Injuries to casualties who die 30 or more days after the accident from injuries sustained in that accident

C. Examples of **'Slight'** injury are:

Whiplash or neck pain
Shallow cuts/lacerations/abrasions
Sprains and strains (not necessarily requiring medical treatment)
Bruising
Slight shock requiring roadside attention
(Persons who are merely shaken and who have no other injury should not be included unless they receive or appear to need medical treatment)

Appendix B RAIDS Collision Codes

RAIDS COLLISION CODES

	TYPE	1	2	3	4	5	6	7	8
A	Overtaking And Lane Change	Pulling Out Or Changing Lane To Right	Head On	Cutting In Or Changing Lane To Left	Lost Control (Overtaking Vehicle)	Side Road	Lost Control (Overtaken Vehicle)	Weaving In Heavy Traffic	OTHER
B	Head On	On Straight	Cutting Corner	Swinging Wide	Both Or Unknown	Lost Control On Straight	Lost Control On Curve		OTHER
C	Lost Control Or Off Road (Straight Roads)	Out Of Control On Roadway	Off Roadway To Left	Off Roadway To Right					OTHER
D	Cornering	Lost Control Turning Right	Lost Control Turning Left	Missed Intersection Or End Of Road					OTHER
E	Collision With Obstruction	Parked Vehicle	Accident Or Broken Down	Non Vehicular Obstruction (inc Animals)	Workmans Vehicle	Opening Door			OTHER
F	Rear End	Slow Vehicles	Cross Traffic	Pedestrian	Queue	Signals	Other		OTHER
G	Turning Vs Same Direction	Rear Of Left Turning Vehicle	Left Side Side Swipe	Stopped Or Turning From Left Side	Near Centre Line	Overtaking Vehicle	Two Turning		OTHER
H	Crossing (No Turns)	Right Angle (70° to 110°)							OTHER
J	Crossing (Vehicle Turning)	Right Turn Right Side		Two Turning					OTHER
K	Merging	Left Turn In	Right Turn In	Two Turning					OTHER
L	Right Turn Against Traffic	Stopped Waiting To Turn	Making Turn						OTHER
M	Maneuvering	Parking Or Leaving	U-Turn	U-Turn	Driveway Manouvere	Parking Opposite	Angle Parking	Reversing Along Road	OTHER
N	Pedestrian Crossing Road	Left Side	Right Side	Left Turn Left Side	Right Turn Right Side	Left Turn Right Side	Right Turn Left Side	Manouvering Vehicle	OTHER
P	Pedestrians Other	Walking With Traffic	Walking Facing Traffic	Walking On Footpath	Child Playing	Attending To Vehicle	Entering Or Leaving Vehicle		OTHER
Q	Misc	Fell While Boarding Or Alighting	Fell From Moving Vehicle	Train	Parked Vehicle Ran Away	Equestrian	Fell Inside Vehicle	Trailer Or Load	OTHER

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Appendix C Overview of Phase 1 data

C.1 Accident severity (case numbers) by study area

Table C 1: shows the distribution of accident severity for the RAIDS Phase 1 sample, both in terms of the case severity made at the initial accident notification and that made at case completion.

Table C 1: Distribution of accident severity (TRL)

Accident severity	Initial police injury severity		RAIDS final accident severity	
	N	%	N	%
Fatal	76	*13.15*	81	*14.01*
Serious	197	*34.08*	174	*30.10*
Slight	210	*36.33*	226	*39.10*
Injury NFS[9]	13	*2.25*	-	-
Damage only	65	*11.25*	75	*12.98*
Unknown	17	*2.94*	22	*3.81*
Total	**578**	***100***	**578**	***100***

Table C 2 shows the distribution of RAIDS cases by investigation type for the TRL data collection team.

Table C 2: Distribution of case type by accident severity (TRL)

RAIDS accident severity	On-scene	Retrospective Scene (car)	Retrospective Scene (large vehicle)	Total		Target
	N	N	N	N	%	%
Fatal	20	21	41	81	*44.11*	*25*
Serious	57	63	54	174		
Slight	133	66	27	226	*39.10*	*50*
Damage only	72	3	-	75	*12.98*	*25*
Unknown	10	8	4	22	*3.81*	-
Total	**292**	**161**	**126**	**578**	***100***	**-**

For the TRL team, the Retrospective Scene (large vehicle) group comprised 100 Retrospective heavy vehicle investigations and 26 investigations involving a retrospective car and heavy vehicle.

Table C 3 and Table C 4 present the same information for the TSRC data collection team.

[9] NFS=Not further stated

Table C 3: Distribution of accident severity (TSRC)

Accident severity	Initial police injury severity N	%	RAIDS final accident severity N	%
Fatal	54	*7.98*	52	*7.68*
Serious	184	*27.18*	221	*32.64*
Slight	360	*53.18*	299	*44.17*
Injury NFS	1	*0.15*	-	-
Damage only	78	*11.52*	81	*11.96*
Unknown	-	-	24	*3.55*
Total	**677**	***100***	**677**	**100**

Table C 4: Distribution of case type by accident severity (TSRC)

Initial police accident severity[1]	On-scene N	Retrospective Scene (car) N	Retrospective Scene (large vehicle) N	Total N	Total %	Target %
Fatal	11	14	27	52	*40.32*	*25*
Serious	92	85	44	221		
Slight	152	103	44	299	*44.17*	*50*
Damage only	77	3	1	81	*11.96*	*25*
Unknown	6	8	10	24	*3.55*	-
Total	**338**	**213**	**126**	**677**	***100***	

For the TSRC team, the Retrospective Scene (large vehicle) group comprised 94 Retrospective heavy vehicle investigations and 32 investigations involving a retrospective car and heavy vehicle.

C.2 Vehicle numbers

Table C 5 presents the number of vehicles in the RAIDS sample. This shows that passenger cars were the predominant vehicle type examined by RAIDS teams, followed by light and heavy goods vehicles. The data also shows that distribution of vehicle types collected in the two RAIDS study areas is very similar.

Table C 5: Number of vehicles by vehicle type contained in the RAIDS sample

Vehicle type	TRL	%	TSRC	%	Total
Agricultural vehicle (include diggers etc.)	-	*0.00*	5	*0.38*	**5**
Bus or coach (17 or more passenger seats)	15	*1.33*	17	*1.29*	**32**
Car	770	*68.02*	903	*68.67*	**1,673**
Heavy Goods - 7.5 tonnes mgw and over	93	*8.22*	92	*7.00*	**185**
Heavy Goods - mgw unknown	7	*0.62*	5	*0.38*	**12**
Heavy Goods - over 3.5 and under 7.5 tonnes mgw	16	*1.41*	8	*0.61*	**24**
Light Goods - 3.5 tonnes mgw and under	97	*8.57*	123	*9.35*	**220**
Minibus (8-16 passenger seats)	6	*0.53*	3	*0.23*	**9**
Motorcycle - 50cc and under	3	*0.27*	5	*0.38*	**8**
Motorcycle - over 125cc and up to 249cc	2	*0.18*	11	*0.84*	**13**
Motorcycle - over 250cc and up to 499cc	4	*0.35*	4	*0.30*	**8**
Motorcycle - over 500cc	20	*1.77*	21	*1.60*	**41**
Motorcycle - over 50cc and up to 124cc	11	*0.97*	22	*1.67*	**33**
Motorcycle - unknown cc	-	*0.00*	3	*0.23*	**3**
Other motor vehicle (give details)	4	*0.35*	1	*0.08*	**5**
Pedal Cycle	28	*2.47*	25	*1.90*	**53**
Taxi/Private Hire	9	*0.80*	18	*1.37*	**27**
Trailer	1	*0.09*	1	*0.08*	**2**
Tram/Light rail	-	*0.00*	2	*0.15*	**2**
Unknown	5	*0.44*	2	*0.15*	**7**

85 pedestrians were recorded in Phase 1 of RAIDS, 41 by TRL and 44 by TSRC; again highlighting the similarity of the sample between the study areas.

C.3 Casualty severity by study area

Table C 6 and Table C 7 present the distribution of casualty severity and the distribution of casualty severity by investigation type for the TRL RAIDS sample.

Table C 6: Distribution of casualty severity (TRL)

Casualty severity	Initial police injury severity		RAIDS final injury severity		Road Casualties Great Britain (2014)	
	N	%	N	%	N	%
Fatal	84	*5.24*	88	*5.49*	1,775	*0.91*
Serious	271	*16.91*	264	*16.47*	22,807	*11.73*
Slight	483	*30.13*	482	*30.07*	169,895	*87.36*
Damage only	698	*43.54*	683	*42.61*	-	-
Unknown	67	*4.18*	86	*5.36*	-	-
Total	**1603**	***100***	**1603**	***100***	**194,477**	***100***

Table C 7: Distribution of RAIDS investigation type by casualty severity (TRL)

RAIDS Casualty severity	On-scene	Retrospective Scene (car)	Retrospective Scene (large vehicle)	Total	
	N	N	N	N	%
Fatal	24	21	43	88	*21.96*
Serious	76	110	78	264	
Slight	221	150	111	482	*30.07*
Damage only	449	81	153	683	*42.61*
Unknown	39	30	17	86	*5.36*
Total	**809**	**392**	**402**	**1,603**	***100***

Table C8 and Table C9 present the distribution of casualty severity and the distribution of casualty severity by investigation type for the TSRC RAIDS sample.

Table C 8: Distribution of casualty severity (TSRC)

Casualty severity	Police occupant severity		RAIDS final injury severity		Road Casualties Great Britain (2014)	
	N	%	N	%	N	%
Fatal	60	*3.37*	59	*3.31*	1,775	*0.91*
Serious	254	*14.26*	295	*0.39*	22,807	*11.73*
Slight	689	*38.69*	556	*16.56*	169,895	*87.36*
Uninjured	742	*41.66*	758	*31.22*	-	-
Unknown	36	*2.02*	106	*42.56*	-	-
Not answered	-	-	7	*5.95*	-	-
Total	**1781**	***100***	**1781**	***100***	**194,477**	***100***

Table C 9: Distribution of RAIDS investigation case type by casualty severity (TSRC)

RAIDS casualty severity	On-scene	Retrospective Scene (car)	Retrospective Scene (large vehicle)	Total	
	N	N	N	N	%
Fatal	12	17	30	59	*19.95*
Serious	114	119	62	295	
Slight	259	194	103	556	*31.34*
Damage only	513	136	109	758	*42.73*
Unknown	14	56	36	106	*5.98*
Not answered	-	-	-	-	-
Total	**912**	**522**	**340**	**1,774**	***100***

Appendix D Car driver demographics, behaviour and collision causation

Table D 1: Contributory factor types (RAIDS) for male car drivers

		Contributory factor type	17-24 %	25-44 %	45-64 %	65 – 99 %	Total %
	1	Road environment contributed	*1.1*	*2.5*	*1.2*	*0.7*	***5.4***
	2	Vehicle defects	*0.4*	*0.4*	*0.1*	*0.4*	***1.3***
Driver/rider	3	Injudicious action	*4.0*	*4.6*	*2.9*	*1.3*	***12.8***
	4	Driver/rider error or reaction	*7.5*	*18.7*	*11.8*	*8.3*	***46.3***
	5	Impairment or distraction	*1.3*	*5.2*	*1.2*	*2.4*	***10.1***
	6	Behaviour or inexperience	*4.9*	*6.0*	*3.2*	*1.7*	***15.7***
	7	Vision affected by…	*1.3*	*2.4*	*2.4*	*1.5*	***7.5***
	8	Pedestrian only (casualty or uninjured)	-	-	*0.3*	-	***0.3***
	9	Special codes	-	*0.5*	-	-	***0.5***

Table D 2: Contributory factor types (RAIDS) for female car drivers

		Contributory factor type	17-24 %	25-44 %	45-64 %	65 – 99 %	Total %
	1	Road environment contributed	*1.0*	*1.5*	*1.1*	*0.2*	***3.8***
	2	Vehicle defects	*0.4*	*0.6*	-	-	***1.0***
Driver/rider	3	Injudicious action	*2.9*	*4.8*	*2.7*	*0.4*	***10.7***
	4	Driver/rider error or reaction	*11.4*	*18.9*	*11.2%*	*5.3*	***46.9***
	5	Impairment or distraction	*4.6*	*5.5*	*2.3*	*1.5*	***13.9***
	6	Behaviour or inexperience	*5.3*	*5.7*	*2.9*	*1.5*	***15.4***
	7	Vision affected by…	*1.5*	*3.8*	*1.3*	*0.6*	***7.2***
	8	Pedestrian only (casualty or uninjured)	-	*0.2*	*0.4*	-	***0.6***
	9	Special codes	-	*0.2*	*0.4*	-	***0.6***

Table D 3: Contributory factor types (RAIDS) by male road type users

		Contributory factor type	Car %	HGV %	LGV %	Motor Cycle %	Pedal Cycle %	Pedestrian %
	1	Road environment	*5.4*	*1.0*	*6.5*	*10.3*	*3.0*	-
	2	Vehicle defects	*1.4*	*2.0*	*0.8*	*0.6*	-	-
Driver/rider only	3	Injudicious action	*13.1*	*10.2*	*16.9*	*14.9*	*17.9*	-
Driver/rider only	4	Driver/rider error or reaction	*45.9*	*52.0*	*43.5*	*38.3*	*46.3*	*1.6*
Driver/rider only	5	Impairment or distraction	*9.8*	*11.2*	*10.5*	*6.3*	*7.5*	*1.6*
Driver/rider only	6	Behaviour or inexperience	*16.3*	*12.2*	*15.3*	*23.4*	*13.4*	-
Driver/rider only	7	Vision affected by…	*7.3*	*11.2*	*6.5*	*5.1*	*3.0*	*4.8*
	8	Pedestrian only (casualty or uninjured)	*0.2*	-	-	*1.1*	*7.5*	*92.1*
	9	Special codes	*0.5*	-	-	-	*1.5*	-

Table D 4: Contributory factor types (RAIDS) by female road type users

		Contributory factor type	Car %	HGV %	LGV %	Motor cycle %	Pedal Cycle %	Pedestrian %
Driver/rider only	1	Road environment	*3.5*	-	*17.6*	*15.4*	*33.3*	-
Driver/rider only	2	Vehicle defects	*0.9*	-	-	-	-	-
Driver/rider only	3	Injudicious action	*11.1*	-	*5.9*	*15.4*	-	-
Driver/rider only	4	Driver/rider error or reaction	*47.0*	-	*41.2*	*38.5*	*66.7*	-
Driver/rider only	5	Impairment or distraction	*13.9*	-	*23.5*	*15.4*	-	-
Driver/rider only	6	Behaviour or inexperience	*15.8*	-	*11.8*	*7.7*	-	-
Driver/rider only	7	Vision affected by…	*6.7*	-	-	-	-	*5.1*
Driver/rider only	8	Pedestrian only (casualty or uninjured)	*0.7*	-	-	-	-	*93.2*
Driver/rider only	9	Special codes	*0.5*	-	-	*7.7*	-	*1.7*

Appendix E Car user injury experience

Table E 1: Occupants by seating position, age, gender and seat belt use

Seating position and age	Seat belt status & Gender						Total	
	Used		Not used		Unknown			
	M	F	M	F	M	F	M	F
Driver								
0-9	-	-	-	-	-	-	-	-
10-16	1	-	-	-	-	-	1	-
17-24	27	30	3	-	10	5	40	35
25-44	84	66	13	3	28	13	125	82
45-64	64	1446	5	3	24	10	93	59
65+	53	21	1	1	14	8	68	30
Unknown	6	6	-	-	6	2	12	8
Total	235	169	22	7	82	38	339	214
FSP								
0-9	6	2	-	-	-	-	6	2
10-16	6	2	-	-	-	1	6	3
17-24	8	10	2	3	6	3	16	16
25-44	12	14	2	-	4	2	18	16
45-64	8	11	-	-	2	2	10	13
65+	4	16	1	-	-	3	5	19
Unknown	1	2	-	1	2	4	3	7
Total	45	57	5	4	14	15	64	76
RSP								
0-9	7	14	-	-	5	5	12	19
10-16	4	4	1	-	1	2	6	6
17-24	7	2	2	2	-	3	9	7
25-44	1	4	1	1	1	3	3	8
45-64	1	4	-	-	2	3	3	7
65+	2	3	-	-	-	1	2	4
Unknown	3	3	-	-	1	-	4	3
Total	25	34	4	3	10	17	39	54
Total								
0-9	13	16	-	-	5	5	18	21
10-16	11	6	1	-	1	3	13	9
17-24	42	42	7	5	16	11	65	58
25-44	97	84	16	4	33	18	146	106
45-64	73	61	5	3	28	15	106	79
65+	59	40	2	1	14	12	75	53
Unknown	10	11	-	1	9	6	19	18
Total	**305**	**260**	**31**	**14**	**106**	**70**	**442**	**344**

Table E 2: Belted occupant age, gender and seating position as a percentage of all belted occupants in each injury severity

Age	KSI (MAIS 2+)			Slight or uninjured (MAIS ≤ 1)		
	Driver %	FSP %	RSP %	Driver %	FSP %	RSP %
Male						
0-9	-	-	-	-	17.2	26.3
10-16	1.1	10.5	14.3	-	10.3	15.8
17-24	6.5	5.3	14.3	12.9	24.1	31.6
25-44	30.4	26.3	14.3	33.5	24.1	-
45-64	20.7	26.3	-	28.4	10.3	5.3
65+	26.1	10.5	-	17.4	6.9	10.5
Unknown	-	-	28.6	3.2	3.4	-
Total	84.8	78.9	71.4	95.5	96.6	89.5
Female						
0-9	-	-	14.3	-	5.4	44.8
10-16	-	-	28.6	-	5.4	6.9
17-24	23.8	14.3	-	15.2	18.9	6.9
25-44	9.5	9.5	-	45.5	27.0	13.8
45-64	33.3	19.0	14.3	24.2	18.9	10.3
65+	26.2	57.1	28.6	7.6	10.8	3.4
Unknown	-	-	-	4.5	2.7	10.3
Total	**92.9**	**100**	**85.7**	**97.0**	**89.2**	**96.6**

Table E 3: Occupants injury severity by belt use and day of the collision

Day	*KSI / MAIS 2+*			*Slight or uninjured (MAIS ≤ 1)*		
	Seat belt			*Seat belt*		
	Used	*Not used*	*Unknown*	*Used*	*Not used*	*Unknown*
Monday-Thursday	93	14	9	229	16	86
Friday-Saturday	48	8	14	96	3	50
Sunday	23	2	5	57	-	7
Unknown	-	-	-	-	-	-
Total	**164**	**24**	**28**	**382**	**19**	**143**

Table E 4: Occupants injury severity by belt use and time of the collision

Time of day (hr)	KSI / MAIS 2+			Slight or uninjured (MAIS ≤ 1)		
	Seat belt			Seat belt		
	Used	Not used	Unknown	Used	Not used	Unknown
00:00-05:59	21	3	4	19	3	4
06:00-11:59	49	8	8	126	4	41
12:00-17:59	62	2	8	165	1	66
18:00-23:59	28	11	8	69	10	30
Unknown	4	-	-	3	1	2
Total	**164**	**24**	**28**	**382**	**19**	**143**

Table E 5: Occupant severity by seating position and collision type

Collision type	KSI / MAIS 2+				Slight or uninjured (MAIS ≤ 1)			
	Driver	FSP	RSP	Total	Driver	FSP	RSP	Total
Front	54	19	7	80	138	29	20	**187**
Right	18	8	2	28	38	9	7	**54**
Left	9	3	1	13	16	5	6	**27**
Rear	4	-	-	4	24	9	6	**39**
Rollover	28	8	4	40	42	8	2	**52**
Multiple	15	3	-	18	27	9	5	**41**
Other	5	-	-	5	1	1	1	**3**
Total	**133**	**41**	**14**	**188**	**286**	**70**	**47**	**403**

Table E 6: Belted and Unbelted Driver severity by seating position and collision type

Collision type	KSI / MAIS 2+				Slight or uninjured (MAIS ≤ 1)			
	Male	Female	Unknown	Total	Male	Female	Unknown	Total
Front	37	17	-	54	66	72	-	**138**
Right	11	7	-	18	22	16	-	**38**
Left	6	3	-	9	6	10	-	**16**
Rear	2	2	-	4	11	13	-	**24**
Rollover	20	8	-	28	31	11	-	**42**
Multiple	10	5	-	15	19	7	1	**27**
Other	5	-	-	5	-	1	-	**1**
Total	**91**	**42**	**-**	**133**	**155**	**130**	**1**	**286**

Table E 7: KSI occupant age and gender by collision type

Driver characteristics	Collision Type							
	Front	Right	Left	Rear	Roll	Multi	Other	Total
Male								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	1	-	-	-	-	-	**1**
17-24	3	-	-	-	2	3	-	**8**
25-44	11	4	3	-	10	4	3	**35**
45-64	11	3	2	-	3	3	1	**23**
65+	12	3	1	2	5	-	1	**24**
Unknown	-	-	-	-	-	-	-	**0**
Total	37	11	6	2	20	10	5	**91**
Female								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	**0**
17-24	3	2	2	-	2	1	-	**10**
25-44	1	1	-	-	1	2	-	**5**
45-64	6	3	1	-	4	1	-	**15**
65+	7	1	-	2	1	1	-	**12**
Unknown	-	-	-	-	-	-	-	**0**
Total	**17**	**7**	**3**	**2**	**8**	**5**	**-**	**42**

Table E 8: Slight and uninjured occupant age and gender by collision type

Driver characteristics	Collision Type							
	Front	Right	Left	Rear	Roll	Multi	Other	Total
Male								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	**0**
17-24	11	-	2	-	6	2	-	**21**
25-44	27	6	1	2	12	9	-	**57**
45-64	15	10	3	6	7	4	-	**45**
65+	10	6	-	3	5	3	-	**27**
Unknown	3	-	-	-	1	1	-	**5**
Total	66	22	6	11	31	19	-	**155**
Female								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	**0**
17-24	12	2	-	-	4	1	-	**19**
25-44	34	9	3	9	2	3	1	**61**
45-64	14	5	5	4	5	1	-	**34**
65+	8	-	2	-	-	-	-	**10**
Unknown	4	-	-	-	-	2	-	**6**
Total	**72**	**16**	**10**	**13**	**11**	**7**	**1**	**130**

Table E 9: KSI Driver age and gender by object hit in frontal collisions

Driver characteristics	Object hit								
	Car	LGV	HGV	PTW	Narrow	Wide	Other	Unknown/ no object	Total
Male									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	-	-	2	-	-	-	1	-	**3**
25-44	3	-	5	-	-	2	1	-	**11**
45-64	6	-	3	-	-	2	-	-	**11**
65+	7	1	2	-	-	2	-	-	**12**
Total	16	1	12	-	-	6	2	-	**37**
Female									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	1	-	-	-	-	2	-	-	**3**
25-44	1	-	-	-	-	-	-	-	**1**
45-64	2	2	-	-	-	1	-	1	**6**
65+	4	-	-	-	2	1	-	-	**7**
Total	**8**	**2**	**0**	**0**	**2**	**4**	**0**	**1**	**17**

Table E 10: Slight and Uninjured driver age and gender by object hit in frontal collisions

Driver characteristics	Object hit								
	Car	LGV	HGV	PTW	Narrow	Wide	Other	Unknown/ no object	Total
Male									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	7	-	-	-	1	2	1	-	**11**
25-44	21	1	-	1	1	3	-	-	**27**
45-64	12	-	-	-	1	1	1	-	**15**
65+	7	1	1	-	1	-	-	-	**10**
Unknown	2	-	-	-	-	1	-	-	**3**
Total	49	2	1	1	4	7	2	-	**66**
Female									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	10	-	-	-	1	1	-	-	**12**
25-44	21	3	1	1	2	4	2	-	**34**
45-64	13	-	-	-	-	1	-	-	**14**
65+	4	-	-	-	-	3	1	-	**8**
Unknown	4	-	-	-	-	-	-	-	**4**
Total	**52**	**3**	**1**	**1**	**3**	**9**	**3**	**0**	**72**

Table E 11: KSI Driver age and gender by object hit in side impacts

Driver characteristics	Object hit							
	Car	LGV	HGV	PTW	Narrow	Wide	Other	Total
Male								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	1	-	-	**1**
17-24	-	-	-	-	-	-	-	**0**
25-44	5	-	-	-	-	2	-	**7**
45-64	3	1	1	-	-	-	-	**5**
65+	1	-	-	-	-	3	-	**4**
Total	9	1	1	-	1	5	-	**17**
Female								
0-9	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	**0**
17-24	2	-	-	-	2	-	-	**4**
25-44	-	-	-	-	-	1	-	**1**
45-64	4	-	-	-	-	-	-	**4**
65+	-	-	-	-	-	-	1	**1**
Total	**6**	**0**	**0**	**0**	**2**	**1**	**1**	**10**

Table E 12: Slight and Uninjured Driver age and gender by object hit in side impacts

Driver characteristics	Object hit								
	Car	LGV	HGV	PTW	Narrow	Wide	Other	Unknown/ no object	Total
Male									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	2	-	-	-	-	-	-	-	**2**
25-44	5	-	-	-	-	1	1	-	**7**
45-64	8	2	-	-	1	1	1	-	**13**
65+	5	-	-	-	-	1	0	-	**6**
Unknown	-	-	-	-	-	-	-	-	**0**
Total	20	2	-	-	1	3	2	-	**28**
Female									
0-9	-	-	-	-	-	-	-	-	**0**
10-16	-	-	-	-	-	-	-	-	**0**
17-24	2	-	-	-	-	-	-	-	**2**
25-44	6	1	-	1	-	1	2	1	**12**
45-64	5	-	-	1	-	3	0	1	**10**
65+	2	-	-	-	-	-	-	-	**2**
Unknown	-	-	-	-	-	-	-	-	**0**
Total	**15**	**1**	**0**	**2**	**0**	**4**	**2**	**2**	**26**

Table E 13: Occupant percentage of AIS 2+ injuries in each body region by car year of manufacture

Age of car	Body region injured %age AIS 2+								
	Head	Neck	Thorax	L Arm	R Arm	Abdo	Pelvis	L Leg	R Leg
1990-2003	-	-	-	-	-	-	-	-	-
2004-2008	*8.1*	*3.4*	*15.4*	*7.7*	*7.6*	*10.6*	*11.3*	*4.2*	*5.8*
2009-2015	*22.1*	*14.1*	*47.8*	*23.1*	*32.6*	*40.7*	*52.8*	*27.4*	*25.0*
Unknown	-	-	-	-	-	-	-	-	-
All	**30.2**	**17.4**	**63.2**	**30.8**	**40.2**	**51.2**	**64.2**	**31.6**	**30.8**

Table E 14: Occupant percentage of AIS 2+ injuries in each body region by occupant gender and seating position

Age of car	Body region injured %age AIS 2+								
	Head	Neck	Thorax	L Arm	R Arm	Abdo	Pelvis	L Leg	R Leg
Male Driver	18.8	11.4	34.1	12.5	20.5	27.6	34.0	18.9	21.2
Female Driver	4.7	2.0	11.0	7.7	8.3	8.1	15.1	3.2	4.8
Male Passenger	4.7	2.0	7.7	4.8	4.5	8.9	9.4	5.3	1.9
Female Passenger	1.3	2.0	10.4	5.8	6.1	6.5	5.7	4.2	2.9
All	**29.5**	**17.4**	**63.2**	**30.8**	**39.4**	**51.2**	**64.2**	**31.6**	**30.8**

Table E 15: Belted occupant percentage of AIS 2+ injuries in each body region by occupant gender and seating position

Age of car	Body region injured %age AIS 2+								
	Head	Neck	Thorax	L Arm	R Arm	Abdo	Pelvis	L Leg	R Leg
Male Driver	*11.4*	*8.7*	*24.7*	*10.6*	*13.6*	*22.0*	*24.5*	*15.8*	*13.5*
Female Driver	*4.7*	*2.0*	*10.4*	*7.7*	*6.8*	*8.1*	*15.1*	*3.2*	*4.8*
Male Passenger	*4.0*	*2.0*	*6.6*	*4.8*	*2.3*	*8.1*	*9.4*	*4.2*	*0.0*
Female Passenger	*1.3*	*0.7*	*8.8*	*4.8*	*5.3*	*6.5*	*3.8*	*3.2*	*1.9*
All	**21.5**	**13.4**	**50.5**	**27.9**	**28.0**	**44.7**	**52.8**	**26.3**	**20.2**

Table E 16: Belted occupant percentage of AIS 2+ injuries in each body region by occupant gender and seating position in frontal impacts

Age of car	Body region injured %age AIS 2+								
	Head	Neck	Thorax	L Arm	R Arm	Abdo	Pelvis	L Leg	R Leg
Male Driver	*2.7*	*2.0*	*10.4*	*6.7*	*5.3*	*8.9*	*7.5*	*7.4*	*6.7*
Female Driver	*1.3*	*1.3*	*4.4*	*2.9*	*2.3*	*4.9*	*5.7*	*3.2*	*1.9*
Male Passenger	*0.0*	*0.0*	*1.6*	*1.9*	*0.8*	*2.4*	*1.9*	*1.1*	*0.0*
Female Passenger	*0.0*	*0.0*	*3.8*	*3.8*	*3.0*	*3.3*	*0.0*	*3.2*	*1.0*
All	**4.0**	**3.4**	**20.3**	**15.4**	**11.4**	**19.5**	**15.1**	**14.7**	**9.6**

Table E 17: Belted driver gender, MAIS and age group by EES in frontal impacts

Driver characteristics: gender and age	EES (Kph)				
	0-29	30-49	50+	Unknown	Total
Male MAIS ≤ 1					
17-24	3	1	-	-	**4**
25-44	6	-	1	-	**7**
45-64	2	4	-	-	**6**
65+	2	1	-	-	**3**
Unknown	2	-	-	-	**2**
Total	15	6	1	-	**22**
Male MAIS 2+					
17-24	-	-	2	-	**2**
25-44	-	-	1	-	**1**
45-64	-	2	-	-	**2**
65+	-	2	2	-	**4**
Unknown	-	-	-	-	**0**
Total	-	4	5	-	**9**
Female MAIS ≤1					
17-24	4	-	-	-	**4**
25-44	11	3	-	-	**14**
45-64	6	3	-	-	**9**
65+	2	1	-	-	**3**
Unknown	-	-	-	-	**0**
Total	23	7	-	-	**30**
Female MAIS 2+					
17-24	-	1	-	-	**1**
25-44	-	-	-	-	**0**
45-64	1	3	1	-	**5**
65+	-	-	-	-	**0**
Unknown	-	-	-	-	**0**
Total	**1**	**4**	**1**	**0**	**6**