An exploratory study of road crash survivors: injury outcomes and quality of life

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Chapter 1: Introduction

An Exploratory Study of Road Crash Survivors:  
Injury Outcomes and Quality of Life

by

Jo Barnes

Submitted in partial fulfilment of the requirements  
for the award of  
Doctor of Philosophy of Loughborough University

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I need to thank in particular Andrew who has supported me and made it possible for this to happen in every way. Also to my Owl Babies Annabel, Matthew and Lucy may I never have to say 'sorry mummy's got work to do' again!
Chapter 1: Introduction

Abstract

The overall aims of this PhD were to examine what the real effects of injury are on survivors of road crashes and to explore the methods used to assess these effects.

Three studies were conducted for this thesis to explore the effects of injury using quality of life outcomes for survivors of road crashes. Study 1 was a prospective follow-up study of 70 road crash survivors with relatively 'minor' injuries. The aim of study 1 was to determine the effects of the crash or injury on quality of life for a 'minor' injury sample over a 1 year follow-up period. Participants were recruited and interviewed at baseline, 3 months, 6 months and 12 months. The study used the EQ-5D and SF-36v2 health outcome measures as well as a study questionnaire to assess participants at each follow-up period. All interviews were conducted over the telephone. It was found that participants with relatively minor injury had significant physical problems compared to the population norms for the health outcome measures particularly in the first 6 months post injury. At 12 months all participants had returned to work with both physical and mental health rated at or above the population norms for the SF-36v2. There were some noted gender differences identified in study 1 with females having worse scores particularly for mental health.

Study 2 was a prospective follow-up study of 50 'seriously' injured road crash survivors admitted to hospital as a result of their injuries. This recruitment strategy ensured that 'baseline' scores were obtained to assess some 'pre-injury' measure of health. Participants were recruited from two trauma hospitals and were interviewed within the 2 weeks following their crash whilst an inpatient. The same data collection tools were used as study 1 with the addition of the CES-D scale for depression. This study identified significant physical problems for the sample throughout all of the follow-up period. At the 3 month follow-up period there was a noticeable 'poor' assessment of both physical and mental
health prior to steady increases towards pre-injury health state. There were significant differences between the genders with females having 'worse' scores for both physical and mental health compared to males. At 12 months only 32% of the participants stated that they were recovered although 90% had returned to work or normal daily activity. Study 3 incorporated the results of study 1 and study 2 to examine the societal burden of injury. The cost of injury to society used the UK's willingness to pay approach mapped to specific injuries sustained in studies 1 and 2. It was found that lower extremity injury incurred the highest costs for injury type with whiplash injury sustaining further substantial costs. Quality adjusted life years (QALYs) were also calculated using the utility scores from the EQ-5D. It was found that 10.6 QALYs were lost at the 12 month follow-up period for the participants in study 2 compared to 3 for study 1 at the same time point.

In conclusion this thesis found that:

- This thesis has contributed new knowledge to road safety research by examining the road injury outcomes from a quality of life perspective.
- The health outcome measures provided descriptive data on types of health dimensions affect as well as providing a metric to assess the societal burden of road injury.
- Injury outcomes varied between individuals and injury types indicative of the need to assess outcomes at the individual level using quality of life measures.
- Physical health post traumatic road injury was a main concern for survivors of road crashes.
- The physical effects of injury were not just limited to loss of mobility for example but had wider implications for family members, finances and occupation.
- Females appeared to have worse physical outcomes and levels of depression compared to males after sustaining 'serious' injury following a road crash.
• Injuries from road trauma incurred high societal costs between £4 million for 'minor' injury and £9.7 million from 'serious' injury.
• The use of face to face interviews to recruit participants provided valuable baseline data compared to the postal recruitment method.
• Telephone interviews for follow-up data were effective and helped maximise the response rates by allowing flexibility for timing the interview, allowed a strict protocol to be adhered to and also maximised responses to prevent missing data.
• The attrition rate was high in studies 1 and 2 despite the processes in place to minimise this and would need to be considered in future studies.
• The initial future implications following on from this thesis would need to focus on how to prevent or minimise the outcomes identified by participants in this study.
• A further implication from this thesis identifies the potential for future research which would be of value to road safety researchers using similar methodologies to assess outcomes of all injury types and identify the costly impairing injuries to guide future injury prevention strategies in the UK or across Europe.
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Chapter One: Introduction
The introduction to this thesis will present the overall problem of injury burden in society and more specifically in the UK. The definition of injury is examined and how the outcomes of such injuries are currently assessed from a road safety perspective. The overall aims, objectives and research questions will be detailed and the structure of the thesis is also presented.

1.1: Road Traffic Injury a Global Problem

Road traffic injury has a wide reaching effect on both society and individuals on a large scale. The Global Burden of Disease (GBD) study published as a series in The Lancet identified road traffic injuries as being the leading cause of death by injury in 1990 (Murray and Lopez, 1997a,b,c,d). Overall it was the 9th leading cause of all deaths and the 9th leading contributor to the burden of disease worldwide. However, by the year 2020 it is predicted that road traffic injury as a cause of death will rise to 6th place. It is expected that the highest increases will be in developing countries rather than the current highly motorised countries burden' associated with road traffic injury will also rise to 3rd place in 2020 compared to the published 9th place in 1997. The measure used for the burden of disease calculations is the Disability Adjusted Life Year (DALY) developed specifically for the GBD study to provide a global measure allowing for comparisons between disease groups, disability classes and geographical location. The DALY is an incorporated measure of premature mortality and disability to give an estimation of disease burden. What it actually measures is the sum of life years lost due to premature mortality and years lived with disability adjusted for severity (Murray and Lopez, 1997d).

The cost of road traffic injury to a nation's economy is also another consideration on its impact on society. This is particularly so in highly motorised countries; for example, Jacobs, Aaron-Thomas and Astrop (2000) estimate the annual cost of road crashes to be 2% of the gross
national product (GNP) in the United States, which equates to some US$ 450 billion. In direct economic terms the cost of road injuries in the European Union (EU) member states in 2000 was put at Euros 180 billion (US$207 billion). Furthermore the EU countries contribute to 5% of the worldwide death toll associated with road traffic injury.

The WHO also identified that over 50% of the global mortality rate for road traffic injury occurred in the 15-44 year age bracket. Typically this age group consists of the productive work force. In terms of disease burden, 60% of the DALYs lost as a result of road traffic injury were also within this age group in the GBD study. Stereotypically, males are the providers and the impact of losing the provider, particularly in low and middle income countries, has a huge societal affect which simplistically equates to no work, no food (Peden, 2004).

1.1.2: Road Traffic Injury in the UK

Thus, globally the scale of the problem of road traffic injury has a high impact factor on individuals, economy and society. The United Kingdom (UK) is considered a developed nation and as such has shown to have reduced mortality rates compared to less motorised nations associated with road traffic injury. However, the disease burden remains high on the GBD agenda for nations such as the UK as the disease burden in such nations is expected to rise to 5th place in the top 10 leading causes of disease burden as measured by the DALY by 2020 (Murray and Lopez, 1997d).

In 2000, the UK Government launched a policy which targeted an overall reduction in the number of road casualties (Great Britain and DETR 2000). This included a 40% reduction in the number of people killed or seriously injured in road accidents by 2010, compared to the average rates for 1994 -1998. The latest figures from the Department for Transport (DfT) for 2004 indicate there is a 28% reduction in the number of people killed or seriously injured (DfT 2005). Other targets included a 50% reduction in the number of children killed or seriously injured and a 10% reduction in the overall slight casualty rate expressed as the number
of people slightly injured per 100 million vehicle kilometres. Currently in 2004 there is a 44% reduction from the baseline figures in the number of children killed or seriously injured and a 21% reduction from baseline for the numbers of slightly injured. This implies that the policy may be having a positive effect on reducing road traffic injury.

The figures below illustrate the changes over time for road casualties in Great Britain for 2004 (Table 1 and Figure 1). They show that there is a decline overall for all casualties with the most notable decline in the 'slight' and 'serious' categories with those killed showing a general decline over the past 10 years (DfT 2005)\(^1\).

Table 1.1: Great Britain casualty figures 2004

<table>
<thead>
<tr>
<th>YEAR</th>
<th>KILLED</th>
<th>SERIOUS</th>
<th>SLIGHT</th>
<th>ALL CASUALTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>3650</td>
<td>46540</td>
<td>265169</td>
<td>315359</td>
</tr>
<tr>
<td>1995</td>
<td>3621</td>
<td>45533</td>
<td>261533</td>
<td>310687</td>
</tr>
<tr>
<td>1996</td>
<td>3598</td>
<td>44499</td>
<td>272481</td>
<td>320578</td>
</tr>
<tr>
<td>1997</td>
<td>3599</td>
<td>42984</td>
<td>281220</td>
<td>327803</td>
</tr>
<tr>
<td>1998</td>
<td>3421</td>
<td>40834</td>
<td>280957</td>
<td>325212</td>
</tr>
<tr>
<td>1999</td>
<td>3423</td>
<td>39122</td>
<td>277765</td>
<td>320310</td>
</tr>
<tr>
<td>2000</td>
<td>3409</td>
<td>38155</td>
<td>278719</td>
<td>320283</td>
</tr>
<tr>
<td>2001</td>
<td>3450</td>
<td>37110</td>
<td>272749</td>
<td>313309</td>
</tr>
<tr>
<td>2002</td>
<td>3431</td>
<td>35976</td>
<td>263198</td>
<td>302605</td>
</tr>
<tr>
<td>2003</td>
<td>3508</td>
<td>33707</td>
<td>253392</td>
<td>290607</td>
</tr>
<tr>
<td>2004</td>
<td>3221</td>
<td>31130</td>
<td>246489</td>
<td>280840</td>
</tr>
</tbody>
</table>

Figure: 1.1: Great Britain road casualty figures over a 10-year period

\(^1\) 'Slight' - no overnight stay in hospital; 'Serious' - sustained a fracture, or overnight in hospital or died after 30 days in hospital; 'Fatal' - death within 30 days from the crash.
These figures generated by the DfT are derived from personal injury accidents notified to the police. There is the possibility that under reporting of 'Serious' and 'Slight' injuries exists if casualty notifications do not get recorded by the authorities. One estimate is that the figures for the 'Seriously' injured road users should be 2.76 times higher and for 'Slightly' injured 1.7 times higher than stated (Simpson 1996).

**1.1.3: Road Traffic Injury in the East Midlands**

Casualty figures were extracted for the local East Midland counties where the casualty total numbers for all severities was found to be approximately 8.6% of the total of all accident notifications in the English police forces (DfT 2005).

<table>
<thead>
<tr>
<th>POLICE FORCE</th>
<th>FATAL</th>
<th>SERIOUS</th>
<th>SLIGHT</th>
<th>ALL SEVERITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Midlands</td>
<td>299</td>
<td>2671</td>
<td>18323</td>
<td>21293</td>
</tr>
</tbody>
</table>

Overall, road traffic injury is an ongoing problem, although some might suggest an avoidable one. Never the less, as more cars are introduced into the world fleet without proper road infrastructures to accommodate
Chapter 1: Introduction

them the consequences will be self-perpetuating, particularly in the developing countries. Unfortunately the figures which predict major increases in the burden of road traffic injury, as predicted by the WHO for 2020, are potentially achievable on a global scale, albeit in developing countries. Such figures are essential for epidemiological studies to highlight and put the problems of disease and injury into perspective. The DfT in the UK provides a national figure for the level of casualty injury, but does not use a measure to estimate any burden of injury for the UK as a result of road injury. These global and national figures provide a figurative perspective of the impact of road injury and acts to highlight the problem to society, but it is important to note that the individual is not considered.

1.2: Road Traffic Injury Studies in the UK

In the UK there are specialist research centres and organisations which undertake traffic safety studies\(^2\). Even so, there are currently no studies which examine the direct individual consequences of road injury. In the clinical field, follow-up of individuals with an injury is routine and invariably is concentrated on the healing process rather than the consequences for the individual. However, a Burden of Disease study funded by the Department of Health (based at Swansea University) is following individuals up using a battery of measures to determine the burden of all injury and not just road trauma (Lyons 2005). The Vehicle Safety Research Centre at Loughborough University in the East Midlands is amongst the largest road and vehicle safety research centres in the UK and is currently undertaking a number of road safety research programmes. Even so, although the Centre is involved in a large number of studies, none of these focus on the outcomes of the injured persons involved in the crash event.

This is an area which has been neglected but has the potential to provide necessary information to demonstrate that injury has far reaching

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\(^2\) ‘Traffic safety study’ - encompasses a broad range of studies including accidental injury causation, primary and secondary vehicle safety design, road infrastructure, crash research and dummy development etc.
consequences outside of the 'crash event'. The crash event and how the vehicle performs is a priority area for manufacturers to reduce the severity of any injuries often without considering the residual impairment and what effect this has on an individual. To date there are few studies which have examined in any detail the effects of road injury from an individual's perspective. Added to this is the complex nature of injuries and how they can be categorised for research purposes.

1.3: Injury

An Injury has been defined as “a bodily lesion at the organic level, resulting from acute exposure to energy (mechanical, thermal, electrical, chemical or radiant) in amounts that exceed the threshold of physiological tolerance” (Baker, 1984). Langley and Brenner (2004) explored the definition of injury further and defined it as damage to the body produced by some 'energy exchange' that has sudden relatively discernible effects. The latter is a fitting description, particularly for those sustained mechanically as in a car crash, and is a similar definition to Bakers', albeit more generally descriptive in nature. Even from these descriptions it is easy to recognise that difficulties may arise from attempting to study injury as a participant group in its own right. What is known about injury related to road trauma is that they tend to be mechanically derived and depending on the velocity range from minor to fatal injuries. Again the outcome for a fatally injured road user is obvious but the outcomes for the survivors can only be diverse to match the spread of injury between 'Minor' to 'Life-threatening'.

1.3.1: Outcomes of Injury

The outcomes of injury can be classified at the most basic level as 'dead' or 'alive'. Thus dead is a definite outcome and is a reliable measure. The difficulty however, is to quantify the outcomes of those who survived their injury. The very individuality of injuries would imply that the outcomes will be different for everyone and consequently have varying effects on individual lives. Traditionally the outcomes from injury could be
categorised into impairment, disability or handicap as defined by the World Health Organisation (WHO 1980). Impairment is considered to be 'any loss or abnormality of psychological, physiological, or anatomical structure or function', whereas disability is 'any restriction or lack (resulting form impairment) of ability to perform an activity in the manner or within the range considered normal for a human being'. Handicap is therefore 'a disadvantage for a given individual, resulting from an impairment or disability that limits or prevents the fulfilment of a role that is normal for that individual'. There has been a move since that day to re-classify these definitions towards a more meaningful application relating to functional ability (WHO 1999). However, these terms provide no measure of the consequences at an individual level. Thus the effects of the injury on every day activity are not considered and where two people are considered to have the same impairment their perceptions of how disabled they were would not necessarily be the same dependent on their role in society. For example, the main wage earner possibly sees their injury as more disabling compared to the same injury sustained by the secondary wage earner. Furthermore, injuries to the leg will have different consequences for a desk worker compared to a footballer.

Assessing injury outcome is further confounded by a lack of standard assessment procedures and the diversity of the 'type' of outcome. For instance, outcomes could be measured by the consequences to society as measured by the cost of injuries, or the consequences to the individual in terms of how long it takes someone to return to work, residual impairment from the injury, loss of functional activities and even disability.

1.4: Reasons for the Research

It is evident that the burden of road injury is real, both on a global and national scale. Despite this the area of outcomes in road injury survivors is under-researched in the UK although there are implications for the individual and society. Injury outcomes for road crash survivors is a relatively new area and by researching this it has the potential to provide
Chapter 1: Introduction

valuable information at the individual and societal level. The research presented in this thesis is attempting to bring the problem of road traffic injury to the individual level and examine the outcomes of these injuries in one area of the UK, notably the East Midlands. The study involves the follow-up of a group of participants, who have suffered a road traffic injury, using semi-structured interviews and recognised health outcome measures to determine the 'outcomes' of these injuries and the effect on their lives. Thus, this study is aiming to contribute new knowledge to Road Safety Research by examining injuries at least one step beyond mere 'causation' and to look at the 'effect' on the individual and their families and to society in terms of cost.

It should be stressed that this study is somewhat preliminary in nature and new to the area of accident research. To truly examine the effects of injury would require a massive resource, involving a multi-disciplinary team in order to a) derive an adequate sample from the whole of the East Midlands and b) to follow them up over a long period of time. However, it is the intention that this study will develop and pilot new methodologies that can be used by larger follow-up studies of road crash victims in the future.
1.5: Aims and Objectives

Because of the paucity of outcome studies from the individuals' perspective in road traffic injury, this programme of research is exploratory in nature. To address different research areas this research has two aims.

1.5.1: Aims

1. To determine what the effect of the injury or crash event has on an individual's life. This will give an insight into the real world effects of road traffic injury from the individuals' perspective.
2. To pilot the methods used to assess road traffic injury outcome from a vehicle safety research perspective.

1.5.2: Objectives

- To assess the current literature for outcomes of road traffic injury
- To follow-up a group of participants who have sustained a road crash injury at regular intervals over a one year period.
- To use existing health outcome measures to assess their potential contribution in measuring outcomes of road crash injury to the accident research field.
- To estimate potential human costs of injury as a measure of quality of life.
- To examine factors which contribute to a good or bad recovery from road traffic injury.

1.6: Research Questions

The following research questions were derived from the aims and objectives above.

- Are the effects of similar types of injury the same for all individuals?
Chapter 1: Introduction

- What are the factors which render an injury as having a greater impact on life?
- What is the recovery time for road traffic injuries?
- What are the factors which have an effect on recovery time?
- Are the effects of injury wider than merely the individual?
- Is there a psychological effect as well as a physical effect?
- What measurable outcomes are there - such as return to work, length of sick leave, return to social activity and recovery status at 12-months?
- What are the financial implications of sustaining a road traffic injury?
- Do health outcome measures address the main outcomes in a road traffic injury sample?
- Which are the most effective methods for evaluating outcomes in road injury survivors?
- Is there potential for further research?
- What should a larger regional or national study take into account?

1.7: Structure of the Thesis

Overall, this is an exploratory study examining the effects of road traffic injury on everyday quality of life. This is with particular emphasis on the subjective factors of these issues, both in the short and long term, using standard health outcome measures and specific questionnaires to collect the data. The general methodology is presented in Chapter 3. The effects of road traffic injury are explored in Chapters 1 through 17, presenting three studies. Study 1 is presented in Chapters 4 to 9 and reports on a sample of casualties recruited from existing studies at the VSRC, via a postal mail-out. These participants tended to have low severity injuries and on the whole did not have an in-patient stay in hospital. Study 2 is presented in Chapters 10 to 15. This study is based on participants who were recruited immediately following their admission to hospital as a result of their injuries. These participants tended to have
more serious injuries usually resulting in a requirement for surgical procedures prior to discharge home. Studies 1 and 2 explore the effects of injury on two different groups of participants, recruited by post and interviews with relatively 'minor' versus 'serious' injury. The recovery time and factors which influence the recovery are also explored - in particular physical, financial as well as psychological effects to the person and the family. The factors which are examined include: sick time; return to work; pain, and recovery status at varying follow-up interviews over a one year period. Follow-up interviews after the initial baseline assessment were at three, six and twelve months. Study 3 is presented in Chapters 16 and 17 and explores the issue of burden of injury examining impairment and costs related to road traffic injury. The burden of injury explores existing measures to define the costs and impairment of road traffic injury in the two participant groups from Study 1 and Study 2. These chapters also explore how the methodologies used in Studies 1 and 2 are suited to road safety research. The studies are further discussed in Chapter 18 with conclusions presented in the Chapter 19. Figure 1.2 illustrates the structure of the thesis.
Chapter 1: Introduction

Figure 1.2: Structure of the Thesis

Research questions
Research methods
Chapter 1

Study 1
Postal recruitment and 'minor' injury
Chapters 4 to 8

Study 2
Interview recruitment and 'serious injury'
Chapters 10 to 14

Study 3
Societal burden - QALY, impairment, injury costs (WTP)
Chapter 16

Discussion of results study 1
Chapter 9

Discussion of results study 2
Chapter 15

Discussion of results study 3
Chapter 17

Discussion of the thesis
Chapter 18

Conclusions and further work
Chapter 19
Chapter Two: Literature Review
2.1: Introduction

This literature review examines the systems that can be used to classify injury for use in research studies. An exploration of the literature identifies the overall types and specific outcome measures which have potential for studying injury outcomes. These outcome measures are examined further for their use in road injury studies and to what effect they can be used within the current research. Other outcomes of road injury are surveyed with emphasis on psychological outcomes and costs.

2.2: Injury Classification

Injuries range from very minor in nature (e.g. cuts and bruises) to very severe (serious brain injury) and therefore a consistent approach to classify the range is required for analysis. Thus, to study injury in any depth requires some method to classify them into type and severity for analytical purposes. The classification of injury is reliant on injury coding in its various forms to provide a meaningful description and ability to utilise injury as a subject.

The use of codes enables injuries to be used in statistical analyses for comparative purposes and to study predictive outcomes such as mortality in research. Within the clinical field, injury data is used for survival analysis and compiling national statistics and in countries where there is a Medicare system reimbursement fees are calculated from the hospital data. Overall, there are few coding systems in existence on a worldwide scale that are well known and used in everyday practice to code injuries. Garthe et al. (1999) reasoned that injury scales could be categorised into one of five types, which are listed below.

- Severity with focus on identification of injury (Abbreviated Injury Scale)
- Severity with focus on location of injury (National Accident (Automotive) Sampling System)
Chapter 2: Literature Review

- Classification with primary use in mortality (International Classification of Diseases)
- Modified classification with primary use in reimbursement (International Classification of Diseases-Clinical Modification)

There are also those scales which assess the physiological impact of the injury and can monitor the changes in impact over time, for example the Glasgow Coma Scale (Teasdale and Jennet 1974) or blood pressure scale.

2.2.1: General Injury Classifications

2.2.1.1: The Abbreviated Injury Scale

The Abbreviated injury scale (AIS) has its focus on the identification of injury and was developed in its most basic form in the late 1960's as a result of aircraft accident investigations at Cornell University in the US (Ryan et al. 1968). Following on from this a simple set of 75 codes to describe injury and tissue damage was developed by the American Medical Association, American Association for Automotive Medicine and the Society for Automotive Engineers (AMA, AAAM, SAE) (States et al. 1971). These injury codes were used in research at government, industry and university levels for the recording of injuries. From the original list of injuries, modifications were made to the scale with the first dictionary containing over 500 injury descriptors published in 1976, under the guidance of The Joint Committee on Injury Scaling of the American Medical Association, American Association for Automotive Medicine and the Society for Automotive Engineers (1976). Subsequent editions of the dictionary were published in 1980, 1985, 1990 and 1998. With each edition, new and more detailed descriptions of injury were included to reflect all trauma and not just that experienced in the vehicle research field. The latest of these dictionaries, the 1998 version has over 1300 injury descriptors (Association for the Advancement of Automotive Medicine 1998).
Chapter 2: Literature Review

The dictionary is used as a reference manual to look up the injury description, for example 'fractured femur,' and then assign the specific numeric injury code. The injury code is made up of a unique numeric code for a specific injury and a final digit to reflect that injury's threat to life. The threat to life scale is on a 6 point ordinal scale as follows,

- 1 = minor injuries
- 2 = moderate injuries
- 3 = serious injuries
- 4 = severe injuries
- 5 = critical injuries
- 6 = untreatable injuries (usually non survivable)

For example, using the fractured shaft of femur as an example the AIS code for it is 851814.3. The first 6 digits represent the unique numeric descriptor followed by the seventh digit which is a '3' indicating that this injury is a serious injury on the threat to life scale. The AIS is also the basis for further measures of injury severity. These are the Maximum Abbreviated Injury Scale (MAIS) and the Injury Severity Score (ISS) as discussed below.

The Maximum Abbreviated Injury Scale

The Maximum Abbreviated Injury Scale (MAIS) is the highest single AIS code in a person with multiple injuries and is used to describe the overall severity, not nature or location. It is used in vehicle safety research for the purposes of describing overall injury severity and has also been adapted to describe overall severity in body regions. Thus, the MAIS could be used to provide an indicator of the overall severity of injury to a body region in cases where several different severities of injury had been sustained. For example if AIS 1, AIS 2 and AIS 3 injuries had been sustained, the descriptor of MAIS 3 would be used to indicate that this was the highest level of injury sustained in the leg.
Chapter 2: Literature Review

Injury Severity Score

Injury Severity Score (ISS) is used to assess the overall severity of multiple injuries against probability of survival. It was developed by Baker et al. (1974) to give an indication of the overall severity of all of the injuries sustained by the individual. It is used for research and also within the clinical field to measure the level of trauma.

The calculation is simply the squared sum of the three highest severity injuries from three different body regions. For example, someone with chest injuries of AIS 2, extremity injuries of AIS 3 and head injury of AIS 1 would have an ISS of 14 ($2^2 + 3^2 + 1^2$).

2.2.1.2: National Accident (Automotive) Sampling System

The National Automotive Sampling System (NASS) was developed in the US in 1979 as part of a nationwide effort to reduce motor vehicle crashes, injuries, and deaths on American highways (NHTSA).

Where the NASS differs to the AIS is the allowance for assigning an aspect of the body and causative code number to effectively provide an eleven digit code to describe injury and causation. In the UK the CCIS data also assigns causative codes and aspects to an injury but are separate to the AIS injury descriptor.

Both the AIS and NASS codes have the ability to be used in analyses for injury studies. However, the NASS code is only relevant for use in vehicle safety research because of the need for the causative code to be included as an inherent part of the 11 digit code. The AIS is transferable to the clinical field because of being a descriptor of anatomical injury. The proposed new 2005 version of the AIS is to include the aspect as an added extra to the original 7 digit code which will be valuable for research and will still be transferable to the clinical field.
2.2.1.3: International Classification of Diseases

The International Classification of Diseases (ICD) has been used at an international level since 1893\(^3\). The origin of the ICD is founded in the classification of causes of death thus frequency rates for diseases were derived from mortality statistics.

The most recent edition is the ICD-10, which has expanded substantially to code injuries in detail (World Health Organization 2005). Although it is in use in some countries, there is still a requirement for some modifications after a review period. The WHO goal for implementation of ICD-10 in all countries currently using ICD-9 is 2005. In countries hoping to implement a coding system the starting version should be ICD-10. The injury detail has expanded from the ICD-9 version to the ICD-10 version with for example; fractured scapula now having 36 codes compared to 13 in previous editions. The drawback for using this system out of the clinical area is the complexity and length of the manual which makes it difficult to assign appropriate codes. It becomes a lengthy and time consuming process particularly if treatments have to be inherent within the code, which researchers are not always qualified to do.

The above three methods for coding injury are the main 'general' methods used to code all injuries each with particular strengths and weaknesses applying to vehicle safety research. There are other injury coding systems in existence but these tend to be clinically orientated and specific to injury type or body areas, of which the main ones are described below.

2.2.3: Specific Injury Classification

2.2.3.1: AO Fracture Classification

This is a comprehensive classification of fractures to the long bones developed by the AO group (Arbeitsgemeinschaft fur

\(^3\) (http://www.who.int/classifications/icd/en/HistoryOfICD.pdf); February 25\(^{th}\) 2005.
Ostosynthesefragen), which is the Association for the study of internal fixation⁴ (Müller 1990). The classification takes into account the severity of the fracture according to the complexities, treatment and prognosis. It is alphanumeric in nature and allows for specificities, such as bone fragments and more specific locations to be described. The sections within the code cover the:

- Long bone
- Bone segment
- Fracture type
- Fracture group
- Fracture subgroup

### 2.2.3.2: Organ Injury Scale

The Organ Injury Scale (OIS) was developed by the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma in 1987, with continuous updating of codes as appropriate. The scale is graded 1 through 6 for each organ, 1 being the least severe and 5 the most severe from which the patient may survive. Grade 6 injuries are by definition non-survivable, similar to those injuries in AIS (Moore et al. 1995).

### 2.2.3.3: Glasgow Coma Scale

The original Glasgow Coma Scale (GCS) was presented in 1974 as an aid in the clinical assessment of unconsciousness to help prevent misunderstanding and ambiguity of physicians when describing and handing over information about their patients (Teasdale and Jennet 1974). It also has the ability to record changes over time indicating deterioration or improvement in coma status. In 1976 the numerical scores were assigned to the general descriptions previously applied by the original authors (Teasdale 1976).

⁴ A method for holding a broken bone in place using surgically inserted screws, rods or plates.
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It is a scale ranging between 3 and 15, based on the assessment of three responses of:
- best eye response,
- best verbal response
- best motor response.

The scores are correlated with levels of brain injury with mild brain injury associated with scores of 13 and above, moderate injury scoring between 9 to 12, and severe injuries scoring 8 or less. The GCS is also a scale with limited use outside of its purpose in assessing consciousness associated with brain injury but is adopted and used in the AIS dictionary. The GCS has been criticised on numerous occasions but has established itself in the clinical field and has been incorporated into other scores predicting outcome measures.

The scale of common choice for researchers in road traffic injury studies is the AIS. The AIS is used in the US, UK, Europe and Australia for road traffic injury studies and is an acknowledged and acceptable method to adopt for the purposes of coding road traffic injuries. The AIS contains aspects of the other scales, such as the OIS, GCS and the AO scale whose complexities would suggest that orthopaedic training is required. This negates the need to have a series of scales if the AIS combines the principles of some of the more common scaling systems. The ICD-10 is a comprehensive coding system but too large for the purposes of coding road traffic injury and the required training for its use and database capability would make it impractical for research purposes out with the clinical field. The AIS is therefore the method of choice for UK vehicle safety researchers because of its broad coverage of blunt trauma and available training open to researchers to use it appropriately. However, like all of the coding systems there is an emphasis on having reliable and detailed medical notes from which to code injuries consistently. Once an injury is established and the appropriate code applied then this is the conclusion to injury coding. The outcomes of those injuries are not
considered and having two people with the same injury code does not necessarily mean they have the same outcomes. Therefore, measures of these are required.

2.3: Health Outcomes

Available Injury classification systems are based on short term outcomes such as survival or treatment and are not designed to measure longer term outcomes. The long term outcomes are essentially the 'whole body' response to the injury and the consequences on every day activity, therefore a need exists to examine the role of health outcome measures.

2.3.1: The Complexity of Health

The measurement of health or health outcomes has come into its fore over the past three decades within the health sphere with emphasis now being placed on morbidity measurements compared to mortality measures, which traditionally were used as measures of health in the population. However, the concept of assessing outcome is not new as Florence Nightingale developed her own hierarchical scale to assess patients on discharge as being either 'relieved', 'unrelieved' or 'dead' (Rosser 1983). Her classification provided a description for the health state and also a valuation of the particular states. These two in combination are considered essential factors in any current measure today (Kind 1988). The term 'health' as a concept does not have the same meaning between individuals. Thus, before it can be measured, health has to be defined. The WHO describes it as not just the absence of disease but having social, emotional and physical well being (WHO 1947). This long-used definition illustrates that 'health' is a compilation of factors which in turn suggests that to measure health, a multilevel measure is required, taking into account the definition and individual's perceptions of health. Parson, in Patrick et al.. (1973b) defines health as 'the state of optimum capacity for the effective performance of valued tasks'. There is no mention of illness in this definition therefore illness
should not be included in any measure using this definition as it is a separate entity. Parson's definition emphasises the functional ability of an individual to perform on a daily basis. These statements of health have a positive slant to their definition but health also has negative aspects to it. It can be affected by outside factors such as financial and social influences which are not health per se and according to Patrick and Bergner (1990) should not be included in a measure when health is an outcome. However, Segui-Gomez (2000) suggests that social factors have to be included when measuring health if cost benefit analyses are undertaken.

2.3.2: Assessing Health

Thus the actual 'health' state under assessment needs to be implicitly included within a measure to ensure the measure is assessing the same state of health across the sample. The derivation of the health states can be achieved in one of two ways. A 'top down' approach ensures that the researcher's own beliefs of the relevant factors are included compared to a 'bottom up' approach, which asks the population for their opinions or experiences of the health states under measure. Examples of top down approaches would include a literature review where the most common reported problems to health are used to develop the health outcome measure. Bottom up approaches are more likely to ask people in a particular health state what they consider important as well as clinicians, carers and others with no experience or knowledge of the health state under study. Either process will not necessarily be perfect as biases will always exist, even in the bottom up approach the researcher assesses the data and makes subjective decisions for inclusion of the health states based on advanced statistics such as factor analysis. Ultimately, there will be a priority list of particular dimensions which contribute to the overall health. For example 'mobility', 'pain' and 'sleeping' could be the main dimensions which were thought to contribute to overall health status. Thus, a measure would require the inclusion of these particular dimensions to ensure its relevance to the population under study.
2.3.3: Reliability and Validity of Measures to Assess Health

To date there are no 'gold standards' against which health outcome measures can be compared to determine their validity. Thus it is usual to demonstrate content and construct validity. Ultimately, any type of validity is addressing the same issue of how much confidence can be placed on the inferences drawn from scale scores (Bowling 2001; Streiner and Norman 2003). Content validity refers to whether the items within a scale are measuring the attributes being measured in a balanced way. If an item is not falling into a content area then its value to the overall measure is questioned. Thus, the inclusion of items is considered by expert panels and literature reviews although the target population to be studied should assess the item inclusion (Patrick 2003). Construct validity ensures the underlying concepts are being measured by the included items. It involves assessing both the theory and method simultaneously (Bowling 2005).

Reliability is the ability of the measure to repeatedly measure a certain construct. The subparts of an instrument also have to measure the same attribute. Thus a measure is judged to be reliable when it consistently produces the same results across varying sample groups and over a period of time. The internal consistency is a form of reliability where the items in the scale are correlated between each other and with the total score. This is usually performed using Cronbach's alpha statistic (Cronbach 1951), which ranges between 0 and 1, with scores below 0.5 indicating the items do not come from the same conceptual domain. There is a range of arguments at which to accept the alpha level. There are reported ranges between 0.5 or above or, for some, 0.7 as being the minimal acceptable level for inclusion (Bowling 2001). Streiner and Norman (2003) however, put a minimum of 0.85 to indicate adequate internal consistency. Factor analysis is also commonly used as some items would not necessarily have high item-item or item-total correlation because they are tapping into different domains. Thus, it is possible to include an item whose eigen value from factor analysis is considered
large enough (over 1.5), indicating it has the power to explain variation between participants (Bowling 2001).

There are other forms of reliability which have to be assumed which are inter and intra-rater reliability. The former determines how reliable are the ratings between two different raters and the latter for the same rater over a number of occasions. These are assessed using the Kappa statistic (Cohen 1968), where values less than 0.4 are poor agreement, 0.40-0.59 fair agreement, 0.60-0.74 good agreement and 0.75-1.0 excellent agreement (Fleiss 1981).

Thus at the basic level, health outcome measures need to satisfy the principles of having reliability and validity (Streiner and Norman 2003). Bowling (2005) suggests that the 'achievement of standards of validity and reliability requires time and effort and is a reason for using existing scales'.

2.4: Health Related Quality of Life Measures

Health related quality of life measures (HRQoL) fall into two categories; 'profile measures' which provide a description and assign a 'value' to the health state and the 'preference measures' which elicit 'utilities'. It is recognised that there are numerous scales in existence to assess various study groups and are discussed in detail in the literature (Segui-Gomez, 2000; Bowling 2005); the main outcome measures are discussed below.

2.4.1: Profile Measures

Profile measures typically describe the health profile of an individual across multiple domains of function. They provide a score for each domain as well as one or more summary scores for assessing combinations across domains yielding overall measures of physical and mental health. Often with these measures the domain scores are summed to convert what is essentially an ordinal scale into a quasi-interval scale which should not lend itself to robust parametric statistics.
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(Bowling 2005). Common examples of these measures are the SF-36, and the Sickness Impact Profile (SIP), which are discussed in turn.

2.4.1.1: The Sickness Impact Profile (SIP)

Its original design was to provide a measure of perceived health status that was sensitive to changes or differences in health status over time or between groups. The SIP assesses behaviour rather than feelings, as these are perceived to be subjective and difficult to measure and validate. The emphasis therefore is on sickness related dysfunction, not disease, subsequently incorporating the ability to measure minor morbidity (Bergner, Bobbitt et al. 1976a,b, 1981). It was designed for acceptability across communities to measure the effect or outcomes of health care for use in evaluation, programme planning and policy planning.

The SIP has been adopted for use in the UK as a functional limitations profile but it has not been used extensively so there is limited evidence of its suitability. It has also been criticised for its high level of non-item response and ceiling effects (McColl, Steen et al. 1995). McDowell and Newell (1996) considered the SIP to have been developed 'with care and thought', and could be used to compare other measures against. However, the flaws in the scale suggest that it has poor construct validity. On a more practical level the length of the scale and its completion time renders it a time consuming measure and probably impractical to administer effectively by telephone which is a major consideration for this thesis. A further problem for use of the SIP in injury research is that it is considered only suitable for use for those who are regarded or who regard themselves as ill, which is not necessarily the case for injury (Bowling 2005).

2.4.1.2: Short Form 36 (SF-36)

The short form 36 (SF-36) survey is considered to be the most widely evaluated health outcome measure (Garratt, Schmidt et al. 2002). It has its roots in the 1970's RAND Health Insurance Study (HIS) and the 1980's Medical Outcomes Study (MOS) (Brook, Ware et al. 1983; Ware, Snow et
al. 1993). The HIS and MOS batteries (items) were developed to assess physical health, physiological health, medical health, social health and perception of health. These batteries could be used independently for assessments or interrelated (Stewart, Greenfield et al. 1989; Wells, Stewart et al. 1989). From these original batteries the short form 20 (SF-20) was developed which contained 20 items in six health dimensions. The SF-20 was amended by Stewart, Hays et al. (1988) to the SF-36, incorporating 36 items over 8 health dimensions selected from the MOS. The developers perceived the changes between the SF-20 to SF36 to be an improvement for measuring the extremes in each item, standardise the responses for better scoring and provide better psychometric properties. These changes, however, were based on methodological consideration rather than grounded in empirical testing of the items (Stewart, Ware et al. 1992).

Scoring assumptions for items and dimensions

The SF-36 scoring system is based on the Likert method (1932) of summated ratings where scores are rated from a negative association, for example 'poor', to a positive association, for example 'excellent', which includes those points in between. The Likert scoring method used in the SF-36 provides a score for each item derived from a standardised set of response choices; the scores are then summed across the item responses and transformed to a 0-100 scale (Ware, Gandek et al. 1998a; Ware, Gandek et al. 1989b; Ware, Konsinski et al. 1998; Ware, Gandek et al. 1998). The simplistic method here does not require the use of weights or judgements to be made in the scoring but is reliant on simple algorithms to calculate the score. However, its simplistic method is based on a series of assumptions such that the items used in each dimension should be proportional to other items in other dimensions. Secondly the items should roughly contribute to the total scale score in equal measures and thirdly the items should be linearly related to the total score computed from all other items in that scale (Ware, Gandek et al. 1998a; Ware, Gandek et al. 1989b; Ware, Konsinski et al. 1998; Ware, Gandek
et al. 1998). These assumptions are then tested to determine the appropriateness of including an item in a scale and whether items can be summed to provide a total score. The developers provide a manual for scoring the SF-36 and converting the rating scales for statistical analysis (Ware, Snow et al. 1993; Ware 2000a, Ware, Kosinski 2002). Data from the SF-36 is treated as interval because the scores are converted to a 0-100 scale, however the actual scoring is ordinal in nature and if rigorous statistical tests are applied the inferences made from the results should be questioned. A further problem underlying the scoring assumptions of conversion to the 0-100 scale is the notion that all items are equal. This however is not the case as some of the eight health dimensions have a greater number of items and levels of assessment; for example, physical functioning has 10 items and 21 levels of assessment compared to social functioning which has 2 items and 5 levels of assessment. This suggests that some dimensions have been given higher importance in the SF-36 similar to the SIP.

Reliability and validity of the SF-36

The developers also identified two underlying health constructs within the SF-36, these being physical and mental health (Ware, Gandek et al. 1998). These two constructs were further supported by Garratt, Ruta et al. (1993) using factor analysis and shown to have good reliability estimates exceeding 0.9. In terms of construct validity, principal component analysis was undertaken on data from 10 Countries within the IQOLA Project (Ware, Gandek et al. 1998; Raczek, Ware et al. 1998). It was found that the data supported the scoring of mental and physical health components as being the underlying health constructs of the SF-36. Overall, as would be expected, the dimensions for physical functioning, role physical and bodily pain were correlated highly with the physical component compared to mental health, social functioning and role emotional dimensions which favoured the mental health component. The general health and vitality dimensions correlated moderately with both the physical and mental health components.
McHorney et al. (1993) undertook an analysis of the SF-36 to determine the psychometric and clinical tests of validity in measuring the physical and mental health constructs behind the SF36. Using data from the MOS in the US participant groups were identified and over a 2 week period the SF-36 forms were completed by the participants at their health care provider as were supplementary forms (N=22,462). From these returns matched patient and care provider forms were identified and those with any of the tracer diseases under study were telephoned for follow-up interviews and asked to take part in the study. A total of 1,014 participants were enrolled who completed a 1-month follow-up form for the purposes of validity analysis. Four study groups were identified, these were; minor chronic medical conditions, serious chronic medical conditions, psychiatric conditions only and the final group were psychiatric conditions and serious medical conditions. They hypothesised that using principal components regression analysis, the health dimensions would fall between the physical and mental health components depending on the dimension and would have sufficient variance between the groups. Overall, they found that the psychometric and clinical tests of validity agreed with one another and converged with their study hypothesis. They purport that their results indicate that the physical and mental health components are relatively pure and therefore their interpretation is unequivocal. They measure respectively the intended dimensions of health, such that any changes in medical or psychiatric conditions are associated with observed changes in the physical or mental health components which can be interpreted with a high degree of confidence. Brooks et al. (1990) welcomed these finding as previously there was little known about the valid assessment of patients with both medical and physical conditions and the ability to assess changes in both using one measure.

The usability of the SF-36 has been expanded for use in Europe and Japan with its’ translation into other languages. This was part of the International Quality of Life Assessment (IQOLA) Project where the translation of the SF-36 scale was the first part of the project. The
second part of the project included testing the data quality and scaling assumptions in 11 Countries. Thirdly the project was concerned with the structural model of the SF-36 and its relationship of scales to external variables (Ware, Kosinski et al. 1998; Ware, Gandek et al. 1998). Using data collected from a series of population surveys in 11 Countries analyses were conducted to test the reliability and validity of the translated scales. Gandek, Ware et al. (1998) concluded that the SF-36 had good internal consistency as the item means were clustered accordingly within the scales, such as mental health. The SF-36 was also shown to have good internal and item discriminant validity with items having higher correlations with their own dimension compared to other dimensions.

The UK SF-36 data performed consistently with the other countries in the Project. Overall items correlated well with their dimensions compared to the alpha levels proposed in Bowling (2001); physical health (0.55 – 0.83), role-physical (0.74 – 0.84), bodily pain (0.76), general health (0.42 – 0.76), vitality (0.64 – 0.70), social functioning (0.71), role-emotional (0.76 – 0.81), mental health (0.47 – 0.68). The overall internal consistency reliability estimates were good using Cronbach’s coefficient alpha ranging from 0.81 for mental health to 0.93 for physical functioning.

The SF-36 has been adapted and used in the UK and also shown to have good reliability (Garratt, Ruta et al. 1993; Jenkinson, Coulter et al. 1993; Brazier, Harper et al. 1992).

However, there was one problem of concern found in the IQOLA project that of the floor and ceiling effects of some dimensions. Floor effects are where the participants score at the bottom of the scale and if deterioration occurs then these changes will not be detected. Conversely, ceiling effects are where the scores are at the top of the scale and any improvements in health will not be detected (Streiner and Norman 1989). The floor effects were found to be low except for the role physical and role emotional scales (Ware, Snow et al. 1993) but attracted high ceiling effects. High ceiling effects were also found in the social functioning, physical functioning and bodily pain scales. This suggests that the SF-36 would be insensitive to improvements in those dimensions with high
ceiling effects and poor at identifying those persons with a worsened condition with prior assessment at the floor. The developers addressed this issue and made subsequent changes to the SF-36 scale and labelled it ‘version 2’ (SF-36v2). These changes included item layout, word alterations and removing the categorical response choices to try and minimise the floor and ceiling effects. These changes in version 2 are purported to increase the usability and improve reliability and validity (Ware 2000). The role functioning dimension was a particular problem but the change to categorical responses over a dichotomous yes / no response has been considered a vast improvement (Jenkinson 1999b). It is now recommended that all new studies use SF-36v2 because of changes made to improve the usability and reliability from the original SF-36 version (Ware 2000).

2.4.1.3: Scoring the SF-36

The scoring methods of the SF-36 and SF-36v2 are laid out in the developer's manuals to ensure a consistent scoring and subsequent comparability of the data between other studies (Ware, Snow et al. 1993, Ware, 2000, Ware, Kosinski et al. 2002). To score the SF-36 requires recoding of some item scores prior to the summing of the eight dimension scores. These dimension scores are then transformed using the developer's scoring algorithm to convert them to a 0-100 scale; where 0 is poor health and 100 is good health.

A more recent development for scoring the SF-36 is the use of norm based scoring to allow for direct comparisons across study populations and between version 1 and version 2 of the SF-36 (Ware 2000, Ware, Kosinski et al. 2002). A norm based score standardises the population norms so that all the scale means are 50 and have the same standard deviation set at 10 points. Thus graphically and without referring to individual scale norms the changes in data are immediately obvious to the observer. The norm based scoring is also reflected in the physical and mental health component measures. On review of results any scores
below 50 would indicate a poorer than average health (general population norm) and vice versa for scores above 50. The normalised scores are calculated using the z-score which standardises raw scores from different distributions to allow comparisons to be made. In z-scores the mean is 0 and the standard deviation 1. Thus, their use allows the reader to establish whether individual scores are above or below the mean on a given measurement; compare the results of different tests or compare the results of different groups to the population mean. These z-scores are translated into T-scores which are essentially z-scores with a new mean and standard deviation. The common means and standard deviations are either 50 and 10, or 500 and 100 (Streiner and Norman 1995). These are arbitrary and all they do is change the look of the z-scores for better graphical presentation of the data (Jenkinson, Layte et al. 1996).

To ensure the comparability between the version 1 and version 2 scales a U.S population survey was conducted in 1998 with randomisation of the population completing the version 1 or version 2 forms. The hypotheses for the study were that changes to version 2 would not undermine the assumptions underlying the scoring and scaling. Also the changes to categorical responses for role physical and role emotional from the dichotomous responses would substantially reduce floor and ceiling effects and reduce the variances. Lastly, the third hypothesis was that the constructs of physical and mental health components would be replicated in version 2 analyses. Overall, their findings supported their hypotheses with version 2 performing the same or better than version 1 without losing validity or reliability. One main focus of concern in the IQOLA project was the floor and ceiling effects for the role physical and role emotional scales. These were reduced by approximately 10% for the role physical scale and similarly for the role emotional scale. Principal components analysis identified that both versions have the same factor content and can be interpreted reliably irrespective of the version used (Ware 2002).
2.4.1.4: SF-36 in the UK

Much of the work into SF-36 in the UK has been led by the Health Services Research Unit at Oxford University and Sheffield University. There is an agreed UK version of the SF-36 which satisfied the main network of users to ensure the compatibility of studies using this measure (Brazier 1993).

Jenkinson, Wright et al. (1994) utilised the data obtained in a general population health survey (Oxford Healthy Lifestyles Survey; n=13042) to assess the criterion validity and reliability of the SF-36 and establish normative data. Population norms were established for the SF-36 across Oxfordshire, Buckinghamshire, Berkshire and Northamptonshire for adults aged between 18 and 64 years. A 72% response rate was obtained from a total mail out sample of 13,042. The returns were compared with general 1991 population estimates and social class distribution from the 1981 census and were found to mirror these distributions (Wright, Harwood et al. 1992). These norms are used as a base level from which to compare other populations and sample groups (Ware, Snow et al. 1993).

Jenkinson, Wright et al. (1994) used the reliability coefficient to assess interpretability of the results and the alpha statistic to assess questionnaire items for internal validity. Data for seven dimensions broken down into five groups relating to perceived health state, that is: 'excellent'; 'very good'; 'good'; 'fair' or 'poor'. The Kruskal Wallis tests showed clear linear trends in the seven dimension scores and associated health state group (p<.0001). With lower dimension scores reported in the poorer health state groups showing good criterion validity. The Cronbach's alpha tests were good with all but one dimension (social functioning) scoring >0.8. When data were broken down into the five health states by dimensions the internal consistency was >0.7 in all except social functioning, however the authors considered this to be acceptable for reliability assessment due to the small number of items in this dimension. These results suggest that the SF-36 has good reliability and validity when compared to a single item of overall perceived health.
However, McHorney, Ware et al. (1994) questioned the reliability of the SF-36 in those who are very ill or suffering from clinical complications as they found the alpha statistic for general health to be 0.65 in the general health scale.

Brazier, Harper et al. (1992) also undertook a population study based in Sheffield using the SF-36. This study interviewed 2056 adults aged 16 and over and had a 78% response rate, again the sample was compared to 1991 population figures. This study's results compared well with Jenkinson, Wright et al's findings (1994). Good internal reliability was shown using the Alpha statistic ranging between 0.73 (for social functioning) to 0.96 (for role limitation, physical and emotional and vitality) (Brazier, Harper et al. 1992). However, the actual mean scores differed, as did the methods of administration of the SF-36. Brazier, Harper et al. (1992) showed the actual mean dimension scores to be consistently higher which may be a direct result of interviewing participants rather than a postal survey. Bowling, Bond et al. (1999) suggest that people during interviews are more likely to answer positively for social desirability compared to the postal survey where the anonymity may encourage more truthful answers particularly regarding mental health. The mode of administration is an important consideration as is the placing of the SF-36 within the survey structure. Where surveys place the SF-36 at the beginning there is less chance of being influenced by other health questions, however there is no control of postal responses as the participant is at liberty to read all of the survey and start at any place. The interview structure elicits more control over the interview schedule and is also more likely to obtain answers for all of the questions. Using this method also requires care to ensure consistency of the interviews and not allow for prompting of responses. The developers of the SF-36 have been aware of this and have instructions for interviewers to enhance the reliability of the results obtained (Ware, Kosinski et al. 2002).

Since these population norm surveys Jenkinson, Stewart-Brown et al. (1999) have undertaken a further survey using the SF-36v2. The UKSF-
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36v2 scale was assessed in a large community postal survey to determine SF-36v2 UK norms, assess reliability and validity and derive summary algorithms for the mental and physical health components. The data were obtained from 8,889 people with a 64.4% response rate for the original mail-out and were part of the Third Oxford Health and Lifestyles Survey (OHLS-III).

Jenkinson, Stewart-Brown et al. (1999) used statistical methods namely the alpha statistic to analyse the internal consistency, construct validity and the derivation of summary scales. The analysis was undertaken as recommended by the developers of the original SF-36 survey. This found similar results to the 1998 U.S population survey where version 2 performed the same or better in all aspects of the analysis. To examine construct validity the data were broken down into social class, gender and history of longstanding illness, this would also provide normative data for these groups. The data as expected, evidenced mean scores for lower social classes, women and those with history of illness supporting the construct of the scale to identify differences in health states. Cautionary use of these findings as the UK norm for SF-36v2 is recommended as further work is necessary. However, at present these are the only existing norms for use with SF-36v2 in the UK. These cover the age ranges 18 through to 64 years, both sexes, presence of a longstanding illness and also social class. The authors also present weighting factors for the dimensions to calculate the physical and mental health component scores.

Jenkinson (1994-1999) has undertaken numerous studies using the SF-36 and examined the methodological constructs for its use in the UK. In 1999 Jenkinson examined the weights and scoring systems of the SF36 summary measures between the UK and US to enhance the usability and comparability of the SF-36. He hypothesised that if the US weights and scores compare favourably then it is possible that the US scoring algorithms could be used by all countries to calculate the physical component score (PCS) and mental component score (MCS) scores. Jenkinson utilised the UK norms and data from the original OHLS to
compare the US and UK component scores. The 95% confidence intervals for the data were small and overlapped, suggesting minimal differences between the two countries. Also t-tests were undertaken and were found not to be statistically different between the two scoring methods. Overall, the findings suggest that US data can be used instead of the UK norms, however other countries would have to compare their results with the US data before it becomes a standard procedure. For the UK, the findings were found not to alter the original intentions of the developers hence its wide use in the clinical setting. There have been some concerns expressed regarding the use of the 2 summary scores, PCS and MCS, because these may not accurately reflect change which is the essential requirement when assessing medical interventions (Deyo 1986; Deyo and Centor 1986; Guyatt, Walter et al. 1987). However, Jenkinson (1999) reports that the summary measures are useful for those undertaking longitudinal studies as using the two components reduces the number of statistical comparisons to two rather than the eight health dimensions.

Overall, the SF-36 is a widely used measure and has profited from its continued development, both in the US and the UK. As a generic description of health related quality of life it has value for assessing numerous participant groups; however it is limited through the lack of single index measures to analyse costs particularly when used in clinical trials.

2.4.2: Preference Measures (Index Measures)

Preference based measures have two components in their development. The first is to characterise the health state under evaluation and secondly assigning a preference of that state over others. The methodology for the assignment of preferences is also a consideration. Often a decomposed approach is used where only a number of the defined health states within a measure are assessed and subsequent mathematical computations will ultimately result in a preference value for any of the health states covered by that particular measure. Within the core concepts which should be
measured (such as physical functioning) there is a need to assess productivity and social functioning / leisure activities for utilising the measure as a cost effective analysis tool (Segui Gomez 2000). These measures are those of choice by health economists, because of their perceived greater reliability and usability (Brazier 1993). The common preference based measures are the Quality of Well Being Scale (QWB) and the EuroQol (EQ-5D).

2.4.2.1: The Quality of Well Being Scale

Fanshel and Bush in 1970 published a hugely influential piece of work which proposed The General Health Policy Model which could be used to assess cost benefit of health programs based on the gaps in the then current literature. They perceived that ‘well being’ was being able to function to full potential and ‘dysfunction’ being performing below this potential. From this work the QWB scale was developed with the intention of integrating morbidity and mortality into a single index (Kaplan, Bush et al. 1976). The QWB scale assesses the functional status of an individual in three domains of mobility, physical activity and social activity. It also incorporates a fourth domain for the assessment of symptoms / problems. The QWB scale domains selected were from a review of social survey literature available at the time (Patrick, Bush et al. 1973). The assessments are made from actual activity performed based on the capabilities for each day, over the previous six days, rather than the perception of what could be performed. The QWB scale is observer rated and provides a single index score between 0 and 1, derived using the formula below:

\[
QWB = 1 + \frac{\text{symptom / problem complexes weights}}{\text{mobility weight}} + (\text{physical activity weight}) + (\text{social activity weight}).
\]

The preference weights for the QWB scale were derived from varying methods for each of the domains based on Fanshel and Bushes' original work (1970). The values assigned to the health states for the QWB scale
were however not population based but from a limited group of graduate students and qualified nurses. The limitation of using these two groups for valuation tasks narrows down the sample groups from which the QWB scale could make inferences.

Reliability and Validity of the QWB

The construct validity of the QWB scale has been found to be good, with correlations found between SIP and the SF-36 (Anderson, Kaplan et al. 1998; Kaplan, Andersen et al. 1995; Read, Quinn et al. 1987). Although, in the SF-36 study there was poor correlation between the QWB scale and the mental health component (Anderson et al. 1998) but Kaplan et al. (1995) found the QWB scale to be significantly correlated with the Beck Depression Inventory. It was also suggested that where death is an outcome then a health outcome measure incorporating 'death' in the scale is necessary.

Studies using the QWB scale have shown varying results in its use across a range of study populations. Holbrook, Hoyt et al. (1994) found significant improvements in the scores between discharge and six months post trauma and continued to do so over time. It could be argued that detection of changes will be found in any health measure used following trauma due to the sudden impact of such an injury and the subsequent recovery. This is compared to perhaps more chronic conditions where small changes occur which are not always detected by health measures (Tandon, Stander et al. 1989; Calfas, Kaplan et al.1992).

The reliability of the QWB scale has been reported by Kaplan and Andersen (1988) and has been shown to have good internal consistency greater than 0.90 and good test-retest reliability between 0.93 and 0.98.

Administration of the QWB

The QWB scale has not been subject to upgrading of value sets for modern day use as the original weights were set in the late 1960's and would not reflect today's values. The practicalities of using the QWB scale are somewhat limiting as it is interviewer administered and the
training of interviewers can take one to two weeks to complete (Read, Quinn et al. 1987). Although, once the training has been completed Kaplan proposed that the QWB scale can be completed between 7 and 15 minutes, although it has since been considered too cumbersome to administer (Pyne, Sieber et al. 2003). Other studies, however, have also found its administration to be longer than originally proposed (Bombardier, Raboud et al. 1991). When using the QWB scale Kaplan, Feeny et al. (1993) state that ‘considerable probing’ is necessary to elicit accurate responses which would affect the scores if not undertaken. He regards the QWB scale as a research tool and inappropriate for routine clinical practice as the ability to detect change is limited to the symptom / problem complex. Some report that the instrument is complex to use compared to other instruments such as the SF-36 (Andresen, Patrick et al. 1995; Bombardier, Raboud 1991).

In recognition of some of these criticisms Kaplan, Sieber et al. (1997) created the Quality of Well Being-self administered version (QWB-SA) and is considered to be easier to administer in most research and clinical assessment protocols. The QWB-SA was found to be sensitive to gender, age and self reported health state, suggesting that the QWB-SA has convergent validity and test-retest reliability (Sieber, Groessl et al. 2004). The developers of the QWB-SA caution its use in telephone or interview administered assessments as the psychometric properties for these administrations have not been studied (Sieber, Groessl et al. 2004). The development of the QWB-SA has ensured its’ ability to be compared to the more popularly used SF-36 measure in the US, although the SF-36 is not a utility measure.

Unfortunately as with the actual QWB scale the QWB-SA has not been used widely in the UK and population norms are not available from which to make any inferences about the study sample.
2.4.2.2: The Health Utilities Index (HUI)

The health utilities index (HUI) is based on multi-attribute utility theory developed from von Neumann-Morganstern utility theory. Most health outcome measures are multi-attribute measures because of the inherent inclusion of more than one domain to be assessed. Taking these multi-attribute measures and combining them with utility theory provides a technique for determining mathematical formulae to allow preference scores for a large number of health states to be determined based on the measurement of a few carefully selected health states (Torrance, Furlong et al. 1995). This method can then be used to derive values and utility scores.

Torrance and colleagues extended the original work of Fanshel and Bush (1970) and the QWB scale to develop the HUI, which is now on its third version HUI Mark III (Feeny, Furlong et al. 1995). The HUI is a 'within the skin' approach to measuring health status including physical and emotional domains but excludes social interaction as it takes place 'out of the skin'.

The original HUI contained four attributes (domains) - physical function, role function, social emotional function and health problems with four to eight levels of function describing 960 health states. It was developed to examine the outcomes of low birth weight neonates (Boyle, Torrance et al. 1983).

This work was expanded by Cadman and colleagues for paediatric applications (814 Cadman, Goldsmith et al. 1986, 1984). They used a bottom up approach of eliciting preference judgements from parents and children to develop 15 health domains of which the top six were used in the Mark II version. The six domains were sensation, mobility, emotion, cognition, self care and pain. A seventh domain was added to the HUI mark II by Feeny et al. (1995) which was fertility as the participants were survivors of childhood cancer.
These initial versions have evolved into the HUI Mark III adapted from the HUI II for use in population health surveys. It has eight domains which are listed below with the respective number of items in brackets;

- Vision (6)
- Hearing (6)
- Speech (5)
- Ambulation (6)
- Dexterity (6)
- Emotion (5)
- Cognition (6)
- Pain (5)

To assess an individual's HRQoL using the HUI III requires a series of stages before a utility value can be determined. The HUI III initially assesses the health status of an individual within each domain and secondly to value the health states using preference functions and multi-attribute theory.

The preference measures for HUI Mark III were undertaken using Visual Analogue Scales (VAS) and Standard Gamble⁵ (SG) techniques on a sample of 504 adults in Canada. The VAS scores were converted into utility weights using a power curve of risk aversion relationship from the studies by Torrance and colleagues (Torrance et al. 1995).

The HUI III questionnaire is used to obtain raw data, however, actual attributes are distributed differently between the questionnaire and HUI III. For example, cognition is separated into remembering and thinking on the questionnaire and requires complex mapping onto the health state classification. The actual questionnaire can be completed in face to face or telephone interviews, self-completed or in a postal survey.

There are scoring algorithms for the HUI III to map the questionnaire responses onto the relevant health domain. Once this mapping has

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⁵ SG - people are asked to choose between a gamble with a desirable outcome, with risk P, and a less desirable outcome, with risk 1-P, and a certain option of intermediate desirability. The person is asked what probability of obtaining the desirable or less desirable outcome will make them indifferent between the gamble and the certainty.
been completed the utility score has to be determined using multi-attribute utility theory. The utility score is an estimate of the score that would be obtained if the utility for the health state had been measured directly from a random sample of the general population using a SG instrument.

The developers recognise that the sensitivity of the measure is difficult to assess due to the range of patient populations it has been used to assess (Feeny et al. 1995). It is considered to have the potential to be vulnerable to ceiling effects at the well end of the spectrum, but not necessarily floor effects. There is also a limit to capturing, for instance musculoskeletal problems because of the limited ability of the HUI to measure them unless limbs are missing. The HUI III has been shown to have good test retest reliability as measured by the intra-class correlation coefficient.

2.4.2.3: The EuroQoL (EQ-5D)

The EQ-5D is a generic health measure devised by the EuroQol group which is a consensus group whose aim was to develop a standardised non-disease specific instrument for describing and valuing health related quality of life. The overall intention was to provide a single index score for HRQoL valuation such as quality adjusted life years (QALYs) (Brooks 1996). The final instrument design was completed and put into use in 1991.

The EQ-5D itself elicits a profile score derived from five health domains containing three levels of assessment in each. There is also a separate overall self-rating of health on a 0-100 visual analogue scale (VAS). The domains and number of levels (in brackets) are presented below,

- Mobility (3)
- Self care (3)
- Usual activities (3)
- Pain and discomfort (3)
- Anxiety and depression (3)

These domains were selected to cover the minimum requirement of HRQoL factors of physical, social and mental health proposed in the
literature. Brooks (1996) described the process of choosing the domains following a review of other health measures as one 'where researchers principally drew on their own expertise and the evidence available from the literature in order to determine the dimensions (domains) of interest'. Three levels of assessment within the dimensions were chosen to give a more balanced structure to each domain (Kind 1996). They combined social and work activity into the 'usual activity' domain so work and social activities had equal weighting.

2.4.2.3.1: Scoring the EQ-5D

Each dimension is assessed on three levels of 'no problems', 'moderate problems' and 'extreme problems' for that particular day. The number 1 representing 'no problems', 2 is 'moderate problems' and 3 'extreme problems'. Thus, labelling health states using these 5 domain number descriptors ranging from 11111 to 33333. As an example 12221 is the health state 'no problems walking about, some problems washing or dressing, some problems performing usual activities, moderate pain or discomfort and not anxious or depressed'.

The information gained for each dimension can be used either as a health profile as above, or for individuals or groups at a single point in time or over a period of time. Alternatively, health states defined by the 5-dimensional health profile can be converted into a weighted health state index by applying scores from 'value sets' elicited from general population samples (Dolan and Gudex 1995). A further assessment made by the EQ-5D is the respondents' self-reported health status on a graduated (0-100) visual analogue scale (VAS) where the end points are 'best imaginable health state' and 'worst imaginable health state'. This gives a quantitative measure and differences in the scale can be used as measures of outcome as judged by individual respondents (Brooks, Rabin et al. 2003). Respondents are asked to draw a line across the VAS at the point which best describes their current health state for that day.
EQ-5D Preference Weights (value sets)

The EQ-5D overall describes 243 (3^5) health states ranging between 11111 and 33333. However to elicit valuations and conform to the necessary principles of assessing morbidity and mortality the health states 'dead' and 'unconscious' were added to give a total of 245 states addressed by EQ-5D. The methods used to elicit valuations for the EQ-5D were the VAS and the time trade off methods (TTO)\(^6\) (Dolan, 1996; 1997). A sample of 3395 respondents took part in a large scale British survey with interviews being undertaken in their homes. A second interview was undertaken on 221 respondents at 10 weeks later. This survey produced a data set from which values were derived for the 'single index' score. Direct valuations of 45 health states from a maximum of 245 were undertaken by 2,997 people on 12 TTO valuations generating 35,964 individual responses (Kind, Dolan et al. 1998). The health states presented were for a 1-year period and after that it was unknown what would happen. These results were analysed to provide a 'look up' chart of these value sets enabling a matching of the descriptive profile to a weighted index. Alternatively a syntax can be obtained from the EuroQol group to convert profile scores to a weighted index score (www.euroqol.com).

Test retest reliability for both individuals and group levels were found to have good intra class correlations of 0.78 and 0.73 respectively (MVH York 1994).

Reliability and Validity of the EQ-5D

The EQ-5D has been shown to have good test retest reliability in different patient groups (Brazier, Walters et al. 1996; Hurst, Kind et al. 1997).

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\(^6\) TTO - participants are presented with two different health states and treatment choices from which the respondent selects the more preferred option. This continues until the respondent is indifferent between the two alternatives. They then have to judge how long a period in one state could be traded for a different period in another state.
Brazier, Jones and Kind (1993) compared EQ-5D with SF-36 in a postal survey of 1,980 people between 16-74 years in the Sheffield area (Kind, Dolan et al. 1998). The response rates were good (83%) and showed construct validity of EQ-5D dimension responses and the total scores. The EQ-5D was found to be less sensitive with high ceiling effects compared to the SF-36. Thus, suggesting it would not be suited to assessing health states with minor changes. For example, 95% of respondents on the EQ-5D scored in the top level for mobility, self care and usual activity compared to 37-72% for the SF-36. Overall it was found to be less sensitive than the SF-36 in detecting perceived health problems. McDowell and Newell (1996) also criticised the three levels in the domains as it would be too insensitive for detecting smaller changes. However, studies in Scotland showed that there was good correlation with other specific measures of assessing pain and depression, therefore supporting its construct validity in these areas (Hurst, Jobanputra et al. 1994).

The EQ-5D has also been translated into over 50 languages and used across a range of studies (Greiner, Weijnen et al. 2003). One of the aims of Greiner's study (2003) was to attempt the development of a European EQ-5D VAS based set of values using existing European data from 11 studies in six European countries. There were three TTO valuations as well as the 11 VAS generated valuations. Overall, the health states differed between the studies and not all included dead or unconsciousness in the assessments. All had varying response rates and were not necessarily representative of the Country's population due to convenience sampling. However, using statistical modelling, the authors found that a robust model could be developed and a set of European values was an obtainable goal.

**Modes of Administration**

The EQ-5D was designed as a self report measure, however guidelines for other methods of administration have been produced. Where
telephone interviews are used there is a general script to follow as well as face to face interviews (Selai and Rosser 1995). The use of telephone interviews generally increases the response rate compared to impersonal postal surveys. In terms of examining the reliability of the different methods of administration Wu, Jacobson et al. (1997) compared self versus interview completion, face to face versus telephone and self administration versus proxy interviews. They found no real differences between the first two types of completion however the self and proxy completed forms showed the proxies rating the patients lower on the VAS scores. Humphreys et al. (1995) stated that the EQ-5D usually took 10 minutes to administer, although its' perceived brevity administration may take less than this.

The EQ-5D has been shown to achieve good respondent rates for face to face interviews, around 98-100%, compared to postal surveys which have ranged between 26%-55% (Kind et al. 1994; Dolan and Gudex 1995). Postal surveys are always problematic for ensuring a good return rate. Overall the EQ-5D complies with what a generic measure should include according to Brooks (1996) these being assessments of physical state, mental state and social functioning. The inclusion of social functioning goes against Fanshel and Bush's (1970) opinion of it not being relevant to HRQoL as in their concept it was 'out of the skin' and not a 'within the skin' concept which is the foundation for the QWB scale.

The EQ-5D was designed to be simple and removed from the multi-dimensionality of other instruments. The developers recognise that its very simplicity cannot be a comprehensive measure of health status but does measure across a spectrum from best to worst. Its use in studies where the mean change in HRQoL is a designated primary or secondary endpoint then the EQ-5D can provide the requisite information. Studies in which outcome data are generated may be used to provide information for economic analysis. This is where the weighted EQ-5D index can be utilised however there is the consideration of which reference source of values are used to compute the single index score either those generated by VAS or TTO methods (Dolan and Gudex 1995). This selection is based on the purpose of its use; for example cost utility analysis requires
the use of population utilities based on an accepted economic method thus TTO utilities are required (Kind 2003). Kind purports that the EQ-5D is the only measure based on solid empirical evidence for use in economic studies despite its brevity (personal communication 2005). Its application therefore would have to be considered based on the use of the data to be collected, for instance if a description of the health state is required then EQ-5D would not be a suitable measure but it is suitable for calculation of QALYs.

2.4.2.4: The SF-6D

Following a pilot study by Brazier, Usherwood et al. (1998) a study was designed to generate a preference based measure from the SF-36 namely the SF-6D for use in economic evaluation (Brazier, Roberts et al. 2002).

Initially the SF-36 had to be reduced to the SF-6D which was achieved by removing the general health items and dimension, and combining the role emotional and role physical dimensions. This resulted in the six dimensional scale compared to the original eight dimensions. Eight items for the six dimensions were taken from the shortened SF-12 and 3 from the SF-36 (Ware, Kosinski et al. 2002).

The dimensions and number of items are listed below;

- physical functioning (6)
- role limitations (4)
- social functioning (5)
- pain (6)
- mental health (5)
- vitality (5)

Thus an overall health state could be described as 111111 (best health state) to 645655 (worst health state). Where 111111 represents 'your health does not limit you in vigorous activities, you have no problems with work or other regular daily activities as a result of your physical health or any emotional problems, your health limits your social activities none of
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the time, you have no pain, you feel tense or downhearted and low none of the time, you have a lot of energy all of the time'. The worst health state 645655 represents 'your health limits you a lot in bathing and dressing, you are limited in the kind of work or other activities as a result of your physical health and accomplish less than you would like as a result of emotional problems, your health limits your social activities all of the time, you have pain that interferes with your normal work extremely, you feel tense or downhearted and low all of the time, you have a lot of energy none of the time'.

Overall, the SF-6D describes 18,000 health states however for the valuation task a total of 249 health states were selected. A representative sample of the public (n=836) were interviewed where each had to rate six out of the 249 of the health states and then value the health states using SG techniques. The six states ranged between 'good', 'moderate' to 'bad' and overall each of the 249 states were assessed on average 15 times.

A total of 3,518 observed SG valuations across the 249 health states were reported. Subsequent modelling of these data was undertaken using econometric methods rather than utility theory due to the distribution of the data. A series of models were developed and the authors recommended the use of one, to elicit the preference weights from SF-36 data. An algorithm for the conversion of the SF-36 to SF-6D weights is obtainable from Brazier (Brazier, Usherwood et al. 1998).

Brazier's work in this area provides a useful tool for those studies that have SF-36 data and need the subsequent conversion to preference weights to undertake cost utility analyses. Brazier suggests it as a method when there is no other means of estimating the preference based health values for generating QALYs. He believes it may have greater sensitivity than the EQ-5D because of the greater number of descriptive health states obtained.

The work is commendable and has great potential but there are still problems with the data modelling and caution in its use is offered by Brazier et al. (1998). One notable inherent problem of the SF-6D is that it is taking a profile score to generate a preference score and reducing
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substantially a measure (SF-36) with good psychometric principles to one that does not necessarily uphold them.

2.5: Health Outcome Measures and Their Use in Injury Studies

Having reviewed the main health outcome measures it is necessary to review how they have been used in injury research studies. Injury studies tend to concentrate on treatment for types of fractures and the variation on recovery rates or return to work rates. Other studies examine injury from an epidemiological perspective (Segui-Gomez 2003; Peden 2004). There have been few studies which have concentrated solely on examining health related quality of life and outcomes in road trauma.

General Trauma Studies

An injury surveillance study of 4,639 Dutch residents identified differences between those hospitalised following injury and not hospitalised using the outcomes of functioning and work status (Meerding, Looman et al. 2004). They attempted follow-up using a postal survey of the injured population at two, five and nine months using the EQ-5D, with a 39% response rate. Mechanism of injury was a factor in the return to functional status with RTA a detrimental factor in the recovery process. They reported higher average days off sick for the hospitalised group (72.1 days), below population norms at nine months on the EQ-5D with lower extremity injury and long hospital stays an indicator of poor return to work rates. Those with upper extremity fractures also reported high numbers of lost work days whether they were hospitalised or not. The main predictors of functioning and work status using multiple regression analysis were age, sex, injury type, length of stay, educational level, motor vehicle accident, surgery and Intensive Therapy Unit (ITU) admission. At the time of the study there were no Dutch population norms for the EQ-5D and as a proxy the Swedish
weights were used. The accuracy of the weights is debateable, as the Swedish norm was 0.79 and this study identified the injured population as having a mean score of 0.74. Unfortunately, the absence of Country specific norms does bias the study as there is no comparative group to examine data against.

Their study population was skewed toward the minor injury non hospitalised participant population which reflects the high incidence of minor injury occurring on a daily basis, in this study it was 90%. The non-hospitalised group had almost 10 times less days off sick at 5.2 days. In burden terms the minor injury population is a large contributor, especially when combining the 90% minor injury with average days off sick being 5.2. A Second Dutch study using the EQ-5D and Glasgow Outcome Scale (GOS)\(^7\) as the measures of disability examined the determinants of disability and return to work (Vles, Steyerberg et al. 2005). The study prospectively included 295 patients with an ISS of 16 or greater and were surveyed at least one year post injury. To compensate for the lack of cognitive assessment, additional questions to assess this and other factors, such as, effect of injury on sports and everyday activity were included in the postal survey. Of the 195 participants still alive at one year, 77% of the group were back to normal, despite minor deficits; 15% were disabled but independent, and 8% were conscious but reliant on others for daily care, as defined by the GOS. Changes in work / daily activity were made in 33% and 25% had changes in sports activity. Return to work was not possible for 26% who were relying on social security benefits. Injury to the spine and pelvis had the main impact on the ability to return to work or do sports. At post injury assessment over half of the group experienced problems with everyday activities and pain as assessed by the EQ-5D, with self care having the least reported problems (15%). Overall, a mean index score of 0.76 was identified for this population, similar to Meerding et al's. (2004) study of 0.74 but below the Swedish norm of 0.79 which indicates the 'benchmark' of the average health state. Scores below 0.79 indicate that the sample had a worse

\(^7\) GOS - assesses outcome on a 5 point ordinal scale; 5 = good recovery, 4 = moderate disability, 3 = severe disability, 2 = persistent vegetative state, 1 = death.
than average health state compared to the population norm. Lower extremity injury was a main determinant for return to work as were being female and having an ISS of 25. Females also tended to score lower on the index score suggesting a worse outcome than men, this has also been found elsewhere in injury studies (Meerding et al. 2004, Holbrook, Hoyt et al. 2001).

Vles et al. (2005) also identified a large proportion of the sample group with problems in cognitive function particularly those with head injury a very real problem which is missed by using the standard EQ-5D form.

**Lower Extremity Studies**

MacKenzie, Morris et al. (1998), as part of the lower extremity injury (LEI) study in the US, examined other factors which may influence the return to work of those with LEI. They assessed social support, alcohol dependency, job characteristics, personality / motivation and compensation, as well as disability using SIP (Mock, MacKenzie et al. 2000). They identified that being in receipt of workers' compensation or being involved in the legal system were factors in low return to work rates and conversely higher education, higher income, job flexibility and white collar work were associated with higher return to work rates; this was also identified by Glancy, Glancy et al. (1992). The SIP was used to assess disability and the assessed impairment scores correlated well with the overall SIP scores but only 21% of the variance in SIP scores was accounted for by impairment. This low variance indicates that other factors are important in the role of disability in LEI which were found to be age, pain, compensation and socioeconomic status.

The SF-36 has been shown to perform well in assessing outcomes following ankle fracture in conjunction with a disease specific measure (Olerud Mulander ankle score). Kaufman, Moshciff et al. (2001) assessed 400 patients with both measures and identified that the SF-36 contributed more to the understanding of recovery following ankle surgery such as general health perception rather than limiting the assessment to the ankle score.
Brenneman, Redelmeier et al. (1997) studied long term outcomes of blunt trauma using return to work as the outcome and the SF-36. Self reported recovery and nature of employment were the main determinants for return to work in those with ISS of 10 or greater and not including severe head trauma. A total of 195 participants had pre-discharge and one year follow-up data. The main determinant for return to work was pre-employment status with professional workers regardless of injury severity as being the strongest predictor for return to work. Improvements in the SF-36 were noted between assessments with better scores assigned by those back in employment at one year. The main differences between the employed and unemployed at one year were found in the role physical, physical functioning and role emotional dimensions.

2.5.1: Outcomes of Trauma

One of the major series of studies of examining trauma outcomes was undertaken in the US; the Trauma Recovery Project (TRP) led by Holbrook (1998-2001). This was a large prospective epidemiological study where recruitment took nearly three years and included 1,048 eligible trauma patients. Their criteria for participant recruitment were age 18 years and over, no serious head trauma and length of stay over 24 hours in hospital. They used the QWB scale as the HRQoL measure of choice as well as other measures including psychological measures namely the CES-D scale (Centre for Epidemiological Studies-Depression) and Impact of Events Scale (IES) which determines posttraumatic stress syndrome a precursor to PTSD. Of the sample population, 62% were road traffic victims. The study followed up the sample at; discharge, 6, 12 and 18 months with a follow-up rate of 74% achieved at 18 months. There was a range of injuries within the sample with ISS ranging between 4 and 66 (mean 13). Scores on the QWB scale ranged from 0.4 at discharge to 0.633 at 6 months, 0.67 at 12 months and 0.678 at 18 months follow-up indicating some improvement between these time points but still below the US norm of 0.8. Overall, by 18 months, only 20% had QWB scores of 0.8 or above. Extremity injury was one of the main
factors significantly associated with lower QWB scale scores at 6 months. Depression was a large factor in the study with 60% of the population at discharge with depressive symptoms and 31% at 6 months which influenced the 12 and 18 month states of depression. Gender differences were also apparent in this study population (Holbrook, Hoyt et al. 2001). Women were significantly more likely to have lower functional outcome at all follow-up periods compared to men and also scored lower QWB scores and were significantly more likely to be depressed even when controlling for age, injury severity and injury mechanism. However, there was no assessment of depression prior to the injury and could be a pre-existing condition.

Not having a baseline assessment of a participant is one of the main concerns when undertaking follow-up studies because there is nothing with which to compare subsequent results. Thus the importance of general population norms is evident in these situations as being in some way a proxy for this lack of baseline assessment. The benefit of the QWB scale here is its six day assessment schedule which does allow for pre-injury assessments to be made depending on the timing of the initial interview post injury, but is limited to the items within the scale. A further advantage to this study was the availability of US population norms and the funding and network of people involved to recruit and collect the data over a long period of time.

2.5.1.1: Outcomes of Road Injury

There have been few studies which have examined road traffic injuries as these are often incorporated under the broader trauma samples although they appear to be a large percentage of the total sample. Read, Kufera et al. (2004) have recently published results looking at lower extremity injury in RTA victims. Read's work is part of the Crash Injury Research and Engineering Network (CIREN) in the US which has similar vehicle criteria to the CCIS, however there are close hospital links with researchers working out of specific trauma centres to gather pre and post injury and outcome data (Read et al. 2004). Pre-injury information was
obtained during interview and follow-up at six and 12 months assessing cognitive, economic, physical and psychosocial outcomes using standard interview forms and specific questions to assess depression, PTSD and the SF-36. Ninety eight patients were included in this study over a 56 month period. At discharge, only 6% were walking and fully weight bearing which rose to 54% at 12 months. Pain was a main problem for 26% at 12 months interfering with daily activities. The SF-36 showed decline in physical and mental health at six months post crash; there was improvement at 12 months but significantly lower levels of functioning compared to pre-injury baseline. Fifty seven percent of this group considered the financial impact of the injury to be moderate or severe causing hardship for themselves and their family. Median costs for those discharged home after treatment compared to inpatients were over $10 000 (US) higher. They found high psychosocial issues present at both follow-up periods including depression however it must be noted that a large proportion of their sample had pre-injury depression (40%) which could adversely affect recovery. Those with ankle / foot fractures fared worse in recovery, and other factors such as return to work, pain, depression and return to driving. Interestingly, the AIS scores were generally low for the CIREN sample which illustrates the use of this scale for coding injury as threat to life but no allowance is made for impairment or long term recovery.

In Read et al's (2004) study only 48% of their sample group received disability pay or continued salary at six months with 14% relying totally on family support. Those not returning to work at 12 months had a tendency to have higher psychosocial morbidity. Their study used direct cost of treatment and benefits to determine cost of injury which given their choice of outcome measure limits the study in looking at the cost in utility terms of QALYs. Given that Brazier (2002) has developed the SF-6D this will allow an exploration of the use of their data in this way.
2.5.1.2: Impairment as an Outcome in Trauma Studies

Lower extremity injury is notable in the literature for its limiting affects on individuals, high costs and high levels of impairment. They are a common subject group to study for these very reasons. Luchter (1995) examined the long term outcomes of lower extremity injury in motor vehicle accidents in the US using the as yet un-validated Functional Capacity Index (FCI) and the measure of Life-years lost to injury (LLI). The FCI was developed by Mackenzie, Damiano et al. (1996) as a way of using the AIS to predict the expected outcome of the injury at 12 months. It has 10 health dimensions with varying levels of assessment and has an assigned weighted score for each AIS injury code which relates to the expected incapacity of that particular injury at 12 months (Appendix A). This score is then multiplied by life expectancy for the individuals to obtain the LLI. Luchter (1995) identified that lower extremity injury was 28% of the total incidence and contributed to 41% of the total LLI. Although in cost terms he approximated that lower extremity injury accounted for 17% of the total cost with minor external injury accounting for the most (33.4%) of the total cost.

The FCI has not performed well in studies in predicting functional outcome compared to the actual functional outcomes. Schluter, Neal et al. (2005) followed up 617 individuals of which 587 could be assigned an AIS score from which to predict a FCI score. A telephone survey one year post injury using the developers' questionnaire obtained the actual functional outcomes for comparison with the predicted outcomes (MacKenzie, McCarthy et al. 2002). They found poor agreement between predicted and actual functional capacity using a series of models to assess functionality. Interestingly, where some injuries were predicted to have a 0 FCI they scored highly on the actual assessment not necessarily as a direct result of the physical injury but the chronic effects of depression, anger and frustration which are not accounted for in the FCI. This highlights the complexity of injuries as a subject group because of the interplay between so many other factors which influence outcome.
The prediction of outcomes using the FCI from the AIS could be one of the major contributions to injury outcome research if it were accurate, however it has not performed well in any study to date (Schluter et al. 2005; MacKenzie, McCarthy et al. 2002; McCarthy and MacKenzie 2001).

Mock, MacKenzie et al. (2000) examined what makes lower extremity injury become a disability in the Lower Extremity Injury Study. They measured physical impairment by assessing range of motion, strength, pain and disability using the SIP in 302 patients at baseline and one year post injury. SIP at baseline was used to assess pre-injury status and at one year their current status. There was a significant difference between pre (2.0) and post injury mean SIP scores at one year (6.9), the physical and psychosocial dimension scores were also raised. Good correlation was found between SIP and the pain and impairment scores, however, very little variance of SIP scores was accounted for by the impairment or pain scores. This suggests that other factors contribute to the level of disability post injury. These factors were; low income, social support, and involvement in the legal system which accounted for 52% of the variance including impairment and pre injury SIP score. This still suggests that other factors can influence the outcomes. Using SIP retrospectively is not a normal method for its application and asking pre-injury status at discharge may well alter the perceptions of the individual who would assess themselves in a positive manner due to their current situation.

Jurkovitch, Mock et al. (1995) also used the SIP to assess LEI and return to work at one year post trauma. The main domains affected were the sleep and work categories and then the physical and psychosocial health. Although it would appear that those with high energy fractures, multiple fractures or specific foot fractures had the most problems at 12 months.

One of the noticeable findings in many of the studies is the psychological impact that traumatic injury has on the individual.
2.5.2: Psychological Impact of Road Crash Injury

Mayou (1995) recognised the wide individual variation in outcome following a major or minor road accident injury with an important minority of patients suffering psychiatric disorder. In addition there can be considerable effects on quality of life. Psychosocial factors can contribute substantially to adverse effects on quality of life and exacerbate the considerable pain, distress and physical impairment associated with many severe injuries.

2.5.2.1: Studies of Road Injury Survivors

Mayou et al. (1995-2002) in a series of studies in the UK further examined the psychological effects of road trauma. These were prospective follow-up studies of consecutive hospital patients either as outpatients from Accident and Emergency, or inpatients. The inpatient group had an assessment within 24 hours then at one, two and four weeks and then again at six months using a postal survey once discharged. The outpatient group were sent surveys within 48 hours of the crash then four weeks and six months post crash. They found a significant relationship between persistent dissociation at four weeks with post traumatic stress disorder (PTSD). This problem was considered to be a result of not accepting the crash and developing coping mechanisms to address any issues. Where rumination and continual questioning are present the person was more likely to continually re-experience the event and relive the trauma. PTSD is a severe condition associated with persistent re-experiencing of the event, avoidance of stimuli associated with the event and symptoms of increased arousal. PTSD is an extreme reaction to trauma but more common disorders post trauma are anxiety, depression, substance misuse and specific phobias (Mayou and Bryant 2003).

The authors also found that the severity of injury did not influence psychological status post trauma however other studies have found the
opposite in RTA victims (Hickling and Blanchard 1992, Blanchard, Buckley et al. 1998, Blanchard, Hickling et al. 1996a,b, Frommberger, Stieglitz et al. 1998). In particular Mayou and Bryant (2002b) focussed on whiplash being a 'minor' injury.

2.5.2.2: Psychological Impact of Whiplash Injury

Spitzer, Skovron et al. (1995) state that whiplash injury is the most common type following an RTA and claims for persistent symptoms make up 85% of personal injury claims in the UK from motor vehicle accidents. There is this long standing issue of whiplash sufferers being 'exaggerators' of their physical and psychological symptoms to obtain better compensation payouts, although Mayou and Bryant (2002b) did not find evidence to support this. Mayou and Bryant's (2002b) study looked at 1,441 consecutive patients attending an A and E department following an RTA over a one year period. Three injury groups were identified being: no injury (20%); soft tissue injury (63%), and bony injury (17%). The soft tissue injury had two groups the whiplash (23%) and other soft tissue types (40%). Data were collected at baseline, three months, one year and three years using a shortened version of SF-36, a study questionnaire incorporating feelings about the accident including memories, emotions and worries. The psychological outcomes for whiplash injury were comparable to those for other more serious injuries. Although this group tended to report more problems of pain and effects on leisure, work and finances. The authors particularly examined the role of compensation in whiplash sufferers and found that the actual process of compensation was slow and may perpetuate the psychological impact of the trauma; however this was the same for all injuries sustained. However, the whiplash injury and bony injury groups were more likely to claim compensation than the other groups usually stemming from the fact 'they were not to blame'.
2.5.2.3: Psychological Consequences of Different Road User Groups

Mayou with Bryant (2003) also reported on the consequences of crashes on different types of road user. The main outcome measures were self-reports of physical status, standard measures of post-traumatic stress disorder, mood, travel anxiety, and health status. The vulnerable road users tended to have the most severe injuries with more continuing medical problems and greater resource use within the first three months. Very few differences existed between social and psychological outcomes at any stage of the follow-up period. A third of the injury groups described chronic adverse consequences which were dependent on psychological, social, and legal issues.

The motorcyclists and pedestrians had more severe injuries compared to the car occupants. A follow-up rate of 66% at three months was reported (n=899) and showed some aspects of physical recovery and resource use to be different between groups but few differences in psychological and social consequences. The pedestrians and motorcyclists were more likely to report continuing physical problems, use of resources, and disability at three and one year follow-ups. The vehicle occupants in particular reported persistent pain more frequently than other groups originating mainly from the neck and other musculoskeletal complaints.

Psychologically, there were very few differences in outcome at three months and one year. The passengers, however, described the highest prevalence of phobic anxiety about travel; these anxieties were also different depending on the accident experience. Women were more likely to express travel anxiety even when the data were controlled for gender as women tend to report more psychological distress as compared to men.

Pedestrians had the most time off work; financial problems were experienced in over 40% at three months and 27% at one year as a result of the RTA. Nearly half claimed compensation (43%) by three months and had initiated a claim, a quarter of which were settled.
The three year response was 48%, some still had physical problems and complications and pain remained common. Motorcyclists and pedestrians tended to rate their health as ‘fair’ or ‘poor’ at three years with passengers having poor outcomes for PTSD and anxiety, travel anxiety was worst for motorcyclists and passengers.

Although the study found differences between the accident characteristics and injuries between user groups there were similar patterns of continuing care. The main adverse consequences over time were psychologically and socially determined and the authors advise this needs to be considered in the treatment and follow-up of patients to prevent a small initial problem becoming a long term consequence. The psychological effect in terms of experiencing phobic travel anxiety in similar travel situations were a continuing problem over the follow-up period with passengers experiencing this more frequently. The passenger experience is difficult to determine and possibly results from not being in control of the crash. It was an event that ‘happened’ to them for which they could not apportion blame or accept partial blame for the crash which may be a detrimental feature in their recovery.

Taylor and Koch (1995) believe that the psychiatric consequences of RTA are greatly underestimated by researchers and clinicians (Mayou, Bryant et al. 1993; Green, McFarlane et al. 1993). The consequences are chronic pain and depression, common anxiety disorders of accident related phobia and traumatic stress disorders. Some cynics believed that these orders existed if there was the prospect of secondary gain such as monetary compensation or relief from occupational duties. This however, has been refuted and chronic psychopathology exists regardless of the prospect of any financial gain (Mayou, Bryant et al. 1993; Burstein 1986).

2.5.2.4: Specific Psychological Symptoms

The term ‘accident phobia’ is used to describe the phobia arising from an RTA; this is not limited to vehicle occupants but also includes vulnerable road users as suggested by Mayou et al's studies (1993-2003). On a
formal level Kuch et al's studies (1991, 1994) state that this phobia can be characterised by three features:

1. A DSM-III diagnostic criteria for simple phobia
2. onset and content of the phobia are related to the accident
3. anxiety symptoms and avoidance behaviour centre around excessive fears of repetition of the accident

Actual avoidance behaviour can range from driving with excessive care and attention; avoidance of optional driving, such as pleasure trips; avoidance of driving under particular conditions usually the same as when the crash occurred the use of distraction as a passenger such as closing eyes when large vehicles are approaching as well as back seat driving; that is, excessive warning of the driver about perceived risks on the road (Kuch, Cox et al. 1994; Mayou et al. 1993).

Studies have shown that accident phobia is a very real condition post RTA however the criteria which assessed the incidence of the occurrence were different across studies. For example, Mayou et al. (1993) used the DSM-III-R criteria to assess 188 RTA victims and found that rates of accident phobia remain stable between three months and 12 months post RTA (18% and 15%). The phobic stimulus has to be avoided or endured with intense anxiety or distress. Other studies, however, used more restrictive criteria; for example Blanchard, Hickling et al. (1996) stated that the person had to display an unwillingness or inability to return to driving as a result of the crash. This study is restrictive and can only be utilised in relation to ‘driver’ behaviours and therefore excludes vulnerable road users. None of the 50 RTA victims in Blanchard's study by these criteria were diagnosed as having a phobia but all showed driving reluctance as demonstrated by avoidance behaviours. Malt and Olafsen (1992) study found that 29% of patients showed a fear of accident stimuli but again none were clinically diagnosed as having a phobia. Koch and Taylor (1995) assessed victims 2.5 years after the crash as part of

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8 DSM-III - Diagnostic and Statistical Manual of Mental Disorders 3rd edition. Used for the diagnosis of mental disorders by psychiatrists based on the set criteria within the publication.
litigation assessments and found that 47% met the criteria for accident phobia and 43% presented with a milder form of travel related fear and avoidance.

Koch and Taylor (1995) report cases where the patient is more afraid of being a passenger compared to driving. So although they are able to drive without too much restriction on their everyday life the prospect of being a passenger causes considerable stress. However, these studies have tended to take their subject group from patient lists that have been referred for psychological assessment for litigation purposes; thus, in itself, there is an expectation that problems such as travel anxiety and PTSD will be present.

Jeavons (1999) undertook a prospective follow-up study of 72 consecutive A and E attendees following an RTA to determine any predictive factors for psychological trauma in the first 12 months post crash. This study is one of few in this field not to use medico-legal patients or a seriously injured sub-sample. They used a battery of different psychological measures to assess varying elements of emotional recovery.

Overall, they found that patients not seriously injured or admitted to hospital still suffered psychological trauma and the PTSD sufferers were constant at about 8% over the one year period. Using the information gathered in the initial interview allowed prediction of those with psychological disorder from three to 12 months. This was dependent on which scale was used and accuracy was between 12% and 77%. Those using emotional focussed coping, considered to be distressed, fearing ones' life and subjective experiences were found to be important rather than demographic or accident variables. Injury also had some predictive ability.

**Post Traumatic Stress Disorder (PTSD)**

PTSD is a varying component within the literature and as with all follow-up studies sample groups vary, as do time periods and methods used to assess the phenomena to any certainty. Malt (1988) and Kuch et al.
(1994) focussed their work on survivors of road traffic accidents. The commonality was that injury severity is not a major contributor to psychological distress but an internalising of the event. The prevalence in epidemiological studies for PTSD was found to be at least four times greater in RTA survivors compared to the general population.

Michaels, Michaels et al. (2000) in a series of studies examined trauma outcomes in 247 patients without severe brain injury at admission, six and 12 months using a series of measures including the SF-36, SIP, Brief Symptom Inventory depression scale (BSI) and the Civilian Mississippi Scale for PTSD. The use of the SF-36 identified progressive recovery over the follow-up period toward baseline scores. Follow-up rates were 75% at six months and 51% at 12 months. They identified little change between six and 12 months follow-up in the role physical and physical functioning dimensions. This was particularly true for those with orthopaedic lower extremity injury compared to non-orthopaedic injury. Changes in the SIP were noted and showed also the non return to baseline scores. Overall, 64% had returned to work at 12 months. The presence of mental health problems in the measures used were attributed to poorer outcomes one year post trauma, after controlling for physical recovery, injury severity and baseline status. Factors identified as important to patient recovery and return to function following trauma were level of education, occupational status, presence of insurance and compensation, absence of litigation, chronic pain and the presence of orthopaedic injury. Orthopaedic injury has longer recovery periods compared to non-orthopaedic injury which is not an unexpected finding (Michaels, Madey et al. 2001).

The introduction of utility health outcome measures has added a new dimension into the economic assessment of outcomes of injury or disease. The use of preference measures allows for the calculation of quality adjusted life years (QALYs) which can be used as direct comparisons between injury and diseases rather than the more traditional economic models.
2.6: Economic Evaluation of Injury

Economically the costs of injury are high, although this is dependent on the costs that are included in the 'overall' economic cost. Injury cost studies have been approached by numerous authors from varying backgrounds using different economic models.

2.6.1: Economic Methods to Assess Cost of Injury

2.6.1.1: Human Capital Approach

Millers' work in the U.S. has predominated in the literature examining costs of road traffic injury from a pure economist's perspective. The human capital approach places a value on the gross contribution which the accident victim would have made to the economy together with direct costs. His cost models incorporate a variety of costs including insurance costs, damage costs and work costs (Miller 1997, Miller 1993, Miller 1991, Miller 1990). This human capital approach does not take into account the cost benefits of safety measures.

2.6.1.2: QALYs (Quality Adjusted Life Years)

Health economists have approached costs from a different perspective to enable comparisons to be made across the varying health disciplines to show cost effectiveness, for example, of selecting one treatment method over another. The move to assign values to health states using health outcome measures has opened a new direction for costing injury (Torrance, Boyle et al. 1982; Drummond 2005). The advent of quality adjusted life years (QALYs) has been adopted by health outcome researchers as the preferred method to illustrate the changes in health state as a result of disease or injury in cost utility analysis (Gold, Siegal et al. 1996). QALYs incorporate both quality of life and mortality into one score which allows comparisons across disease populations. It is the arithmetic property of life expectancy and a measure of the quality of life years remaining. By its definition it can be seen that health states have to
be quantified to allow for QALYs to be calculated, thus preference measures can only be used to generate a QALY. A QALY places a weight on time in different health states. A year of perfect health is worth 1; a year of less than perfect health life expectancy is worth less than 1 and death is considered to be equivalent to 0; however, some health states may be considered worse than death and have negative scores. The main aim for a single index (preference) score and its use in QALY calculations is that the state 'dead' with a value of '0' is implicit within the measure such that it produces a cardinal/interval scale (Williams 1995).

2.6.1.3: Willingness to Pay

Other approaches to costing injury have been the willingness to pay approach developed by Mishan (1971) which is based on welfare economics. Willingness to pay (WTP) is an accepted theoretical approach when attempting to incorporate consequences in a cost benefit analysis (Klarman in Torrance 1982). The WTP is an estimate of the amount a person is willing to pay to purchase health improvement/prevention of injury with everything else being equal if it were available on the market (Mishan 1971). It is not restricted to monetary value but also included sacrifices or what one would forgo to obtain these benefits. This method was used by Acton in 1973 to elicit from a sample of the public the amount they would pay to improve cardiac services to reduce the probability of dying from myocardial infarction (Acton 1973). Conversely there is the 'willingness to receive' approach which is the amount an individual would be willing to receive, everything else being equal, in compensation for their health decrement or personal injury. A further method of use is to examine actual market decisions to infer the WTP, for example, using wage premiums paid to those working in hazardous jobs in return for accepting identifiable risk.

The WTP metric therefore is a measure of the health improvement/prevention measure expressed in monetary units. In some ways this method is similar to the standard gamble approach to obtaining preferences and is just as time consuming and in some ways
controversial when asking someone to put a 'monetary' value on one's life and health. This method is used by the Department for Transport (DfT) for costing injuries per se and work has been undertaken to cost injuries using the AIS code to fit into their cost model based on WTP (Morris et al. in press 2006).

Estimating the social costs of life quality due to nonfatal injuries is problematic considering the extensive range of injuries sustained. Willingness to pay is considered the most appropriate method for estimating the marginal rate of substitution of wealth for risk of death or injury (Guria 1993).
2.6.1.4: Harm

Harm is defined as a single metric for quantifying injury costs from road trauma involving both a frequency and a unit cost component. The Harm metric has been used as a means of estimating societal benefits from the introduction of new countermeasures, as well as a means for quantifying the financial benefits to society in evaluation studies. It was developed by Malliaris, Hitchcock et al. (1982) and in its most general form, is a measure of the total cost of road trauma incorporating; injury severity, medical costs, loss of productivity, and other costs including insurance and administration costs. It is based on the human capital approach and places a value on the gross contribution which the accident victim would have made to the economy together with direct costs. Originally it examined the cost to society based on injury severity as defined by the maximum AIS level for one body region. The original harm metric has been developed further both in the US and Australia to expand its capabilities to multiple injury and societal cost (Fildes, Lane et al. 1994) and has since been used in other studies (Barnes, Morris et al. 2001; Fildes, Digges et al. 1995; Gabler, Fildes et al. 2000). However, harm has not been used extensively in the UK for cost studies because of the human capital approach to costing, this method, does not take into account the costing of the benefits of safety measures, which is essentially what people are willing to pay to prevent an injury occurring.

2.7: Selecting a Health Outcome Measure

Injury as a study group does not have a specific outcome measure and therefore a generic measure is necessary. Kopjar (2000) concurs that there is very little known about the profiles of injury of health outcomes because of their diversity. One of the main challenges is how to measure this impact. Unlike diseases, injuries are a group of conditions and not suitable for disease specific measures. A useful measure of decline in health due to injury should provide a common descriptor for various injury
diagnoses, be responsive to changes in health status over time and be able to describe changes in several health dimensions. Thus, evaluating the impact of injury on health is complex as injuries represent a large number of diagnoses and also patients with the same diagnosis may differ in their severity of injury. Also, the type and amount of impact on health, depends on host factors plus there is the complexity of multiple injuries. Kopjar (1996) used the SF-36 to assess changes in health status following unintentional injury and found the SF-36 to perform well and be responsive to changes over time.

Unfortunately, there is no single recommended health outcome measure for all studies, thus each has to be considered on its merits and purpose of use within a particular study (Carr and Higginson 2001).

In the absence of an ideal measure there are qualities which would be expected from the measure itself. These include the need to be comprehensive, reliable, sensitive to change, have low responder burden, minimal administration cost and have unconditional use (Mackenzie 2000). Undoubtedly, health outcome measures will meet some if not all of these qualities, however there are constraints in every health measure purely in their biases of item inclusion; whether a top down or bottom up approach is used.

There also has to be a consideration of the values used for the health states as to the method that has been used to derive them and whether a random sample population has been used to ensure the generalisability of the values for studies and also be available as population norms (Barratt and Victor 1997).

A bibliographical study found that the SF-36 and the EQ-5D had undergone the largest number of evaluations respectively for generic and utility measures (Garrat, Schmidt et al. 2002), but not in studying injury outcomes. Injury outcome studies are few with the majority concentrating on epidemiology or risk factors, rather than on the consequences. Mackenzie (2000) identified the small number of published injury outcome studies (230) in which the SF-36 and EQ-5D had been used but to a lesser degree than other measures such as the HUI III. None of the more commonly used measures from this review have population norms for the
UK a necessary consideration when choosing health outcome measures. Also one has to consider the 'shelf life' of a health outcome measure and interpret the results in relation to when it was developed if no continuous updating has occurred from its inception. This would have implications in the interpretation of any results as societal values of today would be in contrast with those of 40 years ago if using the original QWB scale for example.

Other considerations when selecting a measure, are the floor and ceiling effects. The SF-36 was seen to have problems with this and alterations made for the SF-36v2 to reduce them. The EQ-5D has been criticised for the high ceiling effects and therefore should only be used for assessing those with high morbidity. Injury research does have the potential to change on a gross level, however the small changes at the well end of the spectrum may well be missed using this scale. In its favour is that it is a preference measure and can be used to examine costs of injury.

Overall, the current exploratory study is based within the UK and is seeking to explore the issues relating to outcomes following injury sustained in road trauma. Kind (2003) purports that the only determinants that make some measures better are the underlying principles of their development and usage. For the purposes of this research the main health outcome measures were considered for their appropriateness for use.

The only health outcome measures that have any recent UK norms are the SF-36, both versions 1 and 2, and the EQ-5D. The developments of these measures are considered to be based on sound outcome measure principles and are taken from both profile and utility methods, and initially are the measures of choice for studies in the UK. The responder burden was considered, measures such as the SIP would not be appropriate for a telephone survey, due to its length, and the QWB scale has a long training period for the interviewer, and again has a long administration time. The EQ-5D has a short completion time and has been developed to include telephone survey assessment and has a script to ensure continuity of administration. Its brevity is a concern however, it does provide the basis for economic evaluation unlike the SF-36. The SF-36 is
reported to take about 20 minutes to administer, although longer than the EQ-5D it was considered to provide a broader assessment of various health dimensions, again there is a telephone script for its administration. Both the EQ-5D and SF-36v2 have available scoring algorithms, websites and UK based experts to provide assistance if required. Differences between these measures do exist with the SF-36 considered to be a more sensitive measure when compared to the EQ-5D as the latter tends to have higher ceiling effects within the domains (Jenkinson, Gray et al. 1997). Also the presentation of results is different with the SF-36 having the ability to present individual health dimension scores but it is considered that the EQ-5D should be presented as total scores for health state assessment rather than the profile of domains (Jenkinson et al. 1997).

One area of concern when using the SF-36 and EQ-5D is their use in assessing the elderly population. The age ranges for establishing UK norms is varied in the SF-36, ranging between 18 and 64 years of age, and for the EQ-5D it is 16 to 80 years of age. Thus the study populations used have to be able to fit into the age constraints imposed by the health outcome measures. This age issue was addressed by Brazier, Walters et al. (1996), albeit in an elderly female population (over 75 years). The SF-36 appeared to have greater sensitivity at the lower levels of morbidity compared to the EQ-5D. However, the SF-36 suffered from lower completion rates and consistency compared to the EQ-5D. These are considerations which would have to be addressed in the study methodology and analysis of results.

Considering there are very few studies which have looked at injury outcomes following road trauma particularly in the UK it is an area of interest and would benefit from an exploratory examination from the road safety perspective. To select one measure in an exploratory study would be to do a disservice to the potential differences in data that can be captured by these health outcome measures out of a clinical setting. Thus the SF-36v2 and EQ-5D are the measures of choice for the current research, particularly as they include physical, mental and social health assessments all important considerations to assess the overall impact of
injury. The SF-36v2 is expected to provide a detailed profile of affected health dimensions whilst the brief EQ-5D will provide utility values from which to apply a cost assessment.

2.8: Summary of the Literature

It is evident from the literature that there is a paucity of studies examining the effects of traumatic road injury. The assessment of injury outcomes is a relatively new area compared to the traditional outcome assessments undertaken, for example, in drug trials and surgical interventions. In the road safety research area the emphasis is on injury prevention or injury reduction measured by the Abbreviated Injury Scale (AIS), with little attention paid to the consequences of injury on quality of life. There are tools to measure these quality of life changes available in the clinical field, both generic and disease specific. It is recognised that injuries are complex and will have varying outcomes and thus require the use of generic tools to assess their consequences. More importantly, these health outcome measures are subjective; assessed by the affected person rather than a medical opinion where the injury may well be healing but the impact it has on the person is ignored. Being able to describe and quantify an injury's affect on health related quality of life is in itself a unique opportunity to examine the overall affect of road trauma from the road safety perspective.

This research intends to explore the outcomes of a specific group of people who have been injured in a road traffic accident (RTA) and examines the effects on the individual and family. It is evident that are a variety of factors which need to be considered that are affected by injury including the psychological as well as physical impact. The literature suggests that the psychological impact of these injuries has been studied on a wider scale compared to the 'overall' outcomes on all aspects of quality of life. Thus the selection of any health outcome measure would have to be appropriate and incorporate more than one aspect of injury outcome. The available health outcome
measures were considered and assessed for their suitability and practicality of being used here. The choice was guided by the available literature and the constraints of the research itself in terms of time and limited finances. The studies reported in the literature have all been sponsored by considerable grants allowing for research teams to recruit and collect data over a long period of time.

The main points from the literature are summarised below in two separate sections, that of the general points and the methodological issues which would need to be considered when developing a study methodology.

2.8.1: General Issues

- Injury is a complex study area; although there are methods to classify injury for research purposes.
- Injury outcomes could be traditionally classified as impairment, disability or handicap but health outcome measures has placed the focus onto subjective assessments of outcome as perceived by the individual.
- There are two main 'types' of health outcome measure, namely preference (utility) measures and profile (psychometric) measures.
- Few studies have concentrated on the subjective outcomes following road injury.
- From the studies undertaken it is evident that traumatic injury has implications for both physical and psychological wellbeing.
- Preference measures have the ability to provide outcomes of road injury as QALYs to indicate the societal burden of injury.

2.8.2: Methodological Issues

- Prospective methods appear to obtain in-depth data and are able to determine any changes over a specified time period.
- Follow-up time periods in the studies were varied and have to be considered with respect to the amount of information required in a limited time period.
Road injury survivors tend not to be considered as a separate study group but incorporated in general trauma studies.

One area for road injury survivors that has been studied in some detail is the psychological outcome.

Health outcome measures appear to perform well across a broad range of participant groups / diseases but have not been used extensively in road injury survivors.

The merits of the health outcome measures have to be considered prior to their use in any study.

The merits include availability, acceptability, usability, reliability, validity and availability of population norms.

The implications from the literature suggest that at a minimum the health outcome measure has to include physical and psychological outcomes.

The societal costs require the use of preference measures to calculate the burden of injury.

Actual costs of injury require an economic tool appropriate to the subject and setting.
Chapter Three: General Methodological Considerations
3.1: Introduction

This chapter presents the common methodology for Study 1 and Study 2. The study design, ethical considerations and data collection tools are discussed and presented below. Methods specific to particular studies are presented in the relevant study chapters.

It is apparent that there is a lack of existing knowledge for vehicle safety researchers with regard to the outcomes of those persons who have been involved in a road crash event. Therefore, the ultimate aim of these studies is to determine the actual effect that the crash event and/or the injury outcome has on an individual's quality of life over a one year period and determine if there is a suitable methodology for future research. A longitudinal methodology is necessary to achieve this, thus a follow-up study design incorporating qualitative and quantitative techniques was selected to describe and quantify the phenomena under study (Jicks 1979). The combination of qualitative and quantitative data will enhance the available information to the researcher allowing for an exploration of the issues at different points in time in a series of studies.

3.2: Objectives

The objectives for the first two studies are the following;

- To follow-up a group of participants who have sustained a road crash injury at regular intervals over a one year period.
- To use existing health outcome measures to assess their potential contribution in measuring outcomes of road crash injury to the accident research field.
- To examine factors which contribute to a good or bad recovery from road traffic injury.
3.3: Study Design

This is a non-experimental design as there is no control of the independent variable, that is, the crash event itself. It would also be unethical to ask participants to have a crash and then study the outcomes; thus it is necessary to study crashes as they 'naturally' occur. Under this umbrella, the overall aim is descriptive in nature to observe, describe and document aspects of the phenomena under study as they occur in two prospective follow-up studies. Although it is non-experimental, the researcher still has to control the data for extraneous variables to ensure the study is examining the relationships between the independent and dependent variables of interest. To control this type of research it is necessary to consider the external factors relating to the situational context and internal factors which are more difficult to control and usually considered such as gender and age in the study design. Otherwise the internal factors are controlled in statistical analysis usually using measures of covariance. The external factors can be controlled by using a study protocol and also by administering the study collection tools (either questionnaires or interviews) in a consistent and constant manner. The researcher has chosen to conduct interviews to have control over data collection and use the same format for each participant. However, as this is an exploratory study, there will also be opportunity to elaborate on certain areas once the formal data collection tools have been administered.

One problem with conducting longitudinal studies is that of attrition, where participants drop-out and are then lost to follow-up. It is considered to be a well known limitation for this type of research and requires the recruitment of large sample sizes to allow for this event (Polit and Hungler 1995). To help increase the response rate for this study it was decided to use interviews to obtain the data rather than postal survey methods. Interviews also allow for the further exploration of particular interesting issues as they arise. Using interviews also helps to control the external factors as respondents have to answer the questions in a set order rather than being at liberty to answer questions ad hoc in a postal survey.
3.3.1: Study Site and Setting

The East Midlands has a population of 4.1 million and is a combination of rural and urban areas divided into five counties, Derbyshire, Lincolnshire, Nottinghamshire, Northamptonshire and Leicestershire (UK census 2001). The number of traffic accidents for the East Midlands was reported to be 21,293 in 2004, approximately 7% of the total for Great Britain (DfT 2005). The Vehicle Safety Research Centre is based in the heart of the East Midlands and has easy access to all counties via the road network. The area is served by four large teaching hospitals which accept major trauma as well as other trauma receiving general hospitals. The VSRC is internationally renowned for its work in accident research. However, it has undertaken little research to identify the effect the crash or injury has had on the individuals who contribute to the studies and their potential outcomes.

3.3.1.1: The Study Sample

Sampling establishes the source of data from a population for study purposes. The population is derived from entire numbers of individuals who possess certain characteristics relevant to the study. Under this remit the population for this study was all people involved in a road traffic accident in the East Midlands. However this is a vast number, in excess of 21,000 people using 2004 figures (DfT 2005). Study of such a large sample would prove impractical given both financial and time constraints, thus necessitating the selection of a sample from the population under study. Sampling is the selection of participants which represent a subset of the target population ensuring a representative sample is obtained from which inferences can be made. Generally it is more reasonable and common to use an accessible population from which to draw the sample. However, there are no guarantees that the samples are not biased, although certain sampling techniques will render some samples as less biased. The two types of sampling techniques to remove bias are probability and non-probability sampling. Probability sampling involves a certain amount of random selection
where there is some confidence that each element of the population will be included in the sample. Non-probability sampling is the less robust method of the two and this method has no way of knowing whether each element of the population will be in the sample. Probability sampling is considered to be the only viable method of obtaining representative samples. It is less likely to produce sampling errors on any of the attributes being studied. Strictly speaking it is inappropriate to apply inferential statistics to non-probability samples. However, true randomising of the sample is not always achievable and the use of non-probability sampling is used widely. The types of non-probability sampling are convenience sampling, quota sampling and purposive sampling. Convenience sampling involves using those persons easily accessible by the researcher and will not necessarily be a typical sample. This sampling is considered to be the weakest method, however, if the phenomena under investigation are homogenous within the population, then the risk of bias will be minimised. Quota sampling identifies strata of the population and determines the proportions of elements needed from the various segments to ensure that each are represented proportionally. Purposive sampling tends to be used in qualitative research where samples are handpicked to suit the phenomena under study. They are more likely to represent good representation of the theoretical constructs of the study rather than the proper representation of the people under study.

The exploratory nature of this thesis and the accessibility to the population under study required the use of convenience sampling. Participants were accessed from existing databases at the VSRC and from the admission lists of two large teaching hospitals. They were invited to participate, thereby implying that the sample was self-selecting and may not therefore necessarily be a true representation of the target population. However, it was anticipated that they all had a common denominator of being involved in a crash and as the research is exploring the effects of the crash and injuries sustained it was considered that the sample would reflect the main constructs experienced by victims of road traffic accidents.
3.3.1.1: Sample Size

Determination of an appropriate sample size given the time constraints was considered. This research is a combination of qualitative and quantitative design being conducted by one investigator. Therefore it was considered appropriate to recruit 100 participants. In depth qualitative studies normally tend to have well under 100 participants as the researcher is usually interested in studying some phenomena intensively. Conversely, in quantitative analysis the researcher generally tests hypotheses using formal statistical procedures and small sample sizes have insufficient power to provide meaningful statistics. However, if the sample is relatively homogenous with respect to the variables under study then a small sample may be suitable.

Participant recruitment was monitored for refusal rates as well as inclusion rates, however there were ethical constraints on obtaining the characteristics of those who chose not to take part thus comparisons could not be made. Strategies to improve uptake rates were considered where possible. However as this thesis was exploring the methods used it was seen not to be appropriate to pay participants. An extension of the recruitment period was a possible consideration and this was granted so long as it fitted into the data collection time frame.

3.3.1.1: Inclusion and Exclusion Criteria

Participants were included or excluded on the following basis:

- All participants between the ages 18 to 70 years were approached to take part in the study.
- All participants had to have been involved in a road traffic accident, either as a vehicle occupant or as a vulnerable road user.
- A sound understanding and ability to converse in English was required as follow-up interviews were conducted over the telephone.
- All participants who refused to take part were excluded from the study.
- All participants who were involved in other research studies were also excluded to prevent over-burdening them.
Chapter 3: General Methodological Considerations

The age selection is bound by both tool selection and the current database information at the VSRC as questionnaires are not sent to those over 70 as a matter of course. The lower age limit was bound by the use of telephone follow-ups as younger children would require their parents to be involved. A more acceptable method for following children up is using face-to-face interviews or postal assessment where parents are present. This was considered but would have implied that a consistent methodology was not possible given the necessity for telephone follow-up of participants.

3.3.2: Ethical Considerations

The main ethical considerations for conducting research are based on the protection of human rights so as not to subject the respondents to physical harm. Also, in carrying out research there is the expectation of advancing knowledge without undertaking repeated studies on the same participants and over-burdening them (Burns and Grove 1997; Denzin 1989). This research was considered to be a subject area where very few follow-up studies have considered the quality of life following a crash related to any injury sustained. A written research proposal was submitted and approved by the Loughborough University Research and Ethics Committee to conduct the study (Appendix B). By conducting studies involving participants there are principles to uphold such as; the rights of fair treatment, rights of privacy and basic human rights.

It was suspected that this research could intrude on some personal issues and therefore privacy was guaranteed and follow-up interviews were conducted at the participants' convenience allowing them to choose their preferred time. Anonymity is a requirement for conducting research, however due to the nature of this research and the need to contact participants over time, confidentiality could be granted and anonymous data used to analyse the results. All identifying material was kept separate to any consent forms or data collection sheets in a locked drawer and alphanumeric codes were used as the only identifiers on the database.
All personal identifying information is to be shredded at the end of the study however consent forms have to be kept for seven years to meet ethical requirements.

3.3.2.1: Informed Consent

Informed consent acts to protect the researcher and participant by providing the necessary information to the participant. The participants then have time to consider the information before voluntarily consenting or declining to take part. All participants were provided with a Patient Information Sheet and Informed Consent sheet. To ensure there was an understanding of the informed consent procedure the participants were requested to sign a consent form to the effect that they understood the information given and had the chance to ask questions. The form also ensured that they were aware of their rights to withdraw at any time. It is a requirement that both the participant and the researcher sign the consent form in a face to face situation. The postal expectation ensures that the participants have understood the requirements and return either a consent form or a completed questionnaire indicating consent.

3.3.2.2: Confidentiality

The researcher is aware of the principles of the Data Protection Act of 1998 and has abided by those principles (H.M. Government 1998). All participant consent forms are filed in locked drawers that only the researcher has access to them. Where personal information (such as the contact names and addresses) are detailed these are kept separate to the consent forms and will be destroyed by the researcher at the end of the follow-up period of the research study. All participants were made aware that their non-personal information would be kept on computer prior to the obtaining of informed consent. All information entered on the computer is as impersonal datasets which is password protected. Only the researcher has access to this information.
3.3.2.3: Ethical Responsibility

The researcher is aware of the delicate nature of the information held in medical notes and only relevant information for the admission period immediately following the crash was read and injury information obtained. All participants in the research study were made aware of the fact the researcher required access to their medical records and informed consent was obtained prior to any access of notes. The researcher is aware that she had a responsibility to all of the participants to maintain their privacy and respect any information obtained during the interviews and utilise any results to enhance the knowledge of this subject area.

In conclusion the researchers' ethical obligations were to minimise bias within the research study, protect the participants from harm, respect the privacy of the respondents, maintain confidentiality and anonymity, gain informed consent and maintain uniformity in conditions throughout the research study and finally utilise the results to enhance knowledge.

3.4: Data Collection

The purpose of the research is to collect data about varying outcomes and therefore the need for appropriate tools is paramount to ensure meaningful data are obtained. The selection of the health outcome measures was guided by the currently available instruments with proven validity and reliability and availability of UK population norms published in the literature. The researcher also considered the practicality of administration, consideration for responder burden and the ability to utilise the results further for economic analysis (Gold 1996). So as not to restrict the results the need for descriptive as well as utility data was required to allow exploration for all areas under study. Thus a combination of preference and generic profile measures were chosen to best obtain the necessary data.
3.4.1: Data Collection Tools

The common health outcome measures selected were the EQ-5D (+ cognition), SF-36v2 and a study questionnaire. The health outcome measures were selected because of their reliability and validity found in other studies. They were available to the researcher and had current UK population norms. Selecting two measures would allow for both a general overview of the effects of injury across a number of health dimensions (SF-36v2) and also to obtain utility scores for further analysis (EQ-5D). A study questionnaire was also designed to obtain demographic and specific information pertinent to assess outcomes in road injury survivors.

3.4.1.1: EQ-5D (+ cognition)

The EQ-5D records the level of self reported problems on five dimensions,

- Mobility
- Self care
- Usual activities
- Pain / discomfort
- Anxiety / depression

The added dimension of cognition was also included, however this is not used for calculating index scores.

All problems are reported on a three level scale ranging from 'no problems', 'some problems' and 'severe problems' to provide a profile score (Appendix C). These were converted to health index scores using the UK value sets provided by Dolan and Gudex's (1995) study using TTO methods and standard scoring algorithms from the developers (www.euroqol.com).

The visual analogue scale was also used to generate the self-perceived level of health state on a 0-100 scale. As per the developers' protocol all respondents were asked to imagine a line like a thermometer with '0' at the bottom as the worst health state and '100' at the top as the best health state to be in. They were then asked to put themselves on that line for their health 'today'. The line was marked by the researcher to correspond to what the participant stated as being an assessment of their health state.
3.4.1.2: SF-36v2

This is a generic multipurpose health survey generating descriptive health states on eight dimensions (Appendix D);

- Physical functioning
- Role physical
- Bodily pain
- General health
- Vitality
- Social functioning
- Role emotional
- Mental health

It also allows for two summary scores to be calculated using standard scoring algorithms from the developers. These are the physical and mental health component scales (PCS and MCS) (Ware et al. 2002). These component scores summarise the data into its two underlying components which can be analysed. It was administered using the standard telephone interviewer instructions as provided by the developers (Ware et al. 2002). The norms used for comparative purposes were taken from Jenkinson et al.'s (1999) UK survey using the SF-36v2 form. However, these norms only take into account the ages 18-64 which were considered in the results. The SF-6D index scores were calculated from the SF-36v2 using Braziers' scoring algorithm (Brazier - personal communication).

3.4.1.3: Study Questionnaire

The study questionnaire was designed to collect such demographic information as age, gender, occupation and earnings. It also considered such factors as; perceived social networks, hobbies undertaken, road user type, injury information and rehabilitation (Appendix E). Other follow-up studies of trauma patients were examined and the relevant information extracted to develop a questionnaire to be used in this research. This questionnaire was designed to be semi-structured with the majority of questions being closed to
elicit such information as ‘did you receive any follow-up treatment?’ The responses to this were either ‘yes’ or ‘no’. Where the researcher wanted to elicit more detailed information, open-ended questions were used so as to allow for detailed responses to be ascertained. These included questions such as ‘what do you consider to be the major effect on your lifestyle as a result of the accident or injury?’

The study questionnaire was designed using the items identified from the literature review which had previously been considered to be important following traumatic injury. These included items of social support, leisure activities, compensation and legal issues, pain and types of rehabilitation as well as allowing for capturing of ‘problems’ encountered during recovery. Other standard questions were included to obtain demographic data and socioeconomic information.

The data provided the researcher with qualitative information to build a more in-depth picture of the participant group such that any effects following the crash could be more directly related to the participants’ usual lifestyle. For example people who were typically active play sport which in turn is their major social network, will possibly be affected more by a debilitating lower extremity injury compared to others who were less active.

Responder burden for the study was considered and the number of instruments chosen was not considered to be too demanding. The proposed interviews were to be at the convenience of the participant so that their expectation of them was assumed. Furthermore, to establish the practicalities of undertaking a follow-up study of this nature, it was considered more appropriate to undertake a wider assessment using more instruments rather than restricting an initial study of this nature.

3.4.1.4:.Data collection protocol

All questionnaires were administered by the researcher using a semi-structured technique. The health outcome measures were administered in the order of study questionnaire, SF-36v2 and EQ-5D (+cognition). Where standard health outcome measures were used the suggested protocol
administration was designed to minimise any interviewer bias and also avoid missing responses which could have rendered the data worthless in the analysis (Ware et al. 2002).

The follow-up periods for this study were as follows; baseline, three months, six months and 12 months post-injury. Those persons who could not be contacted three weeks following the specified follow-up date were considered lost to follow-up. Those participants who chose not to take part at any follow-up period were considered to have dropped out of the study. All interview schedules were entered onto a Microsoft Outlook calendar system as an appointment to ensure that accurate follow-up periods were maintained. These interviews were entered as alphanumeric codes to identify the participants to the researcher only.

3.5: Data Analysis

The data collected from the questionnaire were nominal or ordinal and were suitable for analysis using descriptive and non-parametric statistics. The data obtained from the SF-36V2 are non-interval data and as such required the use of non-parametric statistical analysis. The EQ-5D index scores are interval data and would be suited to parametric analysis, however, the data were skewed and not amenable to these more robust statistical analysis. Therefore analyses were undertaken using the Chi-squared statistic for associations between factors. Where the cell expected frequency count was less than 5 the Fishers exact test was used. The Friedman two-way analysis of ranks for multiple comparisons was used for comparisons between the participants at different follow-up periods. The Wilcoxon-Mann-Whitney U test was used for comparisons between independent groups. Statistical analysis was performed using the statistical package for social sciences version 13 (SPSS) (SPSS inc. 2005).
3.5.1: Interview Data

Content analysis was used to assess the responses of participants to the open-ended questions of the study questionnaire. Content analysis acts to summarise what is being said rather than reporting all details to allow for quantification of the underlying messages (Neuendorf 2002). Thus underlying concepts experienced by the participants were analysed using this method to allow for presentation of the results using descriptive statistics.

3.5.1.2: Injuries

All injuries sustained by the participants in this research were coded by the researcher using AIS 98, the most recent version available at the time. This allowed for injury severity to be used in the analyses and also for descriptive purposes of presenting results.

3.5.1.3: Employment

Employment was classified according to the NS-SEC 2000 categories to allow for categorising jobs and social class (Office for National Statistics 2000a). The Office of National Statistics is responsible for compiling, analysing and disseminating the UK’s social and demographic statistics. Occupational classification is one part of this and the SOC 2000 is the most up to date classification of occupations⁹ (ONS 2000b). Essentially it classifies jobs based on skill level and skill content. Skill is defined in terms of the nature and duration of the qualifications, training and work experience required to become competent to perform the associated tasks in a particular job. There are nine major groups to the classification structure. These are;

- Major Group 1 - (managers and senior officials)

Have a significant amount of knowledge and experience of the production processes and service requirements for efficient functioning of the business.

- Major Group 2 - (professional occupations)

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⁹ SOC 2000 - Standard Occupational Classification 2000
Have a degree or equivalent qualification and possibly post graduate qualifications or period of training.

- **Major Group 3** - (associate professional and technical occupations)
  Have an associated high level vocational qualification requiring training and study.

- **Major Group 4** - (administrative and secretarial occupations)
  Have a good standard of general education and some have will have vocational training as well.

- **Major Group 5** - (skilled trades and occupations)
  Have a substantial period of training usually provided by work based training programmes.

- **Major Group 6** - (personal service occupations)
  Have a good standard of general education and some will have further vocational training provided by work.

- **Major Group 7** - (sales and customer service occupations)
  General education and work based programmes related to sales. Some will also have specific technical knowledge.

- **Major Group 8** - (process, plant and machine operatives)
  Have the knowledge and experience necessary to perform the task at hand. Most will have to meet a minimum specific requirement of competence.

- **Major Group 9** - (elementary occupations)
  Will have a minimum general level of education some will have short period of training for the specific work.

**NS-SEC has replaced the original social class based on occupation and socioeconomic groups, however, it can still be used to match the occupational codes into the original social economic group classifications.**

These are:

I  Professional, etc, occupations
II Managerial and technical occupations
IIIN Skilled occupations non-manual
IIIM Skilled occupations manual
Chapter 3: General Methodological Considerations

IV  Partly skilled occupations
V  Unskilled occupations

3.5.1.4: Case Studies

Case studies are used as illustrative data to explain and enhance the subjective experiences of the participants (Gomm, Hammersley et al. 2000). There are critics who suggest that inferences cannot be made by this method, however logical arguments can be expressed by their use rather than statistical methods (Yin, Campbell et al. 1994). Case study research in its truest social science setting is complex, in-depth and prone to arguments when used to generalise the findings in comparison to social surveys (Yin et al. 1994). Its use as a demonstrative tool to see how particular ‘cases’ fit into the general survey results is valuable in the understanding of the effects on individuals who are not explored in minute detail within the survey structure. Arguments as to the generalisability are somewhat unnecessary in the context of this research as case studies will be included at a basic level in order to provide illustrative and pertinent data experienced by participants. Case studies for participants in Study 1 and Study 2 are presented in appendix F for illustrative purposes of the data at an individual level.
Chapter Four: Follow-up Study of Participants Involved in a Road Crash Using a Postal Recruitment Procedure
Chapter 4: Study 1 - Follow-up study of participants involved in a road crash using a postal recruitment procedure

4.1: Introduction

At the VSRC there are a number of existing databases that have been compiled from ongoing studies such as the Cooperative Crash Injury Study (CCIS) and the On the Spot Study (OTS). The intention of both studies is to gather pertinent accident data related to the crash. The CCIS and OTS studies have slightly different objectives although both are funded by the UK Department for Transport to support road and vehicle safety policy. These databases were used to recruit participants for Study 1.

4.1.1: Co-operative Crash Injury Study (CCIS)

The CCIS study was set up in 1983 and is Europe’s largest study which is specifically aimed at determining causes of car occupant injury. Over 1,300 crashes are investigated each year. The CCIS study utilises a stratified sampling system and takes into account the UK Government accident classification system whereby 'slight', 'serious' and 'fatal' accidents are used. The CCIS study over-emphasises fatal and serious crashes since these cases provide maximum value in terms of information of use to the UK Government and vehicle manufacturing industry.

The study provides an in-depth analysis of the crash and subsequent injuries on a retrospective basis. Vehicles are examined at recovery garages to assess vehicle damage, use of restraints, enhanced safety systems such as airbags or seat belt pretensioners and other pertinent factors. Injury information is also collected including hospital medical notes and information obtained from questionnaires (which are sent to the majority of persons involved). Injuries in the CCIS are coded to AIS 90 to allow for analysis purposes (AAAM 1990).

The main objectives of CCIS are to provide detailed crashworthiness of vehicles, the effectiveness of safety countermeasures, such as airbags,
are at reducing injury and to determine injury biomechanics. Ultimately
the data gathered in this study assist the UK Government and vehicle
manufacturers in understanding how injury prevention can be achieved in
vehicle crashes.

4.1.2: The On the Spot Study (OTS)

This study was set up in the UK in 2000 at both the VSRC and Transport
Research Laboratory (TRL) to investigate crashes at the scene using in-
dept methods. This was in response to the UK Department for
Transport's requirement to understand more about crash causation
factors in UK road accidents. Notably, the most effective way to obtain
quality crash data is by attending the scene immediately after the crash
ensuring all volatile aspects relating to the crash are measured and
recorded at the time and immediate responses from those involved can
also be obtained (Cuerden, Hunt et al. 2003, Hill, Cuerden et al. 2005).
The OTS study has teams of crash investigators based in
Nottinghamshire and the Thames Valley. Both have the assistance of a
police driver and police vehicle as well as access to the police radio
network for crash notification. The protocol ensures that the investigating
crash teams attend the crash scene within 15 minutes of the crash. This
ensures that volatile information from the scene is not lost, such as;
recording of weather conditions, visibility, road conditions and vehicle /
person post-crash rest positions.

Once at the scene the crash investigators collect the relevant data for the
following;

- Vehicles – any damage, where they came to rest, failures and
  likely contribution to the crash
- Highway – design, features, condition, maintenance,
- Human Factors – all persons involved, training of the person,
  experience and user aspects which may have influenced the crash
- Injuries
- Other – such as weather conditions
Further information is sought from those persons involved and questionnaires are sent out where appropriate to complete the data collection. Injuries are also confirmed at a later date with medical records, coroners’ reports and information obtained from the questionnaires. The injuries are subsequently coded using the Abbreviated Injury Scale 90 revision.

The study is relatively new in that only some five years of data are available. A complete analytical overview has not yet been undertaken. However, the data are proposed to be particularly beneficial for determining causation factors and possible countermeasures.

The wealth of information gathered in both the CCIS and OTS studies regarding the individual and their injuries tends to end without any understanding of the true effects of the crash are on those involved. This present study is therefore aiming to contribute new knowledge to both of these crash studies of how the injury or crash may affect the individual and their families in terms of physical and / or psychological consequences.

4.2: Aim and Objectives of Study 1

The aim of Study 1 is to assess the impact that a road crash has on an individual in terms of psychological and physical outcomes. This also includes the implications for an individual's immediate family.

4.2.1: Specific Study Objectives

- To recruit and follow-up a convenience sample of participants from a self-selecting cohort of individuals involved in a crash over a 12 month period.
- Explore the major effects of the injury or crash on individuals and any consequent effects on the family over a 12 month period
- Determine those factors which contribute to a good or bad outcome
Chapter 4: Study 1 - Follow-up study of participants involved in a road crash using a postal recruitment procedure

- To provide an understanding of these effects and contribute to the existing knowledge in the VSRC
- To examine the financial burden experienced by individuals as a direct result of the crash

4.3: Specific Methods

An application was made to the Research and Ethics Committee at Loughborough University and approval granted to conduct the study. Permission was also sought and granted from the copyright holders of the SF-36V2 and the business group EuroQol (EQ-5D) to use their forms in this research.

Study 1 is a prospective cohort study following participants through from recruitment to 12 months post crash.

4.3.1: Sample Population

All persons sent a questionnaire as a result of being in the CCIS and OTS studies in the East Midlands comprised the study population. It was a self-selecting convenience sample from those persons returning the original CCIS and OTS questionnaires. The only exclusion criteria enforced were either that the participant was aged over 70 years at the time of the crash or if it was a fatal crash (thus no questionnaire is sent as a matter of routine). The level of spoken English could not be determined by the Centre study questionnaires until initial telephone contact could be made.
4.3.2: Recruitment of Participants

Participants were recruited from the CCIS and OTS questionnaire returns. That is, they indicated they were willing to receive further contact from the Centre. Those persons who responded positively were sent an information sheet, a consent form and a pre-paid return envelope about the follow-up study (Appendix G). Reminders were sent two weeks later if no information had been received by the researcher. Recruitment commenced in January 2003 and ended mid-December 2003. It was originally intended to recruit participants over a three month period, however the returns were poor, even with reminder letters being sent out. A total of 78 letters and consent forms went out from the January to end of May with a response rate of 44% (n=34). In response to this, from the beginning of June 2003, changes were made to the recruitment of participants. This involved the inclusion of a letter with the questionnaires asking if they would be willing to talk to a researcher about their crash (Appendix H). This went someway in improving initial responses. However, when the study was explained further and permission sought to conduct an interview and subsequent follow-up interviews, many were happy to have the initial interview but not a following one. These tended to be the persons who considered the crash or the injury to be of no major concern to them. Those who had an apparent problem were happy to have follow-up interviews whilst the problem was ongoing. A total of 164 questionnaires including the study letter were sent out between June 1st and 11th December 2003 from which there was a 26% return rate (n=42).

4.3.3: Data Collection Procedures

Telephone interviews were conducted at the participant’s convenience as indicated by the reply forms, the majority of which were in the evenings. It was originally estimated that interviews would take 20 minutes. However, in fact they ranged between 15 and 45 minutes depending on the participant. A strict interview schedule was adhered to ensuring
compatibility of results and reducing bias between participants by changing the interview order. The recruitment study form was administered first, followed by the SF-36V2 and lastly the EQ-5D (+cognition). The latter two interview scripts followed the recommended format of their developers (Ware et al. 2002). The interview around the study questionnaire was semi-structured which allowed for further enquiries to be made and any issues elaborated.

Study codes were assigned to individual participants and data entered onto a database as anonymous datasets. Consent forms were kept in a locked drawer as per study protocol. Injuries were recorded from information obtained during the interview and were corroborated by medical records obtained by the VSRC.

4.3.4: Coding of Injuries

All injuries were coded to AIS 98 and an ISS calculated for each participant as well as recording the MAIS for each body region. The number of injuries were also noted and for the purposes of the study the most ‘severe’ or problematic injury was noted for analysis purposes. For example if the participant had three AIS 2 injuries then the injury which they perceived to be the ‘worst’ for them was used for determining the main body region injured.

It was noted that this recruitment method using postal means resulted in baseline interviews that were at least three weeks post crash and not necessarily a true baseline of the participants' abilities post crash. Again, there were many participants with minor or no injuries who recovered within 12 months. Many of these were reluctant to participate in further interviews. Therefore, data collection stopped when the participant claimed full recovery and as such became a 'drop-out'. These participants were classified as being recovered rather than a ‘drop out’ as a result of non-compliance or non-contactable.
4.3.5: Data Analysis

Non-parametric statistics were used to analyse the data as they did not meet the criteria for using parametric statistics. Statistical tests used were the Chi-squared, Fishers exact, Freidman analysis of variance and the Wilcoxon rank test and where appropriate corrections for multiple comparisons were made. This correction factor was the conservative measure of Bonferroni inequality to ensure the error rate for all comparisons was at \( \alpha \) per experiment (Knapp 1985). Therefore instead of using \( p=0.05 \), a conservative value of \( p=0.05 \) divided by the number of comparisons was used (MacArthur and Jackson 1984).

Content analysis was used to examine the interview data and categorise the responses into a suitable format for analysis. Those people who were lost to follow-up or dropped out of the sample at varying follow-up times were compared to the baseline sample to examine any differences. Attrition rates were recorded at each stage of the follow-up period. All subsequent data were entered onto the database.

Data were analysed for each follow-up period and changes from the previous follow-up period were examined for improvements or decline in health status. Finally an analysis of the data as a whole was undertaken to examine the time series effects of the changes and to plot these for the different time points.

The results for Study 1 are presented separately for each follow-up period in separate subsequent chapters.
4.4: Study 1: Results at Baseline

The results for the baseline assessment are presented below for all data obtained at the initial baseline interview using the study questionnaire and health outcome measures.

4.4.1: The Sample

A total of 185 people were contacted by letter from which 76 participants had an initial interview (41%), some participants were contacted but not interviewed at baseline due to a poor understanding of spoken English or lack of comprehension about what the study involved. Of those interviewed it was found that six had not sustained any injuries in the crash, these were removed from the overall analysis to ensure that all comparisons could be made on an injured population. Interviews on average took place 47 days after the crash; the minimum being 14 days and maximum 142 days post crash (median 44 days).

Fifty three percent of the group were males (n=37) with a mean age of 39 years (median 39, range 18 -70 years). Forty seven percent were single; 47% married, and the remainder either separated or widowed. Some 67% lived with a partner or spouse, 14% lived alone and 17% with friends or other relatives.

Assessment of education level at baseline indicated that the sample was approximately divided into thirds for; senior school attendance only (36%), further education to college level (30%), and further education for university attendance (34%).

It was perceived that the majority had good support from family and friends (73%), some 18.5% from family alone and 8.5% from friends only. No one in the sample perceived themselves to have an overall poor support level from any direction.

4.4.2: Employment

The majority of the sample was employed either full or part time (74%), as shown in table 4.1.
Table 4.1: Employment status at baseline

<table>
<thead>
<tr>
<th></th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time</td>
<td>43</td>
<td>61%</td>
</tr>
<tr>
<td>Part time</td>
<td>9</td>
<td>13%</td>
</tr>
<tr>
<td>Student full time</td>
<td>5</td>
<td>7%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>6</td>
<td>9%</td>
</tr>
<tr>
<td>House duty</td>
<td>2</td>
<td>3%</td>
</tr>
<tr>
<td>Retired</td>
<td>4</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>

Unemployed people were split between long-term (n=4) and short term (n=2) unemployed. One of the long-term unemployed did not work due to a history of depression. The remaining two in this group had been made redundant; one of the redundancies was due to long term sickness due to a back problem.

Typical activities at work / day time were broken down into various activities for which the majority stated they were semi-active on a daily basis (43%, n=30) (table 4.2).

Table 4.2: Typical work activities at baseline

<table>
<thead>
<tr>
<th></th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>8</td>
<td>11%</td>
</tr>
<tr>
<td>Office based</td>
<td>16</td>
<td>23%</td>
</tr>
<tr>
<td>Active</td>
<td>6</td>
<td>9%</td>
</tr>
<tr>
<td>Semi active</td>
<td>30</td>
<td>43%</td>
</tr>
<tr>
<td>Sedentary</td>
<td>10</td>
<td>14%</td>
</tr>
</tbody>
</table>

The distribution of occupations and the approximated social class groups are presented in tables 4.3 and 4.4. The majority of the workers were in non-manual employment, either at the intermediate or junior level (40%). These occupations were typically office workers, such as personnel or wages clerks. The main social class represented in this sample was social class II (managerial and technical 36%) although the combined social class III of skilled workers made up 31% of the sample distribution. The unclassifiable participants included unemployed or housewives and students.
Table 4.3: NS-SEC (2000) classification of occupations

<table>
<thead>
<tr>
<th></th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers large companies</td>
<td>2</td>
<td>3%</td>
</tr>
<tr>
<td>Employers industry small establishments</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Managers small companies</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Self employed professional workers</td>
<td>1</td>
<td>1.5%</td>
</tr>
<tr>
<td>Professional workers employees</td>
<td>6</td>
<td>9%</td>
</tr>
<tr>
<td>Intermediate non manual workers ancillary works</td>
<td>19</td>
<td>27%</td>
</tr>
<tr>
<td>Junior non manual workers</td>
<td>9</td>
<td>13%</td>
</tr>
<tr>
<td>Skilled manual workers</td>
<td>5</td>
<td>7%</td>
</tr>
<tr>
<td>Semi skilled manual workers</td>
<td>5</td>
<td>7%</td>
</tr>
<tr>
<td>Unskilled manual workers</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Own account workers other than professionals</td>
<td>4</td>
<td>6%</td>
</tr>
<tr>
<td>Armed forces</td>
<td>1</td>
<td>1.5%</td>
</tr>
<tr>
<td>Unclassifiable</td>
<td>9</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 4.4: Social class approximations

<table>
<thead>
<tr>
<th></th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional occupations</td>
<td>Social class I 5</td>
<td>7%</td>
</tr>
<tr>
<td>Managerial and technical occupations</td>
<td>Social class II 25</td>
<td>36%</td>
</tr>
<tr>
<td>Skilled occupations non manual</td>
<td>Social class IIIa 14</td>
<td>20%</td>
</tr>
<tr>
<td>Skilled occupations manual</td>
<td>Social class IIIb 8</td>
<td>11%</td>
</tr>
<tr>
<td>Partly skilled occupations</td>
<td>Social class IV 4</td>
<td>6%</td>
</tr>
<tr>
<td>Unskilled occupations</td>
<td>Social class V 4</td>
<td>6%</td>
</tr>
<tr>
<td>Unclassifiable</td>
<td>10</td>
<td>14%</td>
</tr>
</tbody>
</table>
The unclassifiable category included the long term unemployed, students and housewives.

4.4.3: Wages

Earnings were categorised into wage ranges, the median wage earned was £16,000-£20,999. This compares to the current UK national average of £22,411 (http://money.guardian.co.uk/news_/story/html, 16.02.2005). Forty six percent (n=32) stated they were the main wage earner and 11% stated they were equal with their partner.

<table>
<thead>
<tr>
<th>Wage Bracket</th>
<th>Number (N=70)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No wages</td>
<td>11</td>
<td>16%</td>
</tr>
<tr>
<td>Less than £10,999</td>
<td>5</td>
<td>7%</td>
</tr>
<tr>
<td>£11,000 - £15,999</td>
<td>15</td>
<td>21%</td>
</tr>
<tr>
<td>£16,000 - £20,999</td>
<td>12</td>
<td>17%</td>
</tr>
<tr>
<td>£21,000 - £25,999</td>
<td>10</td>
<td>14%</td>
</tr>
<tr>
<td>£26,000 - £35,999</td>
<td>11</td>
<td>16%</td>
</tr>
<tr>
<td>More than £36,000</td>
<td>6</td>
<td>8%</td>
</tr>
</tbody>
</table>

4.4.4: Benefits

Six of the sample claimed benefits other than the child benefit entitlement open to everyone with children. Of the six who claimed benefit and also were unemployed, two were on job seekers allowance, one on incapacity benefit, one on income support with the other two not receiving any benefit payments and being supported by their partners.

4.4.5: Hobbies

The majority of the sample took part in physical activities on a weekly basis (60% n=42), 56% regularly did house chores and 60% regularly did general duties such as gardening and shopping.
Hobbies covered a range of activities the majority of which were sporting in nature some 17 people stated up to two different hobbies, 19 had three hobbies and one person stated 4 hobbies regularly undertaken. Thirteen people stated they did not partake in any hobbies at all.

<table>
<thead>
<tr>
<th>HOBBIES</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hobbies</td>
<td>13</td>
</tr>
<tr>
<td>Gym</td>
<td>12</td>
</tr>
<tr>
<td>Team sports</td>
<td>10</td>
</tr>
<tr>
<td>Running</td>
<td>5</td>
</tr>
<tr>
<td>Swimming</td>
<td>8</td>
</tr>
<tr>
<td>Cycling</td>
<td>4</td>
</tr>
<tr>
<td>Sports other (horse riding, scuba diving, sailing rock climbing etc)</td>
<td>19</td>
</tr>
<tr>
<td>Musical instruments</td>
<td>3</td>
</tr>
<tr>
<td>Driving / motorbikes</td>
<td>4</td>
</tr>
<tr>
<td>Gardening</td>
<td>4</td>
</tr>
<tr>
<td>Sedentary (reading / calligraphy etc)</td>
<td>4</td>
</tr>
<tr>
<td>Other interests (dog training, acting, DIY)</td>
<td>7</td>
</tr>
</tbody>
</table>

### 4.4.6: Pre-existing Health Problems

Twenty participants (29%) stated they had pre-existing health problems of which 13 were on some form of prescribed medication prior to the crash. One person stated they had two health problems prior to the crash these were hypertension and arthritis*.

<table>
<thead>
<tr>
<th>HEALTH PROBLEM</th>
<th>NUMBER (N=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>4</td>
</tr>
<tr>
<td>Arthritis*</td>
<td>3</td>
</tr>
<tr>
<td>Hypertension*</td>
<td>4</td>
</tr>
<tr>
<td>Back problems</td>
<td>5</td>
</tr>
<tr>
<td>Depression</td>
<td>2</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>1</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>1</td>
</tr>
<tr>
<td>Old knee injury</td>
<td>1</td>
</tr>
<tr>
<td>None</td>
<td>50</td>
</tr>
</tbody>
</table>
Chapter 4: Study 1 - Follow-up study of participants involved in a road crash using a postal recruitment procedure

Thirteen people took regular medication for their health problems which mirrored the types of health problems in table 4.8. One person was on two different medications.

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>NUMBER (N=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antihypertensives</td>
<td>3</td>
</tr>
<tr>
<td>Water tablets</td>
<td>1</td>
</tr>
<tr>
<td>Warfarin</td>
<td>1</td>
</tr>
<tr>
<td>Cancer drugs*</td>
<td>1</td>
</tr>
<tr>
<td>Asthma</td>
<td>4</td>
</tr>
<tr>
<td>Analgesics</td>
<td>1</td>
</tr>
<tr>
<td>Antidepressants*</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>57</td>
</tr>
</tbody>
</table>

Only one person stated they had a level of impairment prior to the crash which was numbness in the legs as a result of a previous back injury.

4.5: The Crash and Immediate Consequences

The main road user type in Study 1 was car-driver (77%), whilst 14% were car passengers and 8% vulnerable road users, (table 4.9).

<table>
<thead>
<tr>
<th>ROAD USER</th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td>54</td>
<td>77%</td>
</tr>
<tr>
<td>Front seat passenger</td>
<td>7</td>
<td>10%</td>
</tr>
<tr>
<td>Back seat passenger (behind driver)</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Back seat passenger (behind passenger)</td>
<td>2</td>
<td>3%</td>
</tr>
<tr>
<td>Motorcycle driver</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Motorcycle pillion</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Cyclist</td>
<td>2</td>
<td>3%</td>
</tr>
</tbody>
</table>

The worst or more problematic injury for participants was coded and subsequently classed as the main body region injured. The main body regions injured were the neck (cervical spine), upper and lower extremities and the thorax.
Overall, a total of 244 injuries were sustained by the 70 participants. The mean number sustained was three injuries. The majority of injuries were AIS 1 injuries (74%) such as bruising and whiplash injury. The Maximum Abbreviated Injury Score (MAIS) was four and the highest ISS contained in this group was 17 indicative of major trauma status (figures 4.2, 4.3).
Cumulative percentage of ISS scores are presented in figure 4.3. As can be seen, 76% of participants had an ISS of three or less, indicative of minor injuries. Ninety six percent scored nine or less and only one scored a high ISS of 17 indicative of major trauma. This participant had chest injuries, minor grazes and bruising to the legs.

Figure 4.3: Cumulative distribution of ISS scores

Following the crash, a total of 59 participants (82%) attended Accident and Emergency only and 11 participants were (18%) admitted into hospital. The mean length of stay was 12 days (the median was 2 days) but this was largely due to one person spending 35 days in hospital. This person sustained a fractured calcaneus and rib fractures. No persons were admitted to intensive care.

All persons were discharged home without exception with the majority (77%) referred or self-referred for follow-up treatment to one or more disciplines, table 4.10.
Table 4.10: Distribution of follow-up treatment

<table>
<thead>
<tr>
<th>FOLLOW-UP TREATMENT</th>
<th>NUMBER (N=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient follow-up</td>
<td>18</td>
</tr>
<tr>
<td>Physiotherapy</td>
<td>13</td>
</tr>
<tr>
<td>General practitioner</td>
<td>42</td>
</tr>
<tr>
<td>Occupational therapy</td>
<td>1</td>
</tr>
<tr>
<td>District nurse</td>
<td>1</td>
</tr>
<tr>
<td>Osteopath</td>
<td>1</td>
</tr>
</tbody>
</table>

4.6: Health Outcome Measures

4.6.1: EQ-5D (+ cognition)

For each health domain there is an option for individuals to assign themselves to one of three categories in response to their perceived health status to develop a profile. Thus a profile of 112311 would represent an individual with no mobility problems, no problems with self care, some problems performing usual activities, extreme pain or discomfort, no anxiety or depression and no problems with cognition.

There were 24% (n=17) who scored a profile of 111111 and none scoring a profile at the 333333 level. The cumulative levels of problems within the domains are presented below in figure 4.4. The majority of individuals had at least moderate-to-severe pain or discomfort (71%). Many had some or severe problems in performing usual activities (60%). Over half had some or severe levels of anxiety or depression (54%) and 31% had some or severe mobility problems.
Overall 12 (17%) scored at least one level 3 (severe) problem in one or more domains at baseline.

The baseline mean scores for the visual analogue scale (VAS) were found to be 68 on a 0-100 scale (range 4-100, median 70). The developers of the EQ-5D also have an algorithm to convert the profile scores into a utility score with a maximum value of 1, based on the five domains not including the cognition domain. Mean overall utility score at baseline was 0.68, ranging between -0.07 and 1.0. The negative ratings equate to states (n=2) worse than death although this is not necessarily what the participants actually mean. One had a health profile of 22332 which implies some problems walking about, some problems washing and dressing self, unable to perform usual activities, extreme pain and discomfort and moderate anxiety or depression. This person also rated themselves as '4' on the VAS. Their injuries included fractured patella and they had an injury profile of MAIS 2 and ISS 3. The second person had a profile of 21233 which implies some problems walking about, no problems with self care, some problems performing usual activity, extreme pain and extreme anxiety and depression. Their injuries included whiplash, bruises and abrasions to the chest and abdomen and they had an injury profile of MAIS 1 and ISS 2.
The EQ-5D utility scores at baseline were significantly different to a matched UK norm sample for age and gender (p=<0.0001).

4.6.2: SF-36v2

The SF-36v2 was scored according to the scoring algorithms and the dimension scores are presented in figure 4.5. Data were compared with matched age and gender (UK SF-36v2 norms) using Wilcoxon signed ranks test for paired comparisons. A correction factor for the number of ties was added to give a p-value of 0.006 for the level of significance (0.05/8). There were very significant differences between the UK norms and the baseline sample for all of the dimensions except general health and role emotional (p=0.064 and p=0.008 respectively).

Figure 4.5: Mean health dimension scores for the SF-36v2

![Figure 4.5: Mean health dimension scores for the SF-36v2](image)

PF - physical function; RP - role physical; BP - bodily pain; GH - general health; VT - vitality; SF - social function; RE - role emotional; MH - mental health

The physical component score was also found to be very significantly different at baseline to the UK norms (p=<0.0001), as was the mental health component score (p=0.002 Figure 4.6).
Chapter 4: Study 1 - Follow-up study of participants involved in a road crash using a postal recruitment procedure

Figure 4.6: Mean component scores for the SF-36v2

General health was also assessed at baseline and comparisons made between health 'now' compared to 'one year ago', Tables 4.11 and 4.12.

The majority of the sample considered their health to be very good or excellent (69%) and only 4% rated themselves as having 'fair' health. When asked to compare their health with one year ago 40% stated it was 'somewhat or much worse' now.

Table 4.11: Perceived general health

<table>
<thead>
<tr>
<th>CURRENT GENERAL HEALTH</th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Very good</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Good</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Fair</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.12: Perceived health state compared to one year ago

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=70)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>About the same</td>
<td>36</td>
<td>51</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Much worse</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>
At baseline it was interesting to note these differences between the UK norms and this data sample. The EQ-5D scores were expected to be somewhat lower as they take into account the health state for one particular day compared to the SF-36v2 which includes the previous four weeks. The SF-36v2 scores were considerably lower which is indicative of the fact that initial baseline interviews for this sample group were on average 47 days after the crash event which precludes the pre crash event.
Chapter Five: Study 1
Three Month Follow-up Data
Chapter 5: Study 1 - Three month follow-up data

5.1: Introduction

This chapter presents the results from the three month follow-up interviews using the study questionnaire and health outcome measures.

All participants were contacted at three months following the crash by the researcher rather than three months after the initial interview. This was to ensure that data could be compared with data from other studies at the same time point. These interviews were conducted by telephone and followed the same interview protocol as the baseline interview to ensure continuity and minimise any bias in the interview questionnaire order. The interviews usually lasted between 30 - 50 minutes; some were shorter but the ability to talk about the crash and subsequent discomforts tended to prolong the interview to more than was originally proposed. The majority of participants were contacted within one week of the three month date, however a further two weeks were given on top of this to maximise the opportunity.

5.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop-outs were compared to the remaining sample at three months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann-Whitney U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36V2 dimension and component scores between baseline and 3 months. Content analysis was used to categorise interview responses into a format for data analysis.
5.3: Results

5.3.1: Attrition

At three months, a total of seven people dropped out of the sample, of which four stated they were recovered and reluctant to continue with an interview. The remaining three could not be contacted on numerous occasions. The drop-outs at three months were compared to the remaining sample using Fishers exact test or Chi-squared for nominal data and Mann-Whitney U test statistics for independent groups for ordinal data. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus the groups can be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

<table>
<thead>
<tr>
<th>Table 5.1: Drop-outs at 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Age (mean years)</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wage brackets (median)</td>
</tr>
<tr>
<td>MAIS</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The data were examined for any changes in lifestyle, personal circumstances, employment, health and any knock-on effects of the crash or injury. A summary of the changes that are a result of the crash at three months are presented below in table 5.2 and discussed.
5.3.2: Personal Circumstances

Overall 91% of the sample group stated they were in good general health (n=57) at three months. There were no changes recorded for marital status or living arrangements at this follow-up stage in the study.

**Lifestyle**

At three months, 14% stated they could not manage their daily routine (n=10), 27% (n=17) stated they did not do their usual house duties and again 27% stated they did not undertake their normal general duties. Some 46% (n=29) could not undertake at least one of their hobbies at three months as a result of their injuries; these tended to be sports oriented.

There were some changes to the social contact for some of the sample, 16% saw their friends less than before the crash (n=11) either as a result of the injury and wanting to be at home or not being able to get out due to loss of transport. This coincided with a decline in telephone contact with friends for six people (10%) because the necessity of arranging a social event had been removed due to the injury sustained. In contrast, contact with family tended to be more frequent as a result of the injury or crash with four (6%) seeing their family more often and three (5%) speaking to them more often on the telephone.

5.3.3: Employment

At three months, 89% of the sample had returned to work (or normal everyday activity). Of these, 75% stated they were fully active at work (n=47). The remaining 14% (n=9) stated they were back at work but were restricted in their activities. Seven people were unable to work at three months due to their injuries.

Sixty four percent took time off sick from work or from full time education, 22% didn't take time off from work and for nine it was not applicable. The sick time taken for the students involved was two days for the medical student and 28
days for the conservation student whose asthma was exacerbated by injuries to her ribs thereby excluding her from physical aspects of her course. Twenty four percent of the sample had changes from their normal baseline activity, including those unable to work. This activity change included passing particular tasks on to others which caused pain or discomfort such as lifting heavy weights, sitting in one position, physical activity or activities requiring kneeling. Some 12% of the samples' employment hours were different from baseline with seven unable to work due to their injuries and one did not undertake their normal overtime. Wages were affected for four people (6%) with losses of overtime / commission being incurred. One person incurred a drop in wages and was therefore not the main wage earner at three months in the household; his wife had taken over this role. One person had applied for incapacity benefit at the present time as they were unable to look for gainful employment due to their injuries.

A total of 40 people (64%) had time off sick from work, the mean days being 34, (median 20.5 and range 1 - 91 days). Eight people were still off sick at the 3 month follow-up period. Forty six percent (n=30) received sick pay from their employer schemes and 3% statutory sick pay (n=2). Seven did not receive any payment at all due to being either self employed, students or casual employees whose employers did not pay national insurance for them (thus disqualifying them from statutory sick pay).

Table 5.2: Changes in employment from baseline to 3 month follow-up

<table>
<thead>
<tr>
<th>EMPLOYMENT ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment hours</td>
<td>13%</td>
<td>8</td>
</tr>
<tr>
<td>Typical activities</td>
<td>24%</td>
<td>15</td>
</tr>
<tr>
<td>Wage changes</td>
<td>6%</td>
<td>4</td>
</tr>
<tr>
<td>Off sick</td>
<td>64%</td>
<td>40</td>
</tr>
<tr>
<td>Off duties (if not working)</td>
<td>16%</td>
<td>10</td>
</tr>
<tr>
<td>Received sick pay</td>
<td>46%</td>
<td>32</td>
</tr>
<tr>
<td>Received statutory sick pay</td>
<td>3%</td>
<td>2</td>
</tr>
<tr>
<td>Returned to work / duties</td>
<td>89%</td>
<td>56</td>
</tr>
<tr>
<td>(not necessarily full duties)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.3.4: Health Impacts

At three months, 13% (n=8) of the sample claimed some form of physical impairment different from baseline. The main types of impairment were loss of range of movement for joints (in three people), one who could not straighten their limb, one who could not kneel, one who had a limp and another who had difficulty swallowing. Seven people (11%) claimed some form of sensory impairment and three of these also had a physical impairment. The main sensory impairments were pins and needles (paresthesia) and numbness. Pain was also a major factor at three months for 38 of the sample (60%). Seventeen participants were on medication, 15 of which were taking analgesics on a regular basis as a direct result of their injury. The other two participants on medication were taking prescribed antidepressants, whereas they previously had no history of such a requirement. Two people required walking aids at three months. One had a fractured talus and the other a fracture-dislocation of the big toe. One further person had a splint in situ for their wrist fracture.

Table 5.3: Changes in health impacts at 3 months

<table>
<thead>
<tr>
<th>HEALTH IMPACT</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>13%</td>
<td>8</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>11%</td>
<td>7</td>
</tr>
<tr>
<td>Pain</td>
<td>60%</td>
<td>38</td>
</tr>
<tr>
<td>Medication</td>
<td>27%</td>
<td>17</td>
</tr>
<tr>
<td>Aids / splints</td>
<td>5%</td>
<td>3</td>
</tr>
<tr>
<td>Require further surgery</td>
<td>4%</td>
<td>3</td>
</tr>
<tr>
<td>Relatives took time off initially to look after them</td>
<td>19%</td>
<td>12</td>
</tr>
<tr>
<td>Receiving rehabilitation at 3 months</td>
<td>16%</td>
<td>10</td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>10%</td>
<td>6</td>
</tr>
</tbody>
</table>

Three people were expecting to have further surgery in the future for their original injuries but were being managed conservatively by their consultants
for the interim period. No persons were readmitted to hospital in the three month period. Of those still receiving rehabilitation at three months, physiotherapy was the main type and two were paying privately to visit a chiropractor and osteopath. Nobody was receiving any outside help with care, either at home or in a rehabilitation setting.

5.3.5: Insurance and Litigation

When asked, the sample stated that in 73% of cases they expected their insurance companies to pay out for the crash of which 86% of these had received their settlement at three months. At this point, 64% were involved in solicitor compensation claims of which two were likely to be sued or shown to be at fault for the crash and consequently did not expect any payouts.

Table 5.4: Legal and insurance compensation

<table>
<thead>
<tr>
<th></th>
<th>PERCENTAGE</th>
<th>NUMBER (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court proceedings</td>
<td>64%</td>
<td>40</td>
</tr>
<tr>
<td>Expect compensation</td>
<td>60%</td>
<td>38</td>
</tr>
<tr>
<td>Expect insurance to payout</td>
<td>76%</td>
<td>48*</td>
</tr>
<tr>
<td>Insurance paid</td>
<td>79%</td>
<td>41 (n=52*)</td>
</tr>
</tbody>
</table>

5.3.6: Financial Burden

Eighty percent of the sample (n=51) stated they were experiencing financial burden as a result of the crash / injury. Of the 14 who stated they had no financial burden, two did lose money from paying the policy excess and there was an expectation of losing their no claims bonus in the next insurance premium but these were not significant sums for them. The range of financial losses were £45 to £15,500, mean loss was £2,467.35 and median loss was £1,500. The financial burden experienced was not necessarily a strain on the individual, although for some it was a strain and subsequently was considered by these to be a major effect of the crash. The type of financial burden experienced by the individual was categorised and presented below in figure 5.1.
Figure 5.1: Types of financial costs incurred by the sample group

Over half of the costs incurred were for replacing or repairing the vehicles involved in the crash and the cost of insurance policies. The policy excess was the main insurance cost along with the expected loss of no claims bonuses in the next premium. There were also problems relating to the actual monetary value paid out by the insurance company and the deficit in the cost of buying a new vehicle. Some people opted to replace the model of vehicle they crashed, whereas others opted for more safety features in a newer model and were willing to pay the large deficit between the two. One person who lost out the most financially was a young person with a new sports car on financial credit who was only third party insured. This resulted in him losing his car and being left with considerable debt (£15,500) for the crashed car. The health costs were for prescriptions or private treatment such as physiotherapy, chiropractor or osteopath treatment. The 'other' costs incurred included extra telephone calls for sorting out insurance claims, attendance on a police driving course (instead of facing prosecution for careless driving), and extra bills associated with interest accrued on credit cards whilst not earning usual wages. The loss of wages category includes total loss of wages as well
as loss of overtime and reduced earnings for sick pay. One person's financial burden for loss of wages was £45 for one day's work which for him was a substantial amount to lose.

5.3.7: Major Effects

The majority of the sample (95%, n=60) stated that the crash or injury had at least one major effect on them. The effects were categorised into distinct groups, for example some effects were related to driving behaviour or financial difficulties and these are illustrated below in figure 5.2. As can be seen from the diagram there were overlapping categories, particularly the psychological impact into emotions, finance and to some extent into driving.

**Figure 5.2: Categorised major effects of the sample**

- **Financial**
  - Hire car fees
  - Repairs not covered by insurance
  - Replacing car - insurance deficit costs
  - Finance agreements - and loss of car
  - Stress - money worries
  
  
- **Psychological**
  - Flashbacks
  - Depression
  - Panic attacks
  - Mood changes - irritable
  - Memory affected
  - Dreams
  
- **Emotions**
  - Stuck can't move on
  - Loss of focus / commitment
  - Self esteem - confidence
  - Anxious passenger now
  - Anxiety for passengers in car
  - Feel vulnerable in the car
  - What could have happened
  - Aware of own mortality
  - Initial shock of what happened
  - Fatality in other vehicle

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Driving (n=35)
- Nervousness about driving
- Frightened to go out alone on bike
- Cautious more aware in same situations
- Expect the worst from other drivers on the road
- Bought a safer car
- Driving an automatic car due to injuries
- Become a safer driver - considerate / slower
- Unable to do normal everyday activities
- Inconvenience of no car - to get to work,
- socialise
- Work affected by injury
- Unable to do sporting hobbies

Social (n=36)
- Reliance on others for transport or help

Functioning (n=8)
- Loss of mobility
- Loss of fitness
- Time to heal

Health (n=21)
- Physical symptoms
- Constant pain
- Secondary problems
- Being sued
- Changed life completely

Other (n=10)
- Husband now in care unable to look after at home
- Compensation dragging on
- Injuries changed husband mentally

No effects (n=3)
5.4: Health Outcome Measures

5.4.1: EQ-5D (+cognition)

A total of 24 (38%) had a profile of 11111(1) compared to 17 (24%) at baseline having that profile. No persons had a floor effect of a 33333(3) profile. There were four people scoring at least one three on their health profile at three months compared to 15 at baseline. Most health domains improved, except for usual activities and cognition. Some participants were finding undertaking tasks such as housework or gardening to be causing more problems at three months compared to baseline and one participant had become 'more forgetful' which is represented in the cognition dimension.

![Figure 5.3: EQ-5D health domain distributions at 3 months](image)

The visual analogue scores for the EQ-5D were found to be significantly higher at three months compared to baseline scores. The mean scores were 68 and 74.5, (range 4-100 and 5-100, median 70 and 80 Wilcoxon rank sum test p = 0.0002).

The EQ-5D utility scores were also different as would be expected from the health profiles at three months. The utility at baseline was 0.68 (-.08 - 1.0)
and 0.79 (-.24 - 1.0) at three months, median scores 0.69 and 0.8 (Wilcoxon rank sum test p=.0001).

There was only one person scoring below 0 at three months this being -.24. This person had a health profile of 22333 compared to baseline of 21233 and a utility score of -.08. Their injuries were whiplash and abdominal bruising from the seat belt. She had her own small catering business and would normally be involved in all aspects of the business, including; lifting, driving, cooking and standing for long periods of time. Her profile indicated that she had some problems with mobility, some problems with self care, was unable to perform her daily activities, had extreme pain and was extremely anxious or depressed. She could walk around for short periods but then had to sit down; she was unable to wash her hair because she couldn't stretch her arms over her head. She passed on the lifting and driving to others and 'just gave out the orders'. The pain she experienced was not alleviated for any length of time even with analgesics and visits to the chiropractor. Her extreme anxiety was credited to her trying to continue her business, family, putting up with the pain and also coping with her husband who had been involved in the same crash. Her husband was 'a changed man' since the crash; he had become moody, withdrawn and depressed and she was in the process of trying to get him referred to a psychologist through the GP.

Those with profiles of 11111(1) had AIS1 injuries including bruising, whiplash injury, wrist sprain and fractured nose with one person having an AIS 2 injury which involved fractured ribs.

5.4.2: SF-36v2

At the three month follow-up period the perceived general health was lower for some (n=7) who rated themselves as having fair or poor health (table 5.5). When asked to compare their health to one year ago the results were similar to baseline, 40% rated themselves as having somewhat or much worse health, 49% were about the same and 11% in better health.
Table 5.5: Perceived general health at 3 months

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=63)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Very good</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>Good</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>Fair</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

At three months, there were two people in the sample aged over 64, which is the cut off point for the UK population norms for the SF-36v2. These two were retained in the analysis as their scores did not alter the overall mean scores obtained by the sample at three months.

The SF-36v2 health dimensions at three months post crash were assessed and are presented below in figure 5.4. From the graph it can be seen that there was improvement in all but the general health domain from baseline to three months. There were statistically significant differences at the p=0.006 level for seven of the domains * (p<0.05 corrected for 8 multiple comparisons) using Wilcoxon rank sum test.

Figure 5.4: SF-36v2 health dimensions at 3 months

PF- physical functioning, RP-role physical, BP-bodily pain, GH-general health, VT-vitality, SF-social functioning, RE-role emotional, MH-mental health.

For each of the dimensions, the floor and ceiling effects were considered at three months. This indicates that there were few having low scores on the
health domains. However the ceiling effect shows that some health dimensions are scored at their highest and would not allow for any further health improvements to be rated in these dimensions.

Table 5.6: SF-36v2 floor and ceiling effects at 3 months

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%) (N=63)</th>
<th>CEILING (%) (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>1.6%</td>
<td>35%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>3%</td>
<td>46%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>1.6%</td>
<td>30%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Vitality</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>1.6%</td>
<td>54%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>0%</td>
<td>59%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>1.6%</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

5.4.2.1: SF-36v2 Component Scores

The component scores are normalised scores to enable the differences between scores to be viewed in a simplistic way. The norm is 50 with a standard deviation of 10, thus indicating that a score below 50 indicates below average health status for a particular component. From figure 5.5 it can be seen that the baseline scores for PCS and MCS are below the norm and although PCS has improved at three months (45.5) it is still below the norm. The MCS was calculated to be above the UK norm at 50.6. Both of these component scores were significantly improved at three months (Wilcoxon rank test, p=<0.0001).
Figure 5.5: SF-36V2 component scores at 3 months

During the interview there were common themes expressed. The initial few weeks after the crash were considered the worst for a number of people and at three months the crash was considered in the past and recovery was progressing. For example, the initial experience of attending Accident and Emergency (A and E) was considered a traumatic event where the care received was 'lacking and inconsiderate'. The person who strongly expressed this thought was the driver of a car with three passengers, all of whom were injured including his mother in law and although he felt very guilty, he was adamant the accident was not his fault. The mother in law sustained arm fractures and was 'left in the A and E department for hours before being admitted to a ward'.

The changes people had to make to their life following the crash were also an obvious problem for some. One person had to cancel their holiday as a result of the crash because the car was written off and therefore they could not tow their caravan. The general limitations imposed by the injury were also of concern and disrupted everyday life. For example, one person with whiplash could not make the beds at home, do the washing or shopping, all of which were their normal roles in the house. The loss of role was important for some particularly in the immediate period following the crash. However, as
Chapter 5: Study 1 - Three month follow-up data

time progressed these problems lessened. For those people who worked, their main focus was returning to work as soon as possible because of finances and they felt compromised by not undertaking their normal house or general duties and sporting activities.
Chapter Six: Study 1

Six Month Follow-up Data
6.1: Introduction

This chapter presents the findings following the six month follow-up interview using the study questionnaire and health outcome measures.

All participants were contacted at six months following the crash and interviews conducted by telephone. The researcher followed the same interview protocol as the baseline interview to ensure continuity and to minimise any bias in the interview questionnaire order. The interviews usually lasted 30 minutes although some were shorter. The majority of participants were contacted within one week of the six month date however a further two weeks were given on top of this to maximise the opportunity.

6.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop-outs were compared to the remaining sample at six months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann-Whitney U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36V2 dimension and component scores between 3 and 6 months. Content analysis was used to categorise interview responses into a format for data analysis.

6.3: Results

6.3.1: Attrition

At six months a further five people dropped out of the sample; these were all contacted on numerous occasions. They all gave agreed times for the
researcher to contact them by telephone and were either 'out' or did not answer the phone on each occasion.

The drop outs at six months were compared to the remaining sample using Fishers exact test or Chi-squared for nominal data and Mann-Whitney U test statistics for independent groups for ordinal data. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus the groups can be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

<table>
<thead>
<tr>
<th>Table 6.1: Drop outs at 6 months</th>
<th>BASELINE (N=70)</th>
<th>6 MONTHS (N=55)</th>
<th>TEST STATISTIC</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>53% males</td>
<td>53% males</td>
<td>Fishers exact</td>
<td>.45</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>39</td>
<td>40</td>
<td>Mann-Whitney U</td>
<td>.15</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.76</td>
</tr>
<tr>
<td>School</td>
<td>36%</td>
<td>33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>30%</td>
<td>31%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>34%</td>
<td>36%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage-brackets (median)</td>
<td>£16-20,999</td>
<td>£16-20,999</td>
<td>Mann-Whitney U</td>
<td>.37</td>
</tr>
<tr>
<td>MAIS (n)</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.62</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>18</td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.3.2: Personal Circumstances

There were no changes to marital status although one person’s living arrangements had changed as a result of the crash. This person was the carer for her husband and as a result of sustaining a fractured clavicle in the crash she was unable to perform her normal caring activities. As a consequence her husband had to be moved into a nursing home. Her medical management of the fracture was conservative involving the use of a sling to assist in the healing process. However, the fracture had not healed by six months and she was expecting to have surgery to pin the clavicle.
together. This had caused 'a total change in life' particularly having her husband live elsewhere.

Overall 91% of the sample considered themselves healthy at this time point although some still had problems relating to the injury. The majority (89%) stated they were able to undertake their daily routine although three stated to 'some degree' rather than completely able.

<table>
<thead>
<tr>
<th>LIFESTYLE ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage daily routine</td>
<td>89%</td>
<td>49</td>
</tr>
<tr>
<td>Hobbies</td>
<td>33%</td>
<td>18</td>
</tr>
<tr>
<td>House duties</td>
<td>18%</td>
<td>11</td>
</tr>
<tr>
<td>General duties</td>
<td>18%</td>
<td>11</td>
</tr>
</tbody>
</table>

Thirty three percent of the sample still had problems related to their hobbies; again these were mainly sporting hobbies such as running, the gym, swimming and team sports. For some this was having a knock-on effect on their health and some had put weight on as a result of not being able to undertake their normal exercise routines. This prevention of hobbies had a small effect on contact with friends directly related to sport for two people.

6.3.3: Employment

Only two people had not returned to work at six months. One had suffered general bruising, whiplash injury and shoulder strain and they worked as a secretary. The other had suffered a fractured talus and worked as a senior sales person which involved substantial travel. The secretary could not sit in one position for any length of time and activities such as typing were painful for her (she however went back to work the following week). The senior sales person was unable to drive any distance and was now on basic wages without commission and still had to pay for his company car. His wife had become the main wage earner. He was hoping to go back part-time in a limited driving area, however the company required him to undertake a driving course to ensure his 'fitness to drive'. He had also changed his car to an automatic drive instead of a manual gear car.
Table 6.3: Employment status at 6 months

<table>
<thead>
<tr>
<th>EMPLOYMENT ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment hours</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Typical activities</td>
<td>18%</td>
<td>10</td>
</tr>
<tr>
<td>Wage changes</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Main wage earner</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Off sick</td>
<td>12%</td>
<td>7</td>
</tr>
<tr>
<td>Returned to work / duties</td>
<td>96%</td>
<td>53</td>
</tr>
</tbody>
</table>

Those that did not work had resumed their normal everyday activities, apart from one who still was unable to do her previous level of housework. Three people stated they could not manage their daily routine including the housewife, senior sales executive (with the fractured talus) and a car hire rental manager who was able to work but was unable to perform house and general duties. Her injuries were a vertebral body fracture with minimal compression to her cervical spine at C6.

These three stated they were unable to perform their daily routines - although some 20% stated they could not undertake their normal house and general duties. The emphasis seemed to be placed on the work environment and as long as they could work then the household chores could wait or could be passed on to someone else. Thus, they were performing their normal daily routine (of work) but the non-essential chores were considered separately to the daily routine. Many stated they had adapted their everyday practices to minimise pain and discomfort and rely on partners to help around the house where previously this might not have happened. Typical activities at work or daily routine had changed for 10 (18%) of the sample. Usually this involved changing from physical or active employment to semi-active employment. This was generally to minimise lifting and twisting, even in the office environment. Some people had changed their seating positions or did not undertake light lifting such as moving boxes of files. These changes in activity were either because they could not physically undertake an activity due to an injury taking time to heal or because the activity caused pain and was therefore best avoided. Pain has remained an issue six months post crash for 44% of the sample (n=24). However, only 13% of the sample (n=7) was still taking analgesics at this point in time of which one was receiving steroid injections for pain relief and one person was still taking antidepressants.
prescribed after the crash. This person was a cyclist who had been knocked off of his bike on his way to work in the early morning by a truck and was left lying in the ditch. He had sustained bruising and a muscle injury to his shoulder.

The individual with the fractured talus was still using at least one crutch to mobilise with at this point in time. Six people were receiving physiotherapy six months after the crash and two were still attending chiropractor / osteopath appointments. Eighteen percent of the sample (n=10) were attending outpatient appointments more than at three months, as further problems have transpired and GPs had referred people back to the outpatient clinics. For example, the person receiving steroid injections had been referred to the outpatient department. Another, who was experiencing mood swings, had been referred to the psychiatric outpatients and also for an MRI scan. Other examples include an individual with slow healing of bruises on the legs who was referred back to the treating hospital for further investigation and someone with weakness and pain in their shoulder which was not improving was also referred by their GP back to the treating hospital. There were fewer people at six months who still had any degree of physical impairment.

A total of 6 people (11%) (compared to eight at three months) stated they had some problem. These problems included difficulty kneeling (for two people), loss of range of movement in the affected limb, swollen extremities and immobilised arm as a result of a sling in situ. Of those seven people at three months experiencing sensory impairment three were still experiencing numbness and two were now suffering from migraines; the other two had no remaining sensory impairment.
Table 6.4: Health impacts at 6 months

<table>
<thead>
<tr>
<th>HEALTH IMPACT</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>11%</td>
<td>6</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td>Pain</td>
<td>44%</td>
<td>24</td>
</tr>
<tr>
<td>Medication</td>
<td>13%</td>
<td>8</td>
</tr>
<tr>
<td>Aids / splints</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Require further surgery / treatment</td>
<td>8%</td>
<td>5</td>
</tr>
<tr>
<td>Receiving rehabilitation at 3 months</td>
<td>15%</td>
<td>8</td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>18%</td>
<td>10</td>
</tr>
</tbody>
</table>

6.3.4: Insurance and Litigation

At six months, 36 people (66%) were involved in compensation claims of which 33 expected a pay out and three were being sued as a result of the crash. One person had received £1,500 at six months as compensation for a fractured big toe. The majority who were expecting their insurance policy company to pay out on their insurance had received their monies at six months (n=42). One person was waiting for their pay out but was involved in court proceedings. Those who did not expect any insurance payout included individuals at fault and individuals insured as third party only as opposed to fully comprehensive insurance cover.

6.3.5: Financial Burden

Eighty percent of the sample (n=44) stated they were experiencing financial burden at six months, even though the insurance companies had paid out on the majority of the policies held. The mean burden at six months was £2,310 (range £45-£11,000, median £1,500).
6.3.6: Major Effects

Eighty percent of the sample (n=48) stated that the crash still had some effect on them six months after the event.

Figure 6.2: Major effects of the sample at 6 months categorised

- **Financial**
  - (n=3)
    - Hire car fees
    - Stress - money worries

- **Psychological**
  - (n=4)
    - Depression
    - Panic attacks
    - Dreams
    - Stuck can't move on
    - Loss of focus / commitment
    - Emotionally changed life
    - Self esteem - confidence

- **Emotions**
  - (n=15)
    - Anxious passenger / Anxiety for passengers
    - Anger
    - Feel vulnerable in the car
    - What could have happened
    - Fatality in other vehicle
### Chapter 6: Study 1 - Six month follow-up data

#### Driving
- Nervousness about driving
- Frightened to go out alone on bike
- Cautious / more aware in same situations
- Expect the worst from other drivers on the road
- Driving an automatic due to injuries
- Unable to do normal everyday activities
- Changed job - nearer home
- Inconvenience of no car - to get to work,
- Socialise
- (n=13)

#### Social
- Work affected by injury
- Unable to do sporting hobbies
- (n=10)

#### Functioning
- Reliance on others for transport or help
- Loss of mobility
- Time to heal
- Non-healing of fracture
- Health set back
- (n=2)

#### Health
- Physical symptoms
- Constant pain
- Secondary problems
- (n=22)

#### Other
- Being sued
- Changed life completely
- Compensation dragging on
- (n=10)

#### No effects / back to normal
- (n=15)
6.4: Health Outcome Measures

6.4.1: EQ-5D (+cognition)

A total of 31 (56%) had a profile of 11111(1) indicative of having no problems in any of the health domains. No person scored at the lowest of 33333(3); the lowest profile obtained was 22222(2) for three people indicative of some problems in all of the five health domains. The main health domains with continued problems were pain (36%), usual activities (34%) and anxiety and depression (24%), as shown in figure 6.3.

![Figure 6.3: EQ-5D+cognition changes at 6 months](image)

There were significant changes in the VAS scores from three to six months with a mean score of 79.9, median 85, range 20-98 (Wilcoxon signed rank test p<0.003). Again there were significant improvements from three months to six months in the utility scores calculated from the health profiles excluding cognition. The mean score was 0.87, median 1 and range .36 - 1, (Wilcoxon signed rank test p=0.0004). Having positive utility scores indicates that no person considered themselves to be in a health state worse than death at the six months follow-up.
At six months there was an expectation that they should be better and back to normal everyday life. The fact their injuries had still not healed for some was a major blow to their confidence and mental state. One person was angry because they had to have surgery which 'could have been done at the beginning and I would be fully fit by now and a thing of the past'. Another person was annoyed as the consultants had deemed him fit for work in his outpatient's appointment but he could not convince the occupational health nurse at work to allow him to undertake his normal duties. These two people had received fractures. However even those with AIS 1 injuries, were surprised at how long the healing process was taking and again expressed annoyance with the slow healing process and the consequences of them such as missing sports or having to make allowances at work for them.

As a result of the crash two people had attended driving courses to prevent police prosecution. The courses have to be paid for by the person but once completed they were not prosecuted for traffic offences and in so doing accepted liability for the crash.

6.4.2: SF-36v2

At the six month follow-up period then perceived general health was fair for six participants (11%), good for 36% (n=20), very good for 44% (n=24) and excellent for 9% (n=5). When asked to compare their health to one year ago the results showed that 36% considered their health to be worse now and responded 'that if it wasn't for the crash then they would probably be about the same', table 6.5.

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=55)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>About the same</td>
<td>36</td>
<td>66</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Much worse</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

The SF-36v2 scores were calculated for six months. There was an improvement in all of the health dimensions, (figure 6.4), with significant improvements noted for bodily pain, social functioning, role emotional and
mental health dimensions at the p=0.006 level* (Wilcoxon rank sum test corrected for ties). These health dimensions surpass the UK norms indicating that the participants at six months had better than average health. The ceiling and floor effects are presented in table 6.6 which shows that high percentages are scoring at the ceiling and very few at the floor.

**Table 6.6: Ceiling and floor effects of the SF-36v2 at 6 months**

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%)</th>
<th>CEILING (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>0%</td>
<td>36%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>1.5%</td>
<td>60%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>0%</td>
<td>42%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Vitality</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>0%</td>
<td>75%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>0%</td>
<td>76%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>

**6.4.2.1: SF-36v2 component scores**

There was a significant improvement in the mental component score between six months and three months (p=.002, Wilcoxon rank sum test). There was
an improvement of the PCS scores but this was not significantly noted between these two follow-up periods.

The MCS is considered to be above the normative sample for both three and six month follow-up periods indicative of better than average mental health. The PCS, however, is below the normative sample for the UK, indicative that this sample group have a less than average physical health state.
Chapter Seven: Study 1

Twelve Month Follow-up Data
7.1: Introduction

This chapter presents the results following the twelve month follow-up interview using the study questionnaire and the health outcome measures.

In this study, all participants were contacted at twelve months following the crash to undertake a final follow-up interview. The interviews usually lasted approximately 20 to 30 minutes, occasionally longer. The majority of participants were contacted within one week of the twelve month date, however a further two weeks were given on top of this to maximise the opportunity of obtaining an interview.

7.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop-outs were compared to the remaining sample at 12 months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann-Whitney U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36V2 dimension and component scores between 6 and 12 months. Content analysis was used to categorise interview responses into a format for data analysis.

7.3: Results

7.3.1: Attrition

At 12 months a further 8 people had dropped out of the sample; most of these stated they had recovered and had no wish to continue with the interview or
were not contactable by telephone. This resulted in an overall attrition rate of 33%.

The drop outs at 12 months were compared to the remaining sample. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus the groups could be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

Table 7.1: Drop outs at 12 months

<table>
<thead>
<tr>
<th></th>
<th>BASELINE (N=70)</th>
<th>12 MONTHS (N=47)</th>
<th>TEST STATISTIC</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>53% males</td>
<td>57% males</td>
<td>Fishers exact</td>
<td>.09</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>39</td>
<td>40</td>
<td>Mann-Whitney U</td>
<td>.65</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.21</td>
</tr>
<tr>
<td>School</td>
<td>36% 30% 34%</td>
<td>36% 32% 32%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>36% 30% 34%</td>
<td>36% 32% 32%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage brackets (median)</td>
<td>£16-20,999</td>
<td>£16-20,999</td>
<td>Mann-Whitney U</td>
<td>.29</td>
</tr>
<tr>
<td>MAIS</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>18</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data were examined for any changes in lifestyle, personal circumstances, employment, health and any knock-on effects of the crash or injury. A summary of the changes that occurred as a result of the crash between six and 12 months are presented below and discussed.
Chapter 7: Study 1 - Twelve month follow-up data

7.3.2: Personal Circumstances

One person's marriage had broken down as a result of her husband's involvement in the same crash. Her husband sustained a mild head injury at the time of the crash which had made him 'very depressed and moody' resulting in his referral for psychiatric treatment and MRI scanning. She was available for the 12 month interview but her husband was not, consequently the results of any appointments were not available to the researcher.

Lifestyle

Overall, 94% of the sample considered themselves to be healthy at this follow-up point. The entire sample stated they could manage their daily routine although three people stated that they had adapted different ways to achieve these everyday activities. General duties and shopping remained a problem for some (15%) and at this stage they did not undertake such activities or adapted them to suit their injuries. This included carrying lighter shopping bags and doing more trips between the car and the house or not doing the ironing because it exacerbated pain from a whiplash injury.

Undertaking hobbies was considered to be a main effect of the crash at 12 months with some 32% restricted in their activities. These were mainly sports related or giving up riding motorbikes, not because of physical problems but as a result of loss of confidence in riding ability or being too nervous to get back on the motorbike.

<table>
<thead>
<tr>
<th>LIFESTYLE ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage daily routine</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Hobbies</td>
<td>32%</td>
<td>15</td>
</tr>
<tr>
<td>House duties</td>
<td>15%</td>
<td>7</td>
</tr>
<tr>
<td>General duties</td>
<td>15%</td>
<td>7</td>
</tr>
</tbody>
</table>

Since the crash, two participants' contact with their family had increased and another participant's contact with friends had increased in the previous six months to the level recorded at baseline.
7.3.3: Employment

At twelve months, the entire sample had returned to work or everyday 'normal' activity although their activities were not necessarily at the full extent as prior to the crash (11%). Some had adapted different ways to perform their job and others were accommodated by changes to their working conditions. For example, one person had been given a higher desk to accommodate her whiplash injury and another person had been given a suitcase on wheels to pull along instead of carrying her work samples.

At twelve months, only two people (4%) stated their daily activities at work (normal daily routine) had changed. One did not do heavy lifting and the other did less driving as a matter of course in their work due to their original injuries. Eight percent (n=4) had taken time off sick in the previous six months as a result of the crash. The sick time taken ranged from 31 days for one person (which was a continuation of sick time from the six month follow-up) whereas another two people had taken five and two days off respectively, again a continuation from six months. One person had taken two days off over the previous six months as a result of migraines related to the crash. One person's wages remained less than before their crash. Although this individual had returned to being the main wage earner, he still was not earning sales commission at his usual rate.

Table 7.3: Changes in employment at 12 months

<table>
<thead>
<tr>
<th>Employment Activity</th>
<th>Percentage</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical activities</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Wage changes</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Main wage earner</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Off sick</td>
<td>8%</td>
<td>4</td>
</tr>
<tr>
<td>Returned to work / duties</td>
<td>100%</td>
<td>47</td>
</tr>
</tbody>
</table>

7.3.4: Health Impacts

At 12 months, 17% of the sample stated they had some form of physical impairment resulting from the crash. The main impairments at 12 months included the loss of range of movement in joints and also the difficulty in
kneeling down. Nine percent also had sensory impairment, three of whom also had a physical impairment. The types of sensory impairment experienced were pins and needles and numbness. Pain was also a major factor at 12 months for 45% (n=21) of the sample group. Four people were still taking regular analgesics, one person was still on prescribed antidepressants and another was receiving steroid injections into his shoulder joint for pain relief. One person had the use of sticks at 12 months to aid walking and a second person used a splint to support their thumb injury.

Table 7.4: Changes in health impact at 12 months

<table>
<thead>
<tr>
<th>HEALTH IMPACT</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>17%</td>
<td>8</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>9%</td>
<td>4</td>
</tr>
<tr>
<td>Pain</td>
<td>45%</td>
<td>21</td>
</tr>
<tr>
<td>Medication</td>
<td>13%</td>
<td>6</td>
</tr>
<tr>
<td>Aids / splints</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Readmitted</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Had surgery</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Require further surgery</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td>Receiving rehabilitation at 12 months</td>
<td>6%</td>
<td>3</td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>10%</td>
<td>5</td>
</tr>
</tbody>
</table>

Since the six month follow-up period two people had been re-admitted to hospital to have surgery. One had the wires removed from a fractured patella and a second had their clavicle pinned. Two of the sample still expected to have to undergo surgery at some point in the future. Of those three people receiving rehabilitation at 12 months, two were still having physiotherapy and one was still under a chiropractor for treatment.

**7.3.5: Insurance and Litigation**

At 12 months, the insurance companies had paid out to all those insured. Seventy nine percent of this group were involved in solicitor compensation claims and of these, 89% expected to be awarded compensation. Of those
expecting compensation 21% (n=33) had received monies as a result of the crash and one person had received an interim payment.

Table 7.5: Legal and insurance compensation

<table>
<thead>
<tr>
<th></th>
<th>PERCENTAGE</th>
<th>NUMBER (N=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court proceedings</td>
<td>78%</td>
<td>37</td>
</tr>
<tr>
<td>Expect compensation</td>
<td>89%</td>
<td>33 (n=37*)</td>
</tr>
<tr>
<td>Compensation paid</td>
<td>21%</td>
<td>7*(n=33)</td>
</tr>
</tbody>
</table>

Of the seven people who were awarded compensation, none were in debt at 12 months. Three people were willing to state how much they received in compensation; two received £7,000 with approximate losses of £6,200. One received £1,500 with losses averaged at £270. Those who did not say how much they lost had losses ranging between £0 and £1,000. One person had accepted an interim payment of £5,000 which cleared debts incurred of £4,000 whilst off sick, however he turned down an offer of £20,000 as settlement for compensation. He intends to wait another year until recovery from his injuries is more established, the main injury being a fractured talus.

7.3.6: Financial Burden

Sixty six percent of the sample stated they still had some financial burden at 12 months, ranging from £150 to £5,500. This latter figure was for replacing a car which had been financed by a loan.
The main financial burden was attributed to the costs associated with replacing cars / motorbikes that were not claimable on the insurance

7.3.7: Major Effects

Sixty percent of the sample stated that at least one major effect that the crash or injury had on them, remained an important factor at the 12 month follow-up period. The remaining 40% stated they had no effects or had returned to normal after the crash. The effects are categorised below in figure 7.2.

Figure 7.2: Major effects of the sample categorised

Financial
(n=1)

Stress - money worries

Psychological
(n=4)

Depression
Memory effected

Emotions
(n=14)

Stuck can't move on
Fatality in other vehicle
Self esteem - confidence
Anxious passenger now
Anxiety for passengers in car
Relationship arguments
Guilt

Driving
(n=15)

Nervousness about driving
Driving behaviour changed considerate
Cautious more aware in same situations

Social
(n=6)

Unable to do normal everyday activities
Giving up hobbies - motorbikes
Work affected by injury
Unable to do sporting hobbies

Functioning
(n=1)

Loss of fitness
Chapter 7: Study 1 - Twelve month follow-up data

Time to heal

Physical symptoms
Constant pain
Secondary problems
Prognosis
Sleep disturbance

Being sued

Changed life completely
Compensation dragging on

No effects

(n=21)

7.4: Health Outcome Measures

7.4.1: EQ-5D (+cognition)

A total of 34 (72%) had a profile of 11111(1). No person had a floor effect of a 33333(3) profile. There were no people scoring a '3' for any health domain at 12 months. The worst profile scores were 21222(1) for three people. At 12 months everyone had no problems with their self-care or level of cognition. As can be seen from the figure below the main problem health domains were; usual activities, anxiety, pain and, to a lesser extent, mobility at the 12 month follow-up period.
The visual analogue scores for the EQ-5D were found to be significantly higher at twelve months than at 6 months (mean 84, median 90, range 40-99, p=0.039 Wilcoxon rank sum test).

The utility scores were also significantly higher at 12 months compared to 6 months (mean .93, median 1.0, range 0.62 - 1.0, p=0.001 Wilcoxon rank sum test).

7.4.2: SF-36v2

At 12 months, the general health of the sample was distributed between excellent and poor, with the majority having very good or excellent health (53%, n=47). The participants’ perceptions of their health at 12 months compared to one year ago are presented in table 7.6. Some 53% considered their health to be better than a year ago and 4% worse.

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=47)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>22</td>
<td>47</td>
</tr>
<tr>
<td>About the same</td>
<td>20</td>
<td>43</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Much worse</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Chapter 7: Study 1 - Twelve month follow-up data

The majority (72% n=34), considered their health to be much the same as one year previously; 26% (n=12) considered their health to be somewhat or much better and only 2% (n=1) considered their health to be 'somewhat' worse. The SF-36V2 health dimensions at 12 months post crash were assessed and are presented below in figure 7.4. One person was aged above 64 years, the cut off point for the UK normative. This person's data did not alter the mean scores and was therefore kept in the analysis. From the graph it can be seen that there was improvement in all of the health domains from six months to 12 months. There were statistically significant differences at the p=0.006 level (p=0.05 corrected for 8 multiple comparisons) using Wilcoxon rank sum test for role physical, bodily pain, vitality and mental health.

Figure 7.4: SF36v2 health dimensions at 12 months

![Figure 7.4: SF36v2 health dimensions at 12 months](image)

PF- physical functioning, RP-role physical, BP-bodily pain, GH-general health, VT-vitality, SF-social functioning, RE-role emotional, MH-mental health.

For each of the dimensions, the floor and ceiling effects were considered at 12 months.
### Table 7.7: SF-36v2 floor and ceiling effects at 12 months

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%)</th>
<th>CEILING (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>0%</td>
<td>40%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>0%</td>
<td>72%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>0%</td>
<td>49%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Vitality</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>0%</td>
<td>87%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>0%</td>
<td>92%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>

#### 7.4.2.1: SF-36v2 Component Scores

The component scores are normalised scores to enable the differences between scores to be viewed in a simplistic way. The norm is 50 with a standard deviation of 10 thus indicating that a score below 50 indicates below average health status for a particular component. At 12 months, both the PCS and MCS scores had improved from 6 months with the PCS now reaching the norm of 50 (49.8) and the MCS above this level at 56. Both of these component scores were significantly improved at 12 months from 6 months (Wilcoxon rank test, p=0.008 (PCS) and p=0.007(MCS)).
Figure 7.5: SF-36V2 component scores at 12 months

PCS-physical component score; MCS-mental component score

7.5: Recovery

All participants were asked at 12 months whether they had recovered from the crash / injury; 60% said 'definitely yes' (n=28), 25% 'no' (n=12) and 15% 'on the whole but something always acts as a reminder' (n=7) (for example pain or nervousness in the car). Those who had not recovered stated the reasons why as shown in table 7.8. Pain was the main reason for not being recovered completely and a further reason was 'tiredness'. This was a problem that people were experiencing since the crash, particularly if they had taken a long time to recover from their injuries or the injuries had taken a long time to heal. A number of people reported feeling 'tired' throughout the study period following their injuries. The reasons for this are unclear; one participant suggested that it was 'their body telling them to slow down to allow them to recover'.
Table 7.8: Reason for non-recovery at 12 months

<table>
<thead>
<tr>
<th>REASON</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>10</td>
</tr>
<tr>
<td>Loss of range of movement</td>
<td>3</td>
</tr>
<tr>
<td>Need to have proof not at fault</td>
<td>2</td>
</tr>
<tr>
<td>Secondary injury</td>
<td>2</td>
</tr>
<tr>
<td>No hobbies</td>
<td>3</td>
</tr>
<tr>
<td>Mentally scarred</td>
<td>2</td>
</tr>
<tr>
<td>Physically activities</td>
<td>1</td>
</tr>
<tr>
<td>Tiredness</td>
<td>5</td>
</tr>
<tr>
<td>Nervousness</td>
<td>2</td>
</tr>
<tr>
<td>Healing not complete</td>
<td>1</td>
</tr>
</tbody>
</table>

People were also asked at what point they returned to driving / riding bikes and whether they had had another crash in the 12 month period. The majority of participants had returned to driving at the initial baseline interview (74%), a further 18% at three months and 8% by six months. All had returned to normal everyday driving at 12 months, although one person had given up riding his motorbike for fun. Two people (4%) were involved in a second crash during the follow-up period.

Recovery at 12 months on the whole was complete for the majority of participants although some issues remained, particularly financial loss, loss of hobbies, nervousness about driving or being a passenger.
Chapter Eight: Study 1
Analysis of Data from Baseline to Twelve Month Follow-up Data
8.1: Introduction

The aim of this study was to examine quantitative data as a whole from baseline to 12 months to chart the changes, analyse the data and identify the main factors of changes over time.

8.2: Data Analysis

Analysis of the data was undertaken using Friedman analysis of variance by ranks. This tests whether at least one of the conditions differ from at least one other condition. However, this only tests that there are differences but not which one is different. Thus, a further test was applied to test the critical difference between the rank sums (see equation below). If the difference exceeds a corresponding critical value then it can be concluded that the two conditions are different (Siegal and Castellan 1988).

\[ | \bar{R}_u - \bar{R}_v | \geq z \frac{\alpha}{\sqrt{k(k+1)}} \frac{k(k+1)}{6N} \]

\(\bar{R}\) = sum of ranks
\(z\) = probability of normal distribution
\(k\) = number of groups
\(N\) = number of participants

Thus if the critical value is achieved then it can be determined where the most changes over that time period are made.

8.3: SF-36v2 Data

From figure 8.1 it can be seen that over time the PCS scores progress from below average physical health at baseline to almost reaching the norm at 12 months (49.8). In contrast the MCS was also below average mental health at baseline but by three months this sample group was considered to be above average mental health and continued to improve through the 12 month follow-up.
There were significant changes in the PCS and MCS scores over the follow-up period as indicated by the Friedman test \( (p<0.0001) \). The equation was applied to the PCS data for baseline, three months, six months and 12 months. The critical value was achieved for the baseline to 12 month comparison, indicating that this change over time had the most influence in the analyses and impact on recovery. The overall improvement of PCS between baseline and 12 months would suggest that physical health requires a longer recovery period compared to mental health. For the MCS the changes over time were most significantly found between baseline and six months and baseline and 12 months. The health dimensions which contribute to the component scores are presented in figure 8.1 and help illustrate the PCS and MCS changes over time.

The eight health dimension scores were converted into normalised scores using the developers' algorithm (Ware et al. 2002), and are presented in figure 8.2. This normalisation is such that the norm is 50 and the standard deviation is 10.

From figure 8.2 it can be seen that general health remained constant throughout the follow-up period, indicating that many considered their health to be separate to their injury. This was an unexpected finding as it was assumed that overall health would be impacted by changes to physical and
mental health. Being healthy was the absence of colds or flu for example and not the absence of an injury. The main deviation away from the norm was at baseline. This was surprising as the SF-36v2 was selected to provide data for the previous four weeks and therefore it was hoped that pre-injury health states would be captured. However, this method of recruitment ensured there was a delay between the crash and the initial baseline interview. Thus the previous four weeks in the majority of cases included only the post crash health states. The physical health dimensions (PF, RP, BP) varied away from the norm for the longest period of time with the 12 month follow-up achieving average health for these dimensions. Considering there were reported mental health problems in the major effects this was not reflected in the MH or RE dimensions past baseline assessment.

Figure 8.2: Normalised health dimension scores

The SF-36v2 scores were converted into SF-6D utility scores using Braziers algorithm (personal communication), which are presented in figure 8.3. It can be seen that these scores improve over time which would be expected. The SF-6D does not use all of the 36 items in the SF-36v2 form to create a total score and one would have to be cautious of its interpretation from the original SF-36v2 dimension scores.
8.4: EQ-5D (+cognition)

The changes in each health domain over time are presented in Table 8.1. It can be seen that at baseline there were considerable problems in (1) usual activities, (2) pain / discomfort and (3) anxiety and depression. These 3 health domains, although improved over time, were found to still be of concern to this sample group at 12 months. The problem of cognition (the added dimension) was not of great value in this sample group; those that had cognitive problems considered themselves to be forgetful after the crash. Interestingly these were the older people in the sample. The original five health domain profiles were converted into the utility scores and these were plotted over time (figure 8.4).
### Table 8.1: EQ-5D health domains over 12 months

<table>
<thead>
<tr>
<th>EQ-5D PROFILE (+COGNITION)</th>
<th>BASELINE (N=70)</th>
<th>3 MONTHS (N=63)</th>
<th>6 MONTHS (N=55)</th>
<th>12 MONTHS (N=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No problems (%)</td>
<td>69</td>
<td>82</td>
<td>87</td>
<td>94</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>30</td>
<td>18</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Confined to bed (%)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Self care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No problems (%)</td>
<td>86</td>
<td>93</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>14</td>
<td>7</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Unable to (%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Usual activities</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No problems (%)</td>
<td>40</td>
<td>56</td>
<td>66</td>
<td>75</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>49</td>
<td>41</td>
<td>33</td>
<td>25</td>
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<tr>
<td>Unable to (%)</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Pain/discomfort</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (%)</td>
<td>29</td>
<td>49</td>
<td>64</td>
<td>87</td>
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<tr>
<td>Moderate (%)</td>
<td>67</td>
<td>48</td>
<td>36</td>
<td>13</td>
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<tr>
<td>Extreme (%)</td>
<td>4</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Anxiety/depression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (%)</td>
<td>46</td>
<td>62</td>
<td>76</td>
<td>85</td>
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<tr>
<td>Moderate (%)</td>
<td>50</td>
<td>35</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>Extreme (%)</td>
<td>4</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Cognition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No impairment (%)</td>
<td>99</td>
<td>97</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Some impairment (%)</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Severe impairment (%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 8.4: Utility scores over time

From figure 8.4 it can be seen that improvement was made over the 12 month period which would be expected considering the improvements in each of the five health domains at the follow-up periods.

The Friedman test was also applied to the EQ-5D utility scores which were also found to be significant at the p<0.001 level. The equation was applied to the results to calculate a critical value to determine where the significant changes occurred. The main changes in the utility scores were at baseline to six months, baseline to 12 months and three to 12 months. The changes between baseline and six months would be indicative of this period being where rapid improvements in recovery occur. One would expect there to be significant changes from baseline to 12 months in this type of sample and the results are not surprising for this time period. The three month to 12 month changes are not unlike the baseline to three month changes as the delay in the original baseline interviews may well have had an effect on the three month scores for some as they were nearer to three months than baseline. The utility score is a combination of both physical and mental health assessment rather than the separation of its components like the MCS and
PCS from the SF-36v2 forms and again these significant changes would be expected considering that both of these constructs are included. The utility scores for each follow-up period were compared to a matched sample for age and gender, from Dolan's TTO study (Dolan and Gudex 1995). There were significant differences between the sample and population norm at baseline and 12 months, $p<0.001$ (Wilcoxon rank sum test, corrected for comparisons at the $p=0.01$ level ($0.05/4$). The three month data had a $p$-value of 0.02 and the six month data was not significant as the mean score for the sample group at six months (0.87) was the same for the matched population sample. The 12 month mean score for the sample group was 0.93 and the baseline 0.68.

8.4.1: Visual Analogue Scores

There was a similar pattern for the visual analogue results where the participants had to assign themselves to a point on a 0-100 scale for assessment of health status. Again the main changes of influence in the results were from baseline to 12 months, baseline to six months and three to 12 months. These follow the same pattern of the utility scores and would also support the view that the first six months are important in the recovery from injury.
8.5: Gender Differences

The data were analysed for PCS, MCS and EQ-5D utility scores for differences between the genders. Dividing the sample into males and females however creates a small sample for the females and therefore any results have to be interpreted with caution. The Mann-Whitney U test was used for independent groups and as a conservative measure a significance level of $p=0.05$ was used (not correcting for the number of ties). The MCS was the only variable that showed significant differences between the genders at three months ($p=0.05$) and six months ($p=0.03$).
Chapter 8: Study 1 - Analysis of data from baseline to 12 month follow-up

Figure 8.6: Mean normalised PCS scores by gender

Figure 8.7: Mean normalised MCS scores by gender
8.6: Effects of Injury and Quality of Life

The sample was divided into MAIS groups and their respective scores examined. The results are presented in figures 8.10 to 8.12 below, however it must be noted that the MAIS 0, MAIS 3 and MAIS 4 groups only have one
participant in them. There were variances between the MAIS groups in the PCS, MCS and EQ-5D utility scores over the study period. The PCS scores at baseline were substantially below the UK norm for all but the MAIS 0 injuries (figure 8.10). At three months there were problems in the MAIS 1, MAIS 2 and MAIS 4 injuries, with MAIS 2 notably lower than the other injury groups. This was also noted at six months where MAIS 2 injuries were again below the average UK norm scores and only reaching the norm of 50 at the 12 month follow-up. The MAIS 4 participant had sustained serious chest injuries and the MAIS 3 participant had sustained a cervical spine fractures. Both participants made a full recovery and returned to their normal daily work and social activities which including sports such as sailing and running.

Figure 8.10: Mean normalised PCS scores by MAIS

The Mental Component Scores were found to be below the UK average norms at baseline and three months but all injury groups were above the UK average at the six month follow-up period (figure 8.11). This continued through to 12 months with the MAIS 3 and MAIS 4 participants reporting a high MCS (these are actual scores and not grouped means as presented in the MAIS 1 and MAIS 2 groups).
The EQ-5D scores were again varied between the MAIS groups and the follow-up periods (figure 8.12). Disregarding all but the MAIS 1 and MAIS 2 injuries there are noticeable lower mean scores for the MAIS 2 group compared to the MAIS 1 group which on the whole would be just a whiplash injury or just surface bruising or abrasions. MAIS 2 injuries relate to fractures or minor internal injury or a rib fracture. What also has to be remembered is that all participants could have more than one injury at the same AIS level to result in the same MAIS.
8.7: Major Effects Over Time

The reported major effects were examined over the 12 month period and are presented in figure 8.13. It can be seen that the percentage of the reported major effects changed over the period of time. These effects relate to the participants with reported effects and not those who have stated they had no effects at each time period.
At three months it can be seen that the effect with the highest reported problems were social and driving activities. This probably reflects the immediacy of the crash being on the mind of some participants and the initial impact of their injury on social activities. At 12 months, driving remained an issue for those with stated effects such as being nervous in the car or had become a more cautious or considerate driver. There was an increase in the number of emotional effects reported at 12 months which were related to relationship difficulties, low self esteem and anxiety for passengers. These emotional problems were somewhat separated from psychological problems which related to actual depression and flashbacks. The number of reported health problems rose at six months and remained a problem at 12 months. These reported health problems related to pain, physical problems, and secondary health problems identified since the crash and how long it was taking to heal.
Chapter 9: Study 1 - Discussion of results

This chapter presents a discussion of the results for Study 1 and the corresponding literature, any discussion regarding the methodology is presented in Chapter 18.

9.1: Recruitment and Response

Overall this sample represents self-selecting respondents to a mail out and tended to have 'minor' AIS 1 injuries, treated in Accident and Emergency and discharged home. The response rate was poor for this study with only 41% of the original number contacted willing to take part. This can be attributed to some extent to the number of participants who did not respond because they were not injured. It was hoped there would be more non-injured responses however this was not the case. The attrition rate was also high at 33% despite attempts made and allowances provided for the capturing of participants. One problem with the follow-up was that the majority sustained minor injuries and recovered quickly and were therefore reluctant to continue with the study. The change in recruitment letter also made a difference. Prior to the change, participants were responding to take part in a follow-up study. However, after the change the participants were signing up to 'talk to a researcher' about their crash who would then recruit them into a follow-up after this initial contact. Although the initial contact numbers rose, the number wishing to continue was not any better than the previous method.

9.2: Injury

The injuries sustained by this participant group were predominantly 'minor' whiplash, cuts and bruises. The few (11%) who were admitted to hospital had fractures requiring surgery, such as, fractures to the patella, great toe and talus, which are ranked as more severe according to AIS (i.e. AIS 2+). In isolation, whiplash was the predominant 'main' injury for 22 participants (31%); (one participant suffered cervical spine fractures not as a result of a whiplash).
The high number of whiplash injuries, coupled with bruising to the chest is not a surprising finding as 91% of the participants were car occupants at the time of the crash. Whiplash has been found to be the most commonly occurring injury to car occupants following a road traffic accident; accounting for 85% of personal injury claims (Spitzer, Skovron et al. 1995). Whiplash is also a highly impairing injury in Sweden where much research has been undertaken in this area (Spitzer, Cassidy et al. 1995). One of the main problems of whiplash is that it has different courses of recovery with some recovering within the first few weeks and others still not recovered at 12 months. Whiplash has been graded according to severity under the Quebec WAD (whiplash associated disorder) criteria but no attempt was made to categorise the severity of the whiplash in this study only the effect it had on the individuals. This was because there was not enough evidence from the medical notes to categorise the whiplash injury into the WAD criteria (Spitzer et al. 1995). Whiplash also carries the reputation of being a compensation injury and not a real problem for which an insurance claim will compensate a victim financially for their injury (Pearce 1999). In this study there was a division in recovery time between those with whiplash; the majority recovered within the first month, however at 12 months some were still experiencing problems as a result of their initial injury.

One participant had not taken time off sick but had adapted her work and home life around what she could physically do, although she expected compensation for her injury and vehicle losses. Another participant had only returned to work part time after a period of six months off sick. The majority of participants were also claiming for a personal injury, however, the cost of vehicle replacement outweighed the expected compensation payout for a whiplash injury. The compensation process was considered to be the 'norm' rather than the exception for the participants who were entitled to put in a claim. These claims were often instigated by the insurance companies rather than the individual, possibly to recoup any insurance losses. The exposure to adverts on the television promising compensation for accidents as well as advertising cards in the hospitals has promoted the awareness and rights of individuals that they are entitled to some form of monetary recompense. Whilst the UK judicial board advises a pay out ranging between £500 and
£2,000 for a whiplash injury depending on the severity, the money that participants obtain from the claim was put towards buying a new car and the deficit between the insurance pay out and a replacement vehicle was considerable for some (The Judicial Studies Board 2002).

None of the participants with whiplash in this study were discharged with a soft collar for treatment. Most took analgesics for pain relief and a high proportion had physiotherapy; two paid privately for osteopath and chiropractor treatment. The private treatment continued for two people over the course of the year. Changes in the workplace were also made to accommodate the effect of the whiplash injuries in terms of pain and having to restrict movement. Some participants with whiplash reported a rise in the number of headaches and 'migraines' since the crash which had enforced time off sick. This has been found elsewhere and appears to be a consequence of whiplash injury (Wallis, Lord et al. 1998, Solomon 2005). Chronic symptoms of whiplash have been found in numerous studies but all have different long term incidences of chronic pain and propensity for headaches (Mayou and Radanov 1995, Bannister and Gargan 1993). There have been varying reports of disability resulting from whiplash - some stating 5% at one year whereas others report greater disability (Mayou and Radanov 1995). None of those with whiplash in this study considered themselves to be 'disabled' at 12 months although avoidance of, or restriction in, activities was common to prevent the onset of pain associated with this injury. This study identified pain as a factor over the whole of the study period and was reported as one of the reasons for not being 'recovered' at 12 months.

### 9.3: Pain

Pain was also an issue for those without whiplash and for some was prolonged by the lack of immediate surgery / treatment for their original injury. One participant sustained a fractured clavicle and was treated with a sling and at six months she required surgery to pin the fracture site. This delay in surgery in a 'wait and see approach' resulted in pain, longer sick time and also restricted her ability to care for her husband. Another participant stated that she had experienced pain continually since the accident but was 'not being...
listened to’. He eventually had this area of pain explored which required MRI investigation and treatment, in the meantime this had contributed to his not returning to work and to depression.

The measurement of pain in this study was in response to a direct question to state whether they still experienced pain from their injury. At twelve months 45% of the sample stated they had pain, however the response to pain for the health outcome measures differed. Thirteen percent stated they had moderate pain at 12 months on the EQ-5D, with many selecting to choose 'no pain' for that day as they had 'little' pain which was judged to be nearer to no pain rather than moderate pain in their perception. The SF-36v2 had 51% (n=24) who recorded some degree of pain that interfered with activity, although eight of these actually scored above the UK norm for pain, although there is no real measure for 'extent' of individual pain. The SF-36v2 had similar levels of reported pain to the direct questioning by the researcher. The difference between the levels of reported pain in the health outcome measures is possibly a product of the period of time the measure incorporates 'that day' or the 'previous four weeks'. For the EQ-5D measure the health state assessment for that day of the perceived levels of pain was unlike the SF-36v2 which incorporates other aspects in the pain dimension such as how pain is affecting their ability to work and socialise over the previous four weeks.

9.4: Psychological Impact

Depression appeared to be a problem for some of the participants, even with minor AIS 1 injuries. One participant had depressive symptoms following his crash requiring medication. He had no prior history of depression and to be reliant on tablets at one point 'to function' was difficult for him to comprehend. He exerted avoidance techniques and would not cycle unaccompanied, if at all, as well as attempting to avoid the location of the crash.

There were only two participants who had a history of depression prior to the crash; the remaining participants experienced symptoms during the study. However, it was not possible to formally assess mental state prior to the study due to the absence of pre-crash information, although mental state has been
found to be a contributing factor to post crash state of mind (Michaels, Michaels et al. 2000, (Read, Kufera et al. 2004). The reporting of anxiety or depression was a problem throughout the study using the EQ-5D measure, with 15% reporting symptoms at 12 months. However, the mental health, as measured by the MCS, was found to be below the norm at baseline and three months only. In contrast to this was the reporting of psychological and emotional problems during the interview itself when participants were asked what the major effects of the crash or injury were. There were 18 reports of psychological or emotional effects recorded in this study, although this does not equate to 18 participants. One issue identified with the psychological / emotional assessment of outcomes was the variance between the measures and the reported problems.

9.5: Physical Impact

The physical impact of the injuries was higher than the mental impact as measured by the component scores. The main impact for this sample group was the restriction imposed on social activities, particularly sporting hobbies where the injury had imposed physical limitations associated with causing pain or moving a limb to its full potential. For the person with a fractured great toe he could not run or play rugby due to pain caused by the original injury when attempting to undertake these activities. Another person could not play golf as a result of being unable to swing the golf club due to a whiplash injury. The usual house and general duties were also affected and for some were a 'complete surprise to them as to what they could not do anymore'. One female was unable to kneel or bend her knee to a great degree of flexibility and had to find different ways to perform daily duties, such as loading the dishwasher or weeding the garden.

Work activities were also restricted for a number of participants and adaptations had to be made to enable the person to return to work. One person was a sales representative and had to use a suitcase with wheels to transport her work materials, instead of carrying the materials, as a result of whiplash. Other limitations imposed were restricted travelling areas for a sales executive together with an inability to carry his normal sales products.
any great distance, because of the need to use a walking stick. Other companies where driving was a main aspect of the job provided a driving course for their employees to ensure they were ‘fit to drive’ and rebuild their confidence after the crash.

9.6: Gender Differences

Some studies have found gender differences in the outcomes of trauma participants (Holbrook, Hoyts et al. 2002; Kaplan, 1991), but this study did not identify any significant differences between the genders for MCS, EQ-5D and PCS. The PCS followed a similar trend throughout the study period for males and females.

The differences between injury severity can not be considered through rigorous statistical analysis because of the very small number of participants with the MAIS 3+ injuries. Where there were high numbers of participants in the MAIS 1 and MAIS 2 injuries and it was found that the MAIS 1 participants had higher / better health outcome scores than those with MAIS 2 injuries throughout the study. Females have been found to have worse scores particularly for mental health compared to males following trauma (Holbrook et al. 2002), severity however, is thought not to influence psychological outcome and would appear to be consistent in this study. Those with MAIS 3+ injuries had higher MCS scores compared to those with lower MAIS scores, and the MAIS 1 had higher scores compared to the MAIS 2 injuries. This suggests that there is no consistent pattern for injury severity and psychological outcome, however this is a small sample and is open to interpretation.

9.7: Financial Burden

The area of financial burden was also a concern to some of the participants as their earnings were not high compared to others who were able to accept the losses more readily than others. For one participant the loss of one day’s pay (£40) and also the cost of a driving course (£120) made a big impact on his budget as it totalled more than a week’s wage. Obviously, as would be expected, the losses associated with replacing a vehicle have the greatest
impact as do the other vehicle costs, such as the rise in insurance premiums. The
distribution of the financial burden was varied, however it was apparent that actual 'individual' losses whatever the sum, had the
greatest impact on the burden experienced.

The majority of this sample had returned to work at three months and all by 12 months. This study identified similar findings to
Yates, Heath et al. (1991) who also found that those with minor injury frequently reported restricted house duties, time off work and
financial hardship. In this study, those with the higher AIS injuries had more days off sick than their AIS 1 counterparts, mainly
because they were orthopaedic injuries and required surgery and recovery from these procedures. The return to work rate was high for
this participant group with 89% having returned to work at three months and all at 12 months which possibly reflects the extent of the
injuries sustained.

9.8: Other Factors

Interestingly two participants had a second crash in the one year follow-up period and for one participant, it was her third crash in three years, 'none of which were her fault'. She relied on public transport for everyday journeys because of her experiences with car crashes and whiplash injury. The other person who had a second crash was 'rear ended' at a junction and as such was not at fault for the crash and was uninjured 'apart from a sore neck for a few days'.

9.9: Summary

In summary Study 1 identified real issues for a sample of participants injured in road crashes. It is apparent that relatively minor injury has long lasting effects on quality of life, albeit in non obvious areas such as housework or sporting hobbies. Return to work appears to be the main goal in the recovery process because of the knock-on effects of loss of earnings to everyday life such as paying bills or replacing vehicles.

The use of health outcome measures in this study illustrated the variances between participants and also the health dimensions affected by injury as well as quantifying the losses into scores for comparative purposes. These will be
discussed further in Chapter 20. The differentiation between physical and mental health problems was obvious using these measures as there was an expectation to find more mental health problems as a result of the interview using the study questionnaire. This possibly is a result of isolating and reporting the feelings as in the EQ-5D and study questionnaire whereas the MCS is a measure of how problems with mental health affect everyday activity. Thus, some participants state they have a certain level of anxiety and depression, however, this may not be affecting their everyday life and therefore in calculating the MCS would not be an overt problem. In this study the health outcome measures were used at their basic level to provide a profile of problems at each follow-up phase in comparison to a population norm or previous follow-up point to chart the changes experienced by injured road users. The measures, however, have the capacity to provide economic analyses using the QALY (quality adjusted life year) which are explored in Study 3.

One of the areas of concern in this study was the time point at which baseline assessment took place due to the nature of the recruitment process such that a 'true baseline' was not obtained. If participants were interviewed up to three weeks after their crash then there would be some, albeit limited, capturing of pre-crash health using the SF-36v2. This is a problem which may affect the results when comparing to baseline ability which could be 'worse' than pre crash health and provide false gains in actual health state over the time period. Although it was noted that general health throughout the study remained relatively unaffected by any fluctuations in physical or mental health capabilities, this would suggest that 'general health' is a separate concept for this participant group. This would be an interesting factor to examine in other studies to determine whether those with injuries consider them to affect general ability rather than their general health.

- Relatively 'minor' injury sample predominated by whiplash injury
- Evident that outcomes are varied even for similar injuries, i.e. whiplash
- Pain was a major factor at all follow-up points in time
- Social support did not appear to affect the recovery of participants
• A 100% return to work rate was achieved at 12 months, with all participants wanting to return to work
• There were implications for some who had been treated conservatively rather than immediate surgery and their perceived delay in recovery as a result
• Reported depression was apparent for this sample but this was contradicted by the MCS
• Physical outcomes such as loss of sporting hobbies or work activities were predominately affected
• Significant gender differences in outcome were not apparent
• Injury severity was a factor where MAIS 1 injuries had better measurable outcomes compared to MAIS 2 injuries
• Financial burden experienced by participants had implications for the individual and contributed to 'worry' and 'stress'

9.10: Methodological Implications

This study did not have high proportions of seriously injured participants to make any useful comparisons of their outcomes compared to those with minor injuries. However the methodology was considered to be suitable for a further study to examine the outcomes in a 'seriously' injured sample. A second study was proposed to examine the outcomes of participants admitted to hospital as a result of their injuries sustained in a road traffic accident to establish any variances between the 'minor' injuries in this study and the anticipated 'serious' injuries. Thus, the main implications from Study 1, relating to possible future studies that attempt to replicate the methodology used in this study would need to consider the most important issues which are summarised below:-

• It is necessary to include an actual psychological scale to assess depression in comparison to using the MCS and EQ-5D.
• It was considered that baseline interviews need to be undertaken as soon as possible after the crash to attempt to identify pre-injury health
state. This would also act to provide a set of scores for comparison with follow-up data.

- The postal recruitment was considered to be too slow and rendered the baseline data to be uninformative thus a better method of recruitment is required.
- The level of attrition also has to be addressed and the process of contacting participants at follow-up needs to be improved.
Chapter Ten: Study 2
Follow-up Study of Participants Injured in Road Crashes Admitted to Hospital
10.1: Introduction

This study involved the recruitment of participants from hospital immediately after their crash who had been admitted to hospital as a direct result of the injuries sustained. Thus, recruitment took place at the participant's bedside as did the initial 'baseline' interview. Subsequent follow-up interviews were conducted by telephone at three, six and twelve months post crash. The aim of this study was to recruit a more 'serious' injury sample as well as piloting a different recruitment method to determine its effectiveness for this type of study.

The specific methodology is presented, followed by the initial results from baseline through to 12 months in separate chapters. A discussion of the results from Study 2 is presented in Chapter 15. Individual case studies are presented in appendix F for illustrative purposes at the individual level.

10.2: Study Objectives

- To recruit and follow-up a sample of participants who were admitted to hospital as a result of injuries sustained in a road crash.
- Obtain a true 'baseline' assessment for pre crash status
- Explore the major effects of the injury or crash on individuals and any consequent effects on the family
- Provide a sample of persons with more serious injuries for comparison with Study 1.
- Examine the effectiveness of directly recruiting participants following hospital admission.
- Does a 'true' baseline assessment provide more relevant data on health outcomes?
- Determine whether there is a need for an extra 'outcome measure' in the overall data collection to assess depression formally.
Chapter 10: Study 2 - Follow-up study of participants injured in road crashes admitted to hospital

10.3: Methods

To enable the researcher to gain access to participants immediately following their crash it was deemed necessary to recruit them whilst they were in hospital. Two main trauma hospitals in the East Midlands were approached for participant recruitment into the study. Original approaches were made to the Heads of Trauma at the two hospitals and meetings held to obtain permission to approach participants and also support an application to the relevant Local Research and Ethics Committees. Both hospitals were supportive and consent was granted by all of the Orthopaedic consultants giving their permission to approach their patients. Applications to the Research and Ethics Committees in Leicester and Derby were made and approval granted with some minor amendments and negotiations (Appendix I). Normally it is a requirement to give someone 24 hours to consider their proposed inclusion in a study; however, it was negotiated to give someone a minimum of one hour since many patients are discharged within 24 hours. This approach was chosen to maximise the sample. As the study was ‘low risk’ (being non-intrusive and involving no medical procedures) a minimum of one hour was considered to be suitable and it was strongly emphasised throughout that participants could withdraw their consent at any time during the study.

Constraints were placed on the researcher (by the Ethics Committees) as no comparisons could be made with those participants refusing to take part or those discharged as no access to medical notes or personal information was possible without the patients' informed consent. Honorary research contracts from the participating hospitals concerned were also granted to the researcher to allow access on to the hospital sites and to approach patients on the ward.

Once the ethical approval and honorary contracts were in place, meetings were held with the trauma coordinators to establish the best and most convenient way to obtain the names of potential participants. The trauma
coordinators originally proposed for the researcher to telephone once a week but this would have been inappropriate for the study and finally it was agreed that the researcher would telephone three times a week and obtain the names and location of participants. Information was given to all of the ward managers and in one hospital the trauma coordinator introduced the researcher to all of the wards and a start date for participant recruitment was negotiated. Yearly reports were submitted to the Research Offices at both of the hospitals in accordance with ethical approval requirements.

10.3.1: Sample Population

The sample population comprised participants admitted to the Leicester Royal Infirmary and Derby Royal Infirmary involved in an RTA between 14th July 2003 and December 19th 2003. It was originally proposed to recruit participants over three months, however it was soon apparent that more time was required thus recruitment continued to December taking into consideration the time frame for a 12 month follow-up.

10.3.1.2: Inclusion Criteria

- All participants had to have been admitted with an injury sustained in a RTA either as a vehicle occupant or as a vulnerable road user on a public highway in the course of normal everyday activities.
- All participants had to have access to a telephone for follow-up interviews.
- All participants had to be able to converse in English as follow-up interviews were over the telephone.
- Participants had to be aged between 18 and 70 years of age.
- Participants were still an inpatient on the ward when the researcher visited
10.3.1.3: Exclusion Criteria

- Those aged less than 18 years and above 70 years of age
- Those without a sound ability to converse in English
- Those whose injuries were sustained on a non-public highway for example 'quad bike' and 'speedway' tracks, to ensure a road traffic sample was obtained.
- Those already discharged when the researcher visited
- Participants already involved in other research studies
- Those that refused to take part in the study

10.3.2: Recruitment of Participants

The researcher spoke to the nurse in charge on arrival at the wards to assess the suitability of approaching a particular patient and confirming the method of injury. If participants were considered too old or young, their age was ascertained from the nurse in charge prior to approaching in order to avoid disturbing them unnecessarily. The heads of trauma at both hospitals had provided the researcher with a letter of introduction and this was used in the initial contact with the patient to introduce the researcher (Appendix J). The study was explained and information left for them to consider their inclusion (Appendix K). They were informed that the researcher would return later that day or later in the week if they were likely to be an inpatient for a number of days. It was also determined at this time if they were already involved in a research study to help prevent over-burdening the participant.

On return to the patients they were asked if they would take part in the study and if so informed consent was obtained in triplicate (Appendix L). Copies were held in the patient's medical notes, left with the patient in person and lastly a copy was retained by the researcher. Semi-structured interviews were conducted at the patient's bedside which took approximately 30 to 40 minutes. Many participants wanted to talk
extensively about the crash which was thought to be a useful and necessary procedure both for the patient and the researcher. Contact information was obtained for the participant and, if they agreed a second contact person their personal details were recorded to help locate participants at the specified follow-up time periods.

**10.3.3: Data Collection Procedures**

The data collection tools selected were the same as for Study 1 with the addition of the CES-D\(^\text{10}\) scale to determine levels of depression. The addition of the CES-D scale was considered to be a more definitive assessment of depression, and it was hoped would provide a baseline assessment of mental health which was not available for Study 1 (Appendix M). The interviews were structured in the same order as for Study 1 (the study questionnaire, SF-36v2, EQ-5D (+cognition) and the CES-D) to minimise any bias in the administering of the questionnaires. The CES-D scale is a short self report scale designed to measure depressive symptomatology in the general population (Radloff 1977). Thus it is not a diagnostic tool for depression but a measure of affective component i.e. depressive mood which contributes to the diagnosis of clinical depression. It has proven validity and reliability and is useable by a lay interviewer (Radloff 1977, Comstock and Helsing 1976, Roberts, Rhoades et al. 1990). It has a time frame of reporting symptomatology over the previous one week and consists of 20 items which were selected from pre-existing depression scales. It attempts to assess symptoms from four factors;

- Depressed affect (lonely, sad, feeling depressed)
- Positive affect (hopeful, happy, enjoying life)
- Somatic and retarded activity (poor appetite, sleep disturbance)
- Interpersonal (people unfriendly, feel un-liked)

\(^{10}\) Centre for Epidemiological Study- Depression scale (CES-D)
Respondents have to state how often over the past week they have felt that particular item. For example “You did not feel like eating: your appetite was poor”. The responses available to the participants are ‘rarely or none of the time’ (less than one day), 'some or a little of the time' (1-2 days), 'occasional or a moderate amount of time' (3-4 days) 'most or all of the time' (5-7 days).'

Thus the responses are rated on a 0-3 scale with a range, when summed, between 0 and 60. A score of 16 or above is suggestive of depressive symptomatology and below that of being in the ‘normal range’ (Comstock and Helsing 1976, Radloff 1977). The items have both negative and positive qualities such that a depressed person is less likely to experience the positive affect (lower scores) and would have a high presence of negative affects (higher scores). It is expected that a healthy general population would experience some of the negative affects some of the time thus it is the accumulative affect which is measured.

Following the interview, the researcher reviewed the patient's medical notes and, where possible, the patient's X-rays to review and record all injuries sustained in the crash. Minor injuries such as bruising and abrasions were recorded at the bedside with the participant. Letters were sent to the GP to inform them of their inclusion in a research study as requested by the Local Health Authority ethical requirements (Appendix N).

10.3.4: Coding of Injuries

All injuries were coded to AIS 98 and an ISS calculated for each participant, as well as recording the MAIS for each body region. The number of injuries were also noted and for the purposes of the study the most ‘severe’ or problematic injury was noted for analysis purposes. For example if the participant had three AIS 2 injuries the injury which they perceived to be the ‘worst’ for them was used for determining the main body region injured.
Employment status was coded using the NS-SEC categories and social class was also approximated from these categories (ONS 2000a).

**10.3.5: Data Procedures**

Following the participants' interview a study code was assigned and data entered onto a database as anonymous datasets. The consent forms and contact detail forms were kept in separate locked drawers as per ethical protocol. Microsoft Outlook calendar system was used to enter follow-up reminders using the study code as an identifier.

**10.3.6: Follow-up Studies**

Follow-up interviews were conducted at three, six, and twelve months using the same interview schedule as at baseline. Where contact could not be made directly with the participant the second alternative contact, where available, was contacted for a new telephone number and address. However, where no alternative telephone contact could be made letters were sent to the participant’s address asking for information to enable the researcher to telephone the participant. Attrition rates were recorded at each stage of the follow-up period. All subsequent data were entered onto the database.

**10.3.7: Data Analysis**

Non-parametric statistics were used to analyse the data as these did not meet the criteria for using parametric statistics. Statistical tests used were the Chi-squared, Fishers exact, Freidman analysis of variance and the Wilcoxon signed rank test and where appropriate corrections for multiple comparisons were made. This correction factor was the conservative measure of Bonferroni inequality to ensure the error rate for combined comparisons was at alpha per experiment (Knapp. 1985). Therefore instead of using a significance value of p=0.05 a conservative value p=0.05 divided by the number of comparisons will be used (MacArthur and Jackson 1984).
Content analysis was used to examine the interview data and categorise the responses into a suitable format for analysis. Those people who were lost to follow-up or dropped out of the sample at varying follow-up times were compared to the baseline sample to examine any differences. No comparisons, however, could be made between those patients who refused to take part in the study and those that did because access to any medical notes without permission was not acceptable practice within this research methodology.
10.4: Results

10.4.1: The Sample

A total of 50 participants were recruited from the two hospitals over a five month period. Initial interviews were usually conducted within three days of being admitted into hospital. The mean number of days post crash for the interviews was six and the median was three days, range 0-27 days. Where participants had sustained serious injury, the length of time prior to initial interview was longer due to the nature of their injuries and the restricted access enforced by the nurse in charge. The mean age was 36 years, the median age 34 years and range 18-68 years. The majority were male (78%, n=39) and of white British ethnicity (94%, n=47). The majority were single (52%), 38% were married and 10% were separated or divorced. Fifty percent of the sample lived with a partner or spouse, 18% lived alone, 18% lived with their parents, 2% lived with friends, 10% lived with other relatives and 2% lived in other accommodation such as army barracks.

10.4.2: Employment

The majority of the sample worked in full-time employment (table 10.1). Seventy two percent were the main wage earners with 2% being equal earners and 26% the second income earners.

<table>
<thead>
<tr>
<th>EMPLOYMENT HOURS</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time</td>
<td>34</td>
<td>68%</td>
</tr>
<tr>
<td>Part time</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Student</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>House duties</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Retired</td>
<td>4</td>
<td>8%</td>
</tr>
</tbody>
</table>

The typical daily activity at work / home was split roughly between physical, semi-active and sedentary lifestyles (table 10.2).
Chapter 10: Study 2 - Follow-up study of participants injured in road crashes admitted to hospital

Table 10.2: Daily activities type at baseline

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>Office based</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>Active</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Semi active</td>
<td>17</td>
<td>34%</td>
</tr>
<tr>
<td>Sedentary</td>
<td>12</td>
<td>24%</td>
</tr>
</tbody>
</table>

Employment was categorised into NS-SEC (2000) groups and are presented below. Thirty-four percent of the sample undertook some form of skilled manual work and 18% had their own business. There were 8% who could not be classified into any category because of long term unemployment.

Table 10.3: Socio economic groups (NSSEC 2000)

<table>
<thead>
<tr>
<th>SOCIOECONOMIC GROUP</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers large companies</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Employers industry small establishments</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Managers small companies</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Professional workers employees</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Intermediate non manual workers ancillary works</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Junior non manual workers</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Personal service workers</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Skilled manual workers</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td>Semi skilled manual workers</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Unskilled manual workers</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Own account workers other than professionals</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td>Agricultural workers</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Armed forces</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Unclassifiable</td>
<td>4</td>
<td>8%</td>
</tr>
</tbody>
</table>
Chapter 10: Study 2 - Follow-up study of participants injured in road crashes admitted to hospital

The NS-SEC categories can be approximated into the social class groups with the majority falling into Social Class III for skilled workers (31%). There were 10% who could not be classified into this system because of unemployment or being in the armed forces, table 10.4.

Table 10.4: Approximated social class from NS-SEC 2000

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class I</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Managerial and technical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class II</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Skilled occupations non manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class IIIa</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>Skilled occupations manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class IIIb</td>
<td>17</td>
<td>17%</td>
</tr>
<tr>
<td>Partly skilled occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class IV</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>Unskilled occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social class V</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Unclassifiable</td>
<td>5</td>
<td>10%</td>
</tr>
</tbody>
</table>

10.4.3: Wages

The median wage earned by those in employment was between £16,000 and £20,999, which is slightly below the mean national wage of £22,411, table 10.5 (http://money.guardian.co.uk/news.html); the mean national wage is £22,411 according to pathfinder, with the East Midlands having a mean of £22,528 (February 16th 2005).

Table 10.5: Median earnings at baseline

<table>
<thead>
<tr>
<th>EARNINGS</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>No wages</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Less than £10, 999</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>£11,000 - £15,999</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>£16,000 - £20,999</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>£21,000 - £25,999</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>£26,000 - £35,999</td>
<td>7</td>
<td>14%</td>
</tr>
</tbody>
</table>
Eleven people were on some form of benefit other than child benefit and six were drawing their state pension. Two received income support, four received job seekers allowance, three received working family tax credits, one received incapacity benefit, one received disability allowance and one received education maintenance allowance for his brother.

The majority of the sample had attended senior school only, 54% \( (n=27) \), 40% attended college \( (n=20) \) and 6% \( (n=3) \) attended university.

Socially, 72% of the sample perceived themselves to have good support contacts from family and friends, 20% good support from family only and 8% from friends only.

### 10.4.4: Hobbies

Forty six percent of the sample \( (n=23) \) had just one hobby which they undertook on a regular basis, 6% had no hobbies at all, 24% had two hobbies and 18% had three hobbies they regularly undertook each week (table 10.6).

<table>
<thead>
<tr>
<th>HOBBY</th>
<th>NUMBER ( (N=50) )</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hobbies</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Gym</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Team sports</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>Running</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Walking</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>Cycling</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Sports other (horse riding, swimming,</td>
<td>25</td>
<td>50%</td>
</tr>
<tr>
<td>squash, dancing, mountaineering, hill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>walking)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving / motorbikes</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>Gardening</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Sedentary (reading / calligraphy etc)</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Other interests (DIY, cooking, etc)</td>
<td>5</td>
<td>10%</td>
</tr>
</tbody>
</table>

General house duties were carried out by 54% of the sample but chores such as gardening and shopping were carried out by 76% of the sample on a regular basis.
10.4.5: Pre-existing Health Problems

None of the sample stated they had any pre-existing physical or sensory impairment prior to the crash although two suffered with epilepsy which was serious enough not to allow them to work. Other health problems were experienced by 30% of the sample and are listed below in table 10.7. One person suffered with two of these health problems*.

<table>
<thead>
<tr>
<th>PRE-EXISTING HEALTH PROBLEM</th>
<th>NUMBER (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>5</td>
</tr>
<tr>
<td>Arthritis</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>1</td>
</tr>
<tr>
<td>Bladder problems</td>
<td>1</td>
</tr>
<tr>
<td>Depression</td>
<td>4*</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>2</td>
</tr>
</tbody>
</table>

Only 13 of those with a pre-existing health problem were on any medication prior to their crash and it can be seen that the pattern of medications follows the health problem (table 10.8). Only one of the four people stating they suffered with depression was on actual medication for the problem.

<table>
<thead>
<tr>
<th>PRE-EXISTING MEDICATION</th>
<th>NUMBER (N=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-hypertensives</td>
<td>2</td>
</tr>
<tr>
<td>Anti-inflammatory</td>
<td>1</td>
</tr>
<tr>
<td>Aspirin</td>
<td>1</td>
</tr>
<tr>
<td>Cholesterol tablets</td>
<td>1</td>
</tr>
<tr>
<td>Asthma</td>
<td>5</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>1</td>
</tr>
<tr>
<td>Anti epileptic drugs</td>
<td>2</td>
</tr>
</tbody>
</table>

10.5: The Crash and Immediate Consequences

A high proportion of the sample was vulnerable road users (54%) compared to car occupants (46%) at the time of the crash (table 10.9).
Chapter 10: Study 2 - Follow-up study of participants injured in road crashes admitted to hospital

Table 10.9: Road user type

<table>
<thead>
<tr>
<th>ROAD USER</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td>15</td>
<td>30%</td>
</tr>
<tr>
<td>Front seat passenger</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>Back seat passenger (middle)</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Motorcycle driver</td>
<td>14</td>
<td>28%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Cyclist</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Motorcycle pillion</td>
<td>2</td>
<td>4%</td>
</tr>
</tbody>
</table>

The distribution of the 'main' injuries are presented below in table 10.10; the mean number of coded injuries sustained was five (range 1-13). The main injury is classified by the highest AIS code. If there were numerous injuries or if the AIS codes were the same the injury the person considered to be the 'worst' was classed as their main injury.

Table 10.10: Main body region injured

<table>
<thead>
<tr>
<th>MAIN BODY REGION</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Spine</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Neck</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Thorax</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Pelvis</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>24</td>
<td>48%</td>
</tr>
</tbody>
</table>

Noticeably, there are a high number of lower extremity injuries in this sample group even when pelvis injuries are excluded. These were separated into a category of their own due to the number of injuries sustained in the pelvis alone. Although in combination it can be said that 60% of the 'main' injuries occurred to the lower extremity. The highest MAIS score of 5 was attributed to a pelvic injury.
The mean ISS for the sample was 12 (range 1-57, median 10) and the median MAIS was 3 (range 1-5), figure 10.1.

As can be seen from figure 10.2, the majority of the sample (64%) scored 10 or less on the ISS and at an ISS score of 14, 84% of the sample are accounted for. There is a sharp rise in the curve from 0 upwards for this sample group compared to Study 1 (which was a gentler curve due to the low MAIS scores). Scores below 16 are not classified as major trauma in the UK trauma hospitals unlike the scores above 16. Scores above 16 accounted for 16% of the sample (n=8).
The mean length of stay in hospital for this sample group was 17 days, with a median of nine days. Overall 43% had a stay of one week or less, 69% two weeks or less and 75% three weeks or less. The entire sample was on prescribed painkillers post-crash and one participant was also on newly prescribed antidepressants. Eight percent of the sample had an inpatient episode in intensive care, two participants had a stay of one day and two days respectively and two participants had stays of 10 days in intensive care.

10.6: Health Outcome Measures

10.6.1: EQ-5D (+cognition)

None of the sample scored 11111 in all health domains across the EQ-5D. However 6% (n=3) scored at the floor (33333). Their injuries were fractured lumbar vertebrae (MAIS 2, ISS 4), significant bilateral leg fractures and knee ligament damage (MAIS 3, ISS 10) and fractures to the thoracic spine, ribs and pelvis (MAIS 3, ISS 14). The main problem was mobility for this sample group at baseline. This is a reflection of the
fact that many were actually confined to bed with restricted movement. Obviously being in hospital and confined to bed had a severe restriction on any usual activities that they undertook. Six percent of the sample did not have any problems with pain at baseline, although all were on prescribed analgesics. Over half of the sample was experiencing some anxiety at the time of assessment. Five people stated they had a problem with their cognitive levels - this was perceived to be related to epilepsy and for one 'forgetfulness'.

**Figure 10.3: Distribution of EQ-5D+cognition**

The mean visual analogue score (VAS) score for this sample at baseline was 45, range 0-95. However, the index score calculated from the actual original profile had a range between -.59 to .66. Sixty percent of the sample scored below zero in the index calculations suggesting they had 'health states worse than death' at baseline. The main influencing factors to these low utility scores were their lack of mobility (bed bound), restricted daily activity and pain. The baseline scores were significantly different to a matched population sample for age and gender (p<0.0001, Wilcoxon signed ranks test).
10.6.2: SF-36v2

Respondents were asked to rate their general health at the time of the interview of which the majority 52% had excellent or very good health, (table 10.11).

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Very good</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>Good</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Fair</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Respondents were also asked to rate their health compared to a year ago. The majority considered their health to be about the same as a year ago, with some 11% stating it was actually better.

<table>
<thead>
<tr>
<th>PERCEIVED HEALTH</th>
<th>NUMBER (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>About the same</td>
<td>29</td>
<td>58</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Much worse</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

The SF-36v2 dimension scores at baseline did not vary significantly from matched population norms for age and gender, (figure 10.4). This is probably because the SF-36v2 assessment incorporates the previous four weeks thus captures pre-injury health states unlike the EQ-5D which is an assessment of that particular day.
Figure 10.4: SF-36v2 dimension scores at baseline

PF- physical function; RP - role physical; BP - bodily pain; GH - general health; VT - vitality; SF - social function; RE - role emotional; MH - mental health

The PCS and MCS component scores reflect lower than average physical component scores for this sample which is possibly a reflection of a few choice questions on the 36 item scale which ask directly about capabilities for 'now', (figure 10.5). Mental health is considered average for this sample although over half of the sample was experiencing moderate to severe problems in the EQ-5D anxiety/depression domain.
10.6.3: CES-D

The CES-D inventory for assessing depression was used to determine depression in this sample of participants. A score of 16 and above is indicative of depression and 34% (n=17) of the sample achieved a score at this level, with 16% of the sample scoring zero. Out of those scoring 16 and above only two had a previous history of depression, with one on medication at the time.

The MCS for those classed by the CES-D as depressed was higher than the UK norm for 8 out of the 17 participants. The baseline scores for the MCS and CES-D correlated highly (p<.0001, Kendalls Tau). In contrast the profile scores for these participants on the EQ-5D for anxiety and depression showed 10 of the participants having moderate to severe anxiety / depression. There was a moderate correlation between the EQ-5D VAS scores and the CES-D scores (p=0.039, Kendalls Tau) although the utility scores showed no association with the CES-D scores at baseline. The utility scores were considerably low with only four achieving a score of zero or above.
Chapter Eleven: Study 2
Three Month Follow-up Data
11.1: Introduction

This chapter presents the results following the three month follow-up interviews and examines any changes between baseline and three months for this sample group.

All participants were contacted at three months following the crash to ensure comparability with data from other studies. These interviews were conducted by telephone and followed the same interview protocol as the baseline interview to ensure continuity and to minimise any bias in the interview questionnaire order. The interviews usually lasted between 30 - 50 minutes. Some were shorter but the ability to talk about the crash and subsequent discomforts tended to prolong the interview to more than was originally proposed. The majority of participants were contacted within one week of the three month date, however a further two weeks was allowed on top of this to maximise the opportunity.

11.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop-outs were compared to the remaining sample at three months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann Whitney-U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36v2 dimension and component scores between baseline and 3 months. Content analysis was used to categorise interview responses into a format for data analysis.
11.3: Results

11.3.1: Attrition

At three months a total of four people had dropped out of the sample and, these were non contactable at three months. Telephone numbers were changed or unobtainable and no response was given to letters sent in the post.

The drop-outs at three months were compared to the remaining sample using Fishers exact test or Chi-squared for nominal data and Mann-Whitney U test statistics for independent groups for ordinal data. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus, the groups could be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

| Table 11.1: Drop outs at 3 months |
|-------------------------------|------------------|-----------------|-----------------|-----------------|
|                               | BASELINE (N=50) | 3 MONTHS (N=46) | TEST STATISTIC | P VALUE         |
| Gender                        | 78%             | 78% male        | Fishers exact  | .64             |
| Age (mean years)              | 36 years        | 36.5 years      | Mann-Whitney U | .5              |
| Education                     |                 |                 | Chi-squared    | .7              |
| School                        | 27              | 24              |                 |                 |
| College                       | 20              | 19              |                 |                 |
| University                    | 3               | 3               |                 |                 |
| Wage brackets (median)        | £16-£20,999     | £16-£20,999     | Mann-Whitney U | .1              |
| MAIS                          |                 |                 | Chi-squared    | .7              |
| 2                             | 14              | 13              |                 |                 |
| 3                             | 30              | 27              |                 |                 |
| 4+                            | 6               | 6               |                 |                 |

The data were examined for any changes in lifestyle, personal circumstances, employment, health and any knock on effects of the crash or injury. A summary of the changes that are a result of the crash at three months are presented below and discussed.
11.3.2: Personal Circumstances

There were no changes recorded for marital status. However, 11% (n=5) stated that their living arrangements had changed as a result of the injury. Three lived alone at the time of the crash and were now staying with parents, other relatives or friends as they were not able to manage at home alone. One was living with their partner and had moved back home to their parents and another who was in the armed forces had moved back in with his parents.

Social contact also changed for this group with less contact with friends at three months. 'Speaking to friends' reduced for 37% of the sample; the maximum contact was 2 - 3 times a week compared to baseline daily contact. Seeing friends was also reduced for 44% of the sample. This was as a result of not being at work where friends were and also as a result of missing social hobbies undertaken such as football. However, there were two people who stated that they just 'couldn't be bothered' or felt too tired to initiate any contact themselves so if friends did not get in touch they did not think it a problem.

Conversely, contact with family increased for this group at three months; 11% (n=5) saw more of their family now than before and for three of these, this was a direct result of moving back home. There was some reliance on family to help out for certain things such as shopping or just a general concern from family so they tended to 'pop in' more. There was an increase in telephone contact with family for this group at three months for 9% (n=4) and contact was almost daily if the family lived a distance away.

Lifestyle

General house and garden chores were affected considerably at three months with 64% of the 25 who did house duties at baseline unable or having to 'cut down' on what they were capable of doing prior to the
crash. Again of those 35 who undertook general gardening / shopping duties at baseline, 69% had stopped doing them altogether or had cut down depending on capabilities.

Of the 46 participants in the three month follow-up group, 39 (85%) had at least one regular hobby that was affected by their injury. The hobbies not able to be pursued by those 39 participants are listed in table 11.2.

<table>
<thead>
<tr>
<th>Hobby</th>
<th>Number (N=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports other (horse riding, swimming, squash, dancing, mountaineering, hill walking)</td>
<td>23</td>
</tr>
<tr>
<td>Team sports</td>
<td>10</td>
</tr>
<tr>
<td>Driving / motorbikes</td>
<td>9</td>
</tr>
<tr>
<td>Walking</td>
<td>7</td>
</tr>
<tr>
<td>Cycling</td>
<td>4</td>
</tr>
<tr>
<td>Gardening</td>
<td>4</td>
</tr>
<tr>
<td>Other interests (DIY, cooking, restoring cars)</td>
<td>4</td>
</tr>
<tr>
<td>Running</td>
<td>3</td>
</tr>
<tr>
<td>Gym</td>
<td>2</td>
</tr>
<tr>
<td>Sedentary (reading / calligraphy etc)</td>
<td>2</td>
</tr>
</tbody>
</table>

The hobbies are varied but many involved physical activity / dexterity or involve kneeling, crouching or bending down such as DIY or restoring cars. Given the injuries sustained by some, it is unsurprising that difficulties were encountered.

There were considerable changes in everyday activity for this sample group with 72% stating they could not manage their normal daily routine (table 11.3). Six percent stated that they could either perform their work or housework but couldn't manage both like they used to do. Similar to Study 1, the recovery effort was focused on the return to work and house / general duties were secondary to this.
Chapter 11: Study 2 - Three month follow-up data

Table 11.3: Changes in lifestyle from baseline to 3 month follow-up.

<table>
<thead>
<tr>
<th>LIFESTYLE ACTIVITY</th>
<th>PERCENTAGE CHANGE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage daily routine</td>
<td>72%</td>
<td>33</td>
</tr>
<tr>
<td>Hobbies</td>
<td>85%</td>
<td>39</td>
</tr>
<tr>
<td>House duties</td>
<td>64%</td>
<td>16 (25)</td>
</tr>
<tr>
<td>General duties</td>
<td>69%</td>
<td>24 (35)</td>
</tr>
<tr>
<td>Seeing friends</td>
<td>44%</td>
<td>20</td>
</tr>
<tr>
<td>Speaking to friends</td>
<td>37%</td>
<td>17</td>
</tr>
<tr>
<td>Seeing family</td>
<td>11%</td>
<td>5</td>
</tr>
<tr>
<td>Speaking to family</td>
<td>9%</td>
<td>4</td>
</tr>
<tr>
<td>House adaptation</td>
<td>4%</td>
<td>2</td>
</tr>
</tbody>
</table>

Two people had had their houses adapted to accommodate them in their home. One person with a fractured pelvis had had a second banister fitted to assist him going up and down stairs. Another person, with a fractured pelvis and talus fracture, had been accommodated downstairs in one room. Her bed was moved and a commode obtained because her bathroom and toilet were situated upstairs. This person was in a wheelchair as a result of the crash with poor access around the house such as steps between rooms and up to her front door. She was unable to physically get into any other room in the house other than the adapted room at three months.

11.3.3: Employment

At three months 46% (n=21) of the sample were unable to work due to their injuries. All but one of these were full-time workers, the other a part time worker was still off sick at three months. The types of job these people did are in table 11.4.

Table 11.4: Employment type for those off sick at 3 months

<table>
<thead>
<tr>
<th>EMPLOYMENT TYPE</th>
<th>NUMBER (N=21)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>7</td>
<td>33.5%</td>
</tr>
<tr>
<td>Heating and plumbing</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td>Office based</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td>Physical / technical</td>
<td>7</td>
<td>33.5%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>5%</td>
</tr>
</tbody>
</table>
In terms of normal activity for this sample group, 29 people now classed themselves in a sedentary role at three months. This includes those whose main activity was housework compared to baseline when only 11 people classed themselves in a sedentary role. Notably 67% of those off sick at three months had lower extremity injuries. The MAIS for those off sick was three for 67% of the sample, 24% had a MAIS higher than three and the remainder had a MAIS of 2.

For those that had returned to work at three months (n=11), the lower extremity was the main body region injured for 55%. The MAIS was roughly split into those with MAIS 2 (46%) and MAIS 3 (46%) with the remaining having a MAIS 1 injury (table 11.5). The highest ISS for those returning to work was 14 with 67% scoring 9 or below. A score of nine is indicative of having one injury at AIS 3 level or two AIS 2 injuries plus an AIS 1 injury.

Of these 11 returning to work eight had returned to be able to perform their work as before albeit with some pain at the end of the day whereas three stated they had returned to work but in a somewhat restricted role such as doing 'light duties'.

| Table 11.5: Distribution of return to work and injury |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | OFF SICK (N=21) | OVERALL RETURN TO WORK (N=11) | RETURN TO WORK FULLY (N=8) | RETURN TO LIGHT DUTIES (N=3) |
| Median MAIS     | 3               | 2               | 3               | 2               |
| Highest MAIS    | 5               | 3               | 3               | 2               |
| Lower extremity injury | 67%             | 55%             | 63%             | 33%             |
| Score ISS 9 or below | 24%             | 73%             | 63%             | 100%            |
| Score ISS 15 or above | 29%             | 0               | 0               | 0               |
| MAX ISS         | 57              | 14              | 14              | 6               |

From this table it can be seen that those off sick had higher ISS and MAIS injuries compared to those that returned to work. The two groups for return to work showed a slight disparity with what might be expected.
such as those on light duties having a lower MAIS and ISS. Even taking into account the size of the sample this reflects the importance of what job someone does and what injuries would influence the return to work. One of those who had returned to work full time was a finance manager who sat at a desk all day. His injury was a comminuted fractured shaft of femur which was internally fixed allowing some strength but limited movement in the limb. He was able to drive to work and perform his job but social, family and sporting hobbies were not viable activities. Overall the types of jobs undertaken by those who had returned to work were varied; three were classed as office workers, two were sedentary, four in physical employment and two were semi active.

As a result of being off sick or performing light duties, the wages for 48% of the group had changed (n=22) (table 11.6). All the changes were as a deficit. For example, at baseline, eight people earned less than £10,999 but at three months 21 people were earning at or below this level (46%). There were three more people at three months not earning a wage compared to baseline. This was because of self-employment or working through agencies where sick pay was not a company policy.

<table>
<thead>
<tr>
<th>EMPLOYMENT ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment hours changed</td>
<td>70%</td>
<td>32</td>
</tr>
<tr>
<td>Typical activities changed</td>
<td>76%</td>
<td>35</td>
</tr>
<tr>
<td>Wage changes</td>
<td>48%</td>
<td>22</td>
</tr>
<tr>
<td>Main wage earner</td>
<td>50%</td>
<td>23</td>
</tr>
<tr>
<td>Benefits</td>
<td>13%</td>
<td>6</td>
</tr>
<tr>
<td>Off sick</td>
<td>76%</td>
<td>35</td>
</tr>
<tr>
<td>Off duties (if not working)</td>
<td>22%</td>
<td>10</td>
</tr>
<tr>
<td>Received sick pay</td>
<td>28%</td>
<td>14</td>
</tr>
<tr>
<td>Received statutory sick pay</td>
<td>30%</td>
<td>14</td>
</tr>
<tr>
<td>Returned to work / duties</td>
<td>24%</td>
<td>1</td>
</tr>
</tbody>
</table>
The group not normally employed and not returning to normal activity were considered separately (table 11.7) and included students, retired persons and houseworkers (n=6).

<table>
<thead>
<tr>
<th>NUMBER (N=6)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Median MAIS</td>
<td>2</td>
</tr>
<tr>
<td>MAX MAIS</td>
<td>5</td>
</tr>
<tr>
<td>ISS &lt; 9</td>
<td>50%</td>
</tr>
<tr>
<td>ISS &gt;14</td>
<td>33%</td>
</tr>
<tr>
<td>MAX ISS</td>
<td>26</td>
</tr>
<tr>
<td>% with lower extremity injury</td>
<td>83%</td>
</tr>
<tr>
<td>Return to normal /light activity at 3 months</td>
<td>50%</td>
</tr>
</tbody>
</table>

The two students in this group took two weeks off sick from their studies. One of the retired men had 60 days out of normal routine and was doing activities at a lower level than he did before or getting someone else to do it. Three people were still unable to perform their normal duties at three months because of their injuries, two of which were retired and one was a housewife. The housewife had the most severe injuries in this group. Injuries involved one at MAIS 5 (open book pelvic fracture with substantial blood loss) and a talus fracture (AIS 2) but the ISS was only 26 as all major injuries were to the lower extremities.

**11.3.4: Health Implications**

At three months, 70% of the sample (n=32) reported some form of physical limitation different from baseline. There were five people (11%) who listed two types of physical limitations. The types of limitations perceived by the sample are listed below in table 11.8.
Table 11.8: Types of physical limitation at 3 months

<table>
<thead>
<tr>
<th>TYPES OF LIMITATION</th>
<th>NUMBER (N=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't straighten limb</td>
<td>5</td>
</tr>
<tr>
<td>Can't bend limb</td>
<td>7*</td>
</tr>
<tr>
<td>Reduced range of movement</td>
<td>9*</td>
</tr>
<tr>
<td>Weakness in limb</td>
<td>2</td>
</tr>
<tr>
<td>Impotence</td>
<td>1</td>
</tr>
<tr>
<td>Unable to weight bear</td>
<td>5</td>
</tr>
<tr>
<td>Unable to kneel</td>
<td>1</td>
</tr>
<tr>
<td>In wheelchair</td>
<td>1</td>
</tr>
<tr>
<td>Catheter in situ</td>
<td>1</td>
</tr>
<tr>
<td>Limp</td>
<td>4</td>
</tr>
</tbody>
</table>

What is formally classed as physical impairment, such as being unable to weight bear or low of range of movement in a limb, are recognised as obvious impairments; however, other factors such as impotence and having a catheter in situ can only be classed under limitations.

To assist with any perceived physical 'impairments' 48% (n=22) of the sample used an aid to help with their mobility. For those who used a walking aid the most common were crutches (n=17), walking sticks (n=2) and a wheelchair (n=3). Two people had a secondary aid for mobility; their primary aid was a wheelchair when out of the house but within the house they used a zimmer or crutches. At three months, 10 people (22%) had a splint to support an injured limb and 9% had a plaster.

Sensory impairments were found in 15 (33%) of the sample. The main problem was numbness for 12, pins and needles for one person and short term memory loss for two people.

Pain was a major factor at three months for 80% of the sample group of which 54% were taking regular analgesics for pain. The other medication taken by this group were antidepressants for two people, warfarin for end, antibiotics and warfarin for three, antibiotics for one and one person was on multiple medications.

Thirteen participants (28%) were readmitted in the three month period. A further four people stated they would be admitted in the near future. Of
Chapter 11: Study 2 - Three month follow-up data

those readmitted, 10 had further surgery and three were readmitted for complications such as deep vein thrombosis and pulmonary embolism. Those four people who stated they would be admitted in the near future stated they would need further surgery.

Table 11.9: Changes to health status at 3 months

<table>
<thead>
<tr>
<th>HEALTH IMPLICATIONS</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>70%</td>
<td>32</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>33%</td>
<td>15</td>
</tr>
<tr>
<td>Pain</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aids / splints</td>
<td>48%</td>
<td>22</td>
</tr>
<tr>
<td>Readmitted</td>
<td>28%</td>
<td>13</td>
</tr>
<tr>
<td>Required further surgery</td>
<td>22%</td>
<td>10</td>
</tr>
<tr>
<td>Relatives took time off initially to</td>
<td>37%</td>
<td>17</td>
</tr>
<tr>
<td>look after them</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiving rehabilitation at 3 months</td>
<td>57%</td>
<td></td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>Carers</td>
<td>4%</td>
<td>2</td>
</tr>
</tbody>
</table>

Of those receiving rehabilitation at three months, physiotherapy was the main type whilst two were paying privately to visit an osteopath and two received treatment from the district nurse. Nobody was receiving any outside help with care either at home or in a rehabilitation setting. One person's husband had become her carer as she was confined to a wheelchair for mobility and was unable to weight bear or transfer between bed, wheelchair or commode. This meant that her husband could not work to provide an income. She had been a housewife and was therefore limited to the type and amount of benefit she was entitled to receive.

11.3.5: Insurance and Litigation

Thirty five percent of the sample claimed they were at fault for the crash (n=16). Of the 26 drivers and motorbike riders in the sample, 20 had fully comprehensive insurance, three had third party insurance and three were uninsured at the time of the crash. At three months 13 out of 15 people
who were expecting the insurance company to pay out had received their monies (table 11.10).

<table>
<thead>
<tr>
<th>Legal and insurance compensation</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court proceedings</td>
<td>52%</td>
<td>24</td>
</tr>
<tr>
<td>Expect compensation</td>
<td>50%</td>
<td>23</td>
</tr>
<tr>
<td>Expect insurance to payout</td>
<td>33%</td>
<td>15*</td>
</tr>
</tbody>
</table>

At this point of follow-up there was only approximately half of the sample who were involved in any compensation or court proceedings in relation to their crash. Thirteen of the drivers of cars or motorbikes were involved at this time in compensation proceedings as were six occupants / pillion passengers and five pedestrians. Of those 15 participants expecting an insurance company payout, 13 (87%) had received their money at three months.

11.3.6: Financial Burden

Eighty five percent of the sample (n=39) stated they were experiencing financial burden as a result of the crash / injury. Seven stated they were not suffering from any financial burden as a result of the crash. The range of financial losses was £200 to £25,500 with a mean loss of £3,237 and median loss of £2,000. The loss of £25,000 was a result of an individual not being insured whilst riding a motorbike on holiday in the United States from where he had to be flown home at his own expense. The type of financial burden experienced by the individual was categorised and is presented below in figure 11.1. Loss of earnings was a major factor for this sample group where financial burden was incurred. This may be a result of many being in manual skilled work or being self-employed where sickness benefits are at the Statutory Sick Pay (SSP) levels which do not cover normal wages earned.
Other costs incurred by this group were car and motorbike replacements or repairs. The 'other' category included the cost of shopping locally for food compared to going to the market or larger supermarkets. This involved a participant who was unable to travel great distances and relied on the corner shop for his shopping which was noticeably more expensive than normal shopping. The other category also included the costs incurred from compound car storage following the crash.

### 11.3.7: Major Effects

All but one of the sample stated the crash or injury had at least one major effect on them. The effects were categorised into distinct groups which are illustrated in figure 11.2. The main effects for this group were related to their physical functioning abilities and the effects of this on their social and work roles in society. One person was finding it difficult to be a 'dad' as in his words as he was unable to run, pick his children up or generally undertake normal activities which he took for granted before the crash.
Psychologically and emotionally this group had a range of emotions with one person questioning why he was not asked whether he was angry during the interview. He was angry because he was not at fault and had been crushed by a lorry as a result of the other driver's negligence from which he sustained serious pelvic fractures (AIS 4). Notably relationship problems were an issue for this group with two stating they had split up with their partners at this point and others stated they were having more arguments as a result of the crash. The arguments were partly because of a lack of understanding with regard to the injury. Also, the crash meant increased time spent with their partner due to incapacity for other activities which in turn lead to arguments. One participant's partner had been convicted of dangerous driving and driving without a license and jailed as a result of the crash.

One participant sustained a minor laceration to his thigh as a result of the crash - he was riding his motorbike slowly on the road and hit an object. As a result the handlebar deeply lacerated his leg, although there was no internal damage. For him the crash was minor and he only underwent surgery for exploration of the wound to ensure no internal damage had occurred. At the time of baseline interview he had no worries about going back on his bike. However, since the initial interview his wife was unfortunately affected by the crash and had been admitted to hospital with severe depression. He stated that the crash had brought an awareness of his mortality to his wife which, coupled with factors from her work, resulted in her depression. He had taken time off work initially for his wound to heal but had to take substantially more sick leave to look after his wife as she was expressing suicidal thoughts and was 'scared' to go back to work.

Others stated they had feelings of depression and feeling 'useless' because of the enforced immobility with one admitting to 'hitting the bottle' in the first six weeks as a result of such feelings.

The health category was again a large factor for this group with the main concern being constant pain. Three people were concerned about the fact that their fractures were not healing with one having a poor prognosis. He had been told that he was lucky not to have lost his leg
either at the time of the crash or during his initial surgery. However, the bone loss at the distal end of the femur was rendering the healing process a long and difficult one.

Secondary problems detected for this group included an undiagnosed fractured testicle (which had been disguised by the pelvic fracture at the time of the crash), deep vein thrombosis, pulmonary embolism and contracting MRSA.

This sample group at three months had a variety of concerns which were expressed during the interviews. One person who had suffered lower extremity and chest injuries was at home with no prospect of returning to work as a maintenance engineer in the near future and was having to borrow money to pay his mortgage. He was reliant on his regular overtime to pay the mortgage (on his 'dream home') and because of high repayments he had not take out mortgage protection. Conversely a self-employed driver had both mortgage and work insurance and could live without either borrowing money or amassing debt whilst off sick with lower extremity injuries.
Figure 11.2: Major effects of the sample categorised

Financial (n=8)
- Stress - money worries
- Loss of earnings
- Apathy
- Depression

Psychological (n=11)
- Sleep affected
- Angry
- Down
- Embarrassed and useless
- Anxiety for family
- Waking from period of unconsciousness
- Lucky to be alive
- Anxious passenger now

Emotions (n=14)
- Relationship problems
- Travel back from abroad
- Wife clinically depressed / suicidal
- Children not understanding of injury and limitations
- Boyfriend imprisoned - driver in crash
- Perception of life changed re: mortality

Driving (n=2)
- Nervousness about going on bike
- Unable to do normal everyday activities
- Inconvenience of no transport

Social (n=33)
- Time lost on normal things
- Work / college affected by injury
- Unable to do sporting hobbies
- Lost job
- Reliance on others for transport or help

Functioning (n=31)
- Loss of mobility
- Loss of functioning in limb
- Isolated - unable to go anywhere alone
Chapter 11: Study 2 - Three month follow-up data

Health (n=31)
- Time to heal
- Physical symptoms
- Constant pain
- Secondary problems
- Prognosis
- Non healing of fracture

Other (n=3)
- Changed life completely

No effects (n=1)

11.4: Health Outcome Measures

11.4.1: EQ-5D (+cognition)

A total of two participants (4%) had a profile of 11111(1) compared to no participants at baseline having this profile; no participants had a floor effect of a 33333(3) profile compared to three people at baseline. There were 21 participants scoring at least one three on their health profile at three months compared 49 at baseline. As can be seen from figure 11.3 the performing of usual activities was where the most severe problems were found at three months. Over half of the sample stated they had some problems in all domains except self-care and cognition.
The visual analogue scores for the EQ-5D at three months were higher than at baseline although not significantly higher (Wilcoxon rank sum test \( p = .063 \)).

The utility scores calculated from the profile scores were significantly higher compared to baseline, (mean -0.011 and 0.48, median -0.095 and 0.59 (Wilcoxon rank sum test \( p = < 0.0001 \)). There were three participants scoring below 0 at three months on the utility index who scored three in three of the health domains. These had injuries ranging from an AIS 2 neck injury, to AIS 3 and AIS 5 pelvic injuries.

### 11.4.2: SF-36v2

With regard to general health, at three months, the sample included more participants rating themselves as fair or poor compared to baseline.

<table>
<thead>
<tr>
<th>GENERAL HEALTH</th>
<th>NUMBER (N=46)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Very good</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Good</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>Fair</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Poor</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
When asked to rate their health compared to one year ago, 70% of the sample rated themselves as being 'somewhat' or 'much worse' than a year ago, 20% rated themselves as the same as one year previously. Only one participant considered their health to be better than one year ago which was related to him having lost a substantial amount of weight and reducing his high blood pressure.

The SF-36v2 health dimensions at three months post crash were assessed and are presented below in figure 11.3. From the graph it can be seen that there was a decline in all of the health domains from baseline to three months. There were statistically significant differences at the p=0.006 level (p=0.05 corrected for 8 multiple comparisons) using Wilcoxon rank sum test for all but the bodily pain (p=0.009) and general health dimensions.

For each of the dimensions the floor and ceiling effects were considered at three months. The floor effects were apparent for the role physical dimension at three months.
Table 11.12: SF-36v2 floor and ceiling effects

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%) (N=46)</th>
<th>CEILING (%) (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>41%</td>
<td>4%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Vitality</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>11%</td>
<td>17%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>4%</td>
<td>30%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>0%</td>
<td>12%</td>
</tr>
</tbody>
</table>

11.4.2.1: SF-36v2 Component Scores

The component scores are normalised scores to enable the differences between scores to be viewed in a simplistic way. The norm is 50 with a standard deviation of 10 thus indicating that a score below 50 indicates below average health status for a particular component. From figure 11.4 it can be seen that the baseline score for PCS is below the norm and at three months has dropped two standard deviations below the norm. The MCS at baseline was above the norm. However at three months this was found to have dropped below the norm to a lesser degree than the PCS. Both of these component scores were significantly lower at three months compared to baseline at p=0.05 (Wilcoxon rank test, p=0.0001 (PCS) p=.015 (MCS).
Chapter 11: Study 2 - Three month follow-up data

Figure 11.5: SF-36v2 component scores at 3 months

11.4.3: CES-D

At baseline, 34% (n=17) of the sample group scored 16 or above indicative of depression. This had risen significantly at 3 months with 52% (n=24) of the sample scoring 16 or above on the scale (Wilcoxon rank sum test p=.003). The mean scores at baseline were 10 and median 7.5 (range 0-37). At three months the mean score was 17.5, median 17 (range 0-53).

Of those depressed at three months 44% (n=24) had a higher than norm MCS score and 62% stated a moderate-to-severe problem in the EQ-5D anxiety and depression health domain. Good correlations between CES-D and the MCS and EQ-5D utility scores were found at three months (Kendalls Tau, 0.061, p<0.001(MCS) and 0.5, p=0.001 (EQ-5D utility).

Of those not classed as depressed at baseline (with scores of 15 or below (n= 33)), 43% (n=14) were found to be depressed at three months. Of those depressed at baseline (n=17), 31% were found not to be depressed at three months.
Chapter Twelve: Study 2
Six Month Follow-up Data
12.1: Introduction

This chapter presents the results following the six month follow-up interview and presents changes from three months to the six month period.

All participants were contacted at six months following the crash to ensure comparability with data from other studies. These interviews were conducted by telephone and followed the same interview protocol as the baseline interview to ensure continuity and to minimise any bias in the interview questionnaire order. The majority of participants were contacted within one week of the six month date, however, a further two weeks was allowed on top of this to maximise the opportunity.

12.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop-outs were compared to the remaining sample at six months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann-Whitney U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36v2 dimension and component scores between three and six months. Content analysis was used to categorise interview responses into a format for data analysis.

12.3: Results

12.3.1: Attrition

At six months there were 43 people who were contactable; a further three people had dropped out at six months since the three month follow-up.
These drop-outs were a result of telephone numbers being changed or unobtainable, in other cases, participants delayed the interview to a fixed time but then did not answer the telephone.

The drop-outs at six months were compared to the remaining sample using Fishers exact test or Chi-squared for nominal data and Mann-Whitney U test statistics for independent groups for ordinal data. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus the groups could be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

<table>
<thead>
<tr>
<th></th>
<th>BASELINE (N=50)</th>
<th>6 MONTHS (N=43)</th>
<th>TEST STATISTIC</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>78%</td>
<td>72% male</td>
<td>Fishers exact</td>
<td>.5</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>36 years</td>
<td>37 years</td>
<td>Mann-Whitney U</td>
<td>.5</td>
</tr>
<tr>
<td>Education School</td>
<td>27</td>
<td>21</td>
<td>Chi-squared</td>
<td>.2</td>
</tr>
<tr>
<td>College University</td>
<td>20</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage brackets (median)</td>
<td>£16-£20,999</td>
<td>£16-£20,999</td>
<td>Mann-Whitney U</td>
<td>.2</td>
</tr>
<tr>
<td>MAIS</td>
<td>14</td>
<td>13</td>
<td>Chi-squared</td>
<td>.3</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data were examined for any changes in lifestyle, personal circumstances, employment, health and any knock on effects of the crash or injury. A summary of the changes that are a result of the crash at six months are presented below and discussed.

12.3.2: Personal Circumstances

There were no changes recorded for marital status. However, 5% (n=2) stated that their living arrangements had changed as a result of their injury/crash. These changes were different from at three months; one
participant had changed from living with a partner to living alone and the other had moved out from living with relatives to now living on their own.

Social contact also changed for this group with less contact at six months with friends. On the whole, there were changes in the amount of contact with friends; five people saw less of their friends and six people spoke to their friends less. The reduction was down to either less than once a week or weekly only. This was normally a result of being off sick and not working with friends or not doing normal hobbies.

Compared to three months family contact had reduced at six months to similar levels at baseline. The increase at three months was a result of the injuries and the family needs / concerns but as healing had occurred over time the contact with the family has lessened at six months in line with contact at baseline.

**Lifestyle**

General house and garden chores were affected at six months with 23% of the 25 who undertook house duties at baseline unable to or had 'cut down' on what they were capable of doing prior to the crash. Of those 35 who undertook general gardening / shopping duties at baseline, 35% had stopped doing them altogether or had cut down depending on their capabilities.

Of the 43 participants in the six month follow-up group, 31 (72%) had at least one regular hobby that was affected by their injury. The hobbies that the 31 participants were unable to pursue are listed in table 12.2.
Chapter 12: Study 2 - Six month follow-up data

Table 12.2: Changes to hobbies at 6 months

<table>
<thead>
<tr>
<th>HOBBY</th>
<th>NUMBER (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports other (horse riding, swimming, squash, dancing, mountaineering, hill walking)</td>
<td>18</td>
</tr>
<tr>
<td>Team sports</td>
<td>8</td>
</tr>
<tr>
<td>Driving / motorbikes</td>
<td>7</td>
</tr>
<tr>
<td>Walking</td>
<td>5</td>
</tr>
<tr>
<td>Cycling</td>
<td>3</td>
</tr>
<tr>
<td>Gardening</td>
<td>3</td>
</tr>
<tr>
<td>Other interests (DIY, cooking, restoring cars)</td>
<td>3</td>
</tr>
<tr>
<td>Running</td>
<td>3</td>
</tr>
<tr>
<td>Sedentary (reading / calligraphy etc)</td>
<td>1</td>
</tr>
</tbody>
</table>

The main impact was on physical hobbies which were still affected at six months. These included running, playing football and playing other sports such as squash which all involve load bearing on limbs. The limbs were the main body region injured for the majority of this group.

Table 12.3: Changes in lifestyle from 3 to 6 month follow-up.

<table>
<thead>
<tr>
<th>LIFESTYLE ACTIVITY</th>
<th>PERCENTAGE CHANGE</th>
<th>NUMBER (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage daily routine</td>
<td>44%</td>
<td>19</td>
</tr>
<tr>
<td>Hobbies</td>
<td>72%</td>
<td>31</td>
</tr>
<tr>
<td>House duties</td>
<td>40%</td>
<td>10 (25)</td>
</tr>
<tr>
<td>General duties</td>
<td>43%</td>
<td>15 (35)</td>
</tr>
</tbody>
</table>

At six months, 44% (n=19) of the sample stated they could manage their daily routine, 44% (n=19) stated they couldn't and 12% (n=5) stated they could do either the housework or their job but not both, table 12.2.

At six months two participants who had had their houses adapted at three months were still the only ones in the study who had adaptations. The first participant who lived down-stairs in one room was still accommodated downstairs in the living room. However, on good days she could now manage to get into the other downstairs room or kitchen using a zimmer or crutches. Some of the sample still had problems performing their house and general duties like shopping and gardening.
12.3.3: Employment

At six months, 42% (n=18) of the sample were unable to return to work due to their injuries. Two people were on light duties at six months; coincidentally they were heating engineers, one self employed and the other a contractor. The types of employment for those participants who had not returned to work are in table 12.4.

<table>
<thead>
<tr>
<th>EMPLOYMENT TYPE</th>
<th>NUMBER (N=18)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>7</td>
<td>39%</td>
</tr>
<tr>
<td>Heating and plumbing</td>
<td>1</td>
<td>5.5%</td>
</tr>
<tr>
<td>Office based</td>
<td>3</td>
<td>17%</td>
</tr>
<tr>
<td>Physical / technical</td>
<td>6</td>
<td>33%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

As a result of being off sick or performing light duties, the wages for 40% of the group had changed (n=17). All the changes were at a deficit; for example at baseline eight participants earned less than £10,999. At six months this had risen to 11 participants earning at this level (26%). Two of the participants were also not earning their normal wages in the higher wage brackets with lower incomes in the ranges of £11-15,999 and £26-30,999. There was a 100% increase in the number or people not earning a wage at end months (n=16) compared to baseline (n=8). In all cases this was a direct result of the injury and not being able to return to work. Of these, eight not earning their normal wage, two were on income support and four were on incapacity benefit. The other two were not on any benefits at 6 months. As a result of the injury, six (19%) were now not the main wage earners compared to baseline.
Table 12.5: Changes in employment from baseline to 6 month follow-up.

<table>
<thead>
<tr>
<th>EMPLOYMENT ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment hours</td>
<td>70%</td>
<td>32</td>
</tr>
<tr>
<td>Typical activities</td>
<td>56%</td>
<td>24</td>
</tr>
<tr>
<td>Wage changes</td>
<td>40%</td>
<td>17</td>
</tr>
<tr>
<td>Main wage earner</td>
<td>19%</td>
<td>6</td>
</tr>
<tr>
<td>Benefits</td>
<td>23%</td>
<td>10</td>
</tr>
<tr>
<td>Off sick</td>
<td>76%</td>
<td>35</td>
</tr>
<tr>
<td>Off duties (if not working)</td>
<td>22%</td>
<td>10</td>
</tr>
<tr>
<td>Received sick pay</td>
<td>28%</td>
<td>14</td>
</tr>
<tr>
<td>Received statutory sick pay</td>
<td>30%</td>
<td>14</td>
</tr>
<tr>
<td>Returned to work / duties*</td>
<td>40%</td>
<td>17</td>
</tr>
</tbody>
</table>

* includes light duties

12.3.4: Health Implications

At six months 72% of the sample (n=31) stated they had some form of physical limitation as a result of their injury. The main physical 'impairments' were related to reduced movement, strength and inability to weight bear on limbs, however there were other that expressed other types of physical limitation such has having a catheter in situ. Five participants (12%) listed two types of physical impairment. The types of limitations perceived by the sample are listed below in table 12.6.

Table 12.6: Types of physical impairment at 6 months

<table>
<thead>
<tr>
<th>TYPES OF IMPAIRMENT</th>
<th>NUMBER (N=31) *SECONDARY PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't straighten limb</td>
<td>4</td>
</tr>
<tr>
<td>Can't bend limb</td>
<td>6*</td>
</tr>
<tr>
<td>Reduced range of movement</td>
<td>9*</td>
</tr>
<tr>
<td>Weakness in limb</td>
<td>2</td>
</tr>
<tr>
<td>Impotence</td>
<td>1</td>
</tr>
<tr>
<td>Unable to weight bear</td>
<td>6</td>
</tr>
<tr>
<td>Swollen extremity</td>
<td>1</td>
</tr>
<tr>
<td>In wheelchair</td>
<td>1</td>
</tr>
<tr>
<td>Catheter in situ</td>
<td>1</td>
</tr>
<tr>
<td>Limp</td>
<td>4</td>
</tr>
</tbody>
</table>
To assist with any perceived physical impairments, 48% (n=22) of the sample used an aid to help with their mobility. There were nine people who used a walking aid including; walking sticks (n=6), crutches (n=2), and a wheelchair (n=1). At six months, one person (2%) had a splint to support an injured limb and 5% had a plaster.

Sensory impairments were stated in 12 (28%) of the sample, the main problem being numbness (n=10). Other sensory impairments included pins and needles for one person and short term memory loss for two people.

Pain was a major factor at six months for 84% of the sample group of which 30% were taking regular analgesics for pain and one was having steroid injections into a shoulder joint for pain. The other medications taken by this group were antidepressants for one participant, warfarin for two, antibiotics and warfarin for one, antibiotics for one, one was on heart tablets, one person was on multiple medication and one was on osteoporosis tablets. The person who was on heart tablets had sustained a heart attack since his injury. He blamed the heart attack on the injury (fractured humerus) which was not operated on at the time of injury and left to heal on a 'wait and see approach'. He was a self-employed contractor not able to work because of his injury which he states induced stress because of money worries. The delay in surgery on his arm meant longer time off sick without pay and as a consequence he felt that his heart attack was a direct result of the crash. This is not something that can be proven medically but that was his perception of events.

Six participants (14%) were re-admitted in the three month period from three month to six month follow-up, of which four had undergone surgery. One person (who had sustained a heart attack) was re-admitted for a second time. One person was also expecting to be admitted for further surgery in the future.
Table 12.7: Changes in health status at 6 months

<table>
<thead>
<tr>
<th>HEALTH IMPLICATIONS</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>72%</td>
<td>31</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>28%</td>
<td>12</td>
</tr>
<tr>
<td>Pain</td>
<td>84%</td>
<td>36</td>
</tr>
<tr>
<td>Medication</td>
<td>51%</td>
<td>22</td>
</tr>
<tr>
<td>Walking aids</td>
<td>21%</td>
<td>9</td>
</tr>
<tr>
<td>Splints / plaster</td>
<td>7%</td>
<td>3</td>
</tr>
<tr>
<td>Readmitted</td>
<td>28%</td>
<td>13</td>
</tr>
<tr>
<td>Required further surgery</td>
<td>22%</td>
<td>10</td>
</tr>
<tr>
<td>Receiving rehabilitation at 6 months</td>
<td>42%</td>
<td>16</td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>23%</td>
<td>54</td>
</tr>
<tr>
<td>Carers</td>
<td>5%</td>
<td>2</td>
</tr>
</tbody>
</table>

Of those receiving rehabilitation at six months, physiotherapy was the main type for 84%. One participant was receiving occupational therapy (5%), one was paying to see an osteopath, one participant was seeing a counsellor for stress and another was at a rehabilitation home for intensive physiotherapy and anger management following recommendations from work. This person had received a serious head injury which had lead to a period of unconsciousness as well as upper and lower extremity injuries. One participant relied on her husband as her carer at six months although her mobility had improved slightly. On a good day she could get into the kitchen or even upstairs for a shower, this was a 'massive event' which was done rarely as it rendered her 'exhausted for the rest of the day'. Another participant also had a carer at this point but this was a result of his epilepsy and not a result of him having sustained an injury.

12.3.5: Insurance and Litigation

At six months, two out of the 15 participants expecting compensation from the insurance company were still waiting for their pay out. Two more participants were involved in court proceedings / compensation claims at six months compared to three months. Two participants had also received an interim payout of £7,500 and £2,000 although both still claimed financial burden at six
months. The former was involved in building work and had received no sick pay or statutory pay in the two months he was off sick. He had returned to work but was unable to fully undertake his job and as a result was still losing some wages. The interim payout of £7,500 still left a financial burden of £4,500 at six months as a result of loss of earnings, an insurance deficit and the replacement of a motorbike. The other participant, (a display carpenter) had received sick pay for his 49 days off sick with a fractured tibia and fibula. This had been pinned at the time of the crash and he was able to resume work after nearly three months off sick. His interim payout was £2,000 which left him with a £1,000 financial burden at six months for replacing his motorbike and leathers, loss of earnings and policy excess.

Table 12.8: Compensation

<table>
<thead>
<tr>
<th></th>
<th>PERCENTAGE</th>
<th>NUMBER (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court proceedings</td>
<td>60%</td>
<td>26</td>
</tr>
<tr>
<td>Expect compensation</td>
<td>58%</td>
<td>25</td>
</tr>
</tbody>
</table>

Compensation progress was charted at six months and can be seen below (table 12.9). The majority of people were waiting for solicitors to act on instructions or were waiting for independent medical examinations.

Table 12.9: Compensation progress at 6 months

<table>
<thead>
<tr>
<th>COMPENSATION PROGRESS</th>
<th>NUMBER (N=26)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting for medical examination</td>
<td>7</td>
<td>27%</td>
</tr>
<tr>
<td>Waiting for solicitors</td>
<td>10</td>
<td>38%</td>
</tr>
<tr>
<td>Waiting for police</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>Waiting for other party to admit liability</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>Waiting to be charged</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Waiting court decision</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Waiting final payment</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>
12.3.6: Financial Burden

Eighty eight percent of the sample (n=38) stated they were experiencing financial burden as a result of the crash / injury. Seven stated they were not suffering from any financial burden as a result of the crash. The range of financial losses ranged between £200 to £30,000 with a mean loss of £4,827 and median loss of £4,000. These mean and median losses were higher at six months by £1,000 and £2,000 respectively. The loss of £30,000 was a result of being flown back from holiday due to injuries with no insurance cover and also loss of earnings and business, this participant was self employed and unable to earn any money.

The type of financial burden experienced by the individuals were categorised with loss of earnings remaining the major factor for this sample group where financial burden was incurred. The other main costs were related to car or motorbike replacements.

12.3.7: Major Effects

At six months, 23% (n=10) of the sample stated they were back to normal; however, the remaining 77% stated that the injury / crash still had at least one effect on them. These effects were categorised into distinct groups illustrated below in figure 12.1.

Figure 12.1: Major effects of the sample

Financial (n=10)
- Stress - money worries
- Loss of earnings
- Compensation dragging on

Psychological (n=17)
- Apathy
- Depression / mentally scarred
- Sleep affected
- Moody
- Down / receiving counselling
- Anxiety for family
Chapter 12: Study 2 - Six month follow-up data

**Emotions**
(n=13)

- Relationship problems
  - Frustrated and fed up with enforced inactivity
  - Tired and drained all the time
  - Stuck can't move on
  - Wife clinically depressed / suicidal

**Driving**
(n=2)

- Nervousness about going on bike
- Unable to do normal everyday activities
- Work affected

**Social**
(n=20)

- Time lost on normal things
- Physically unable to drive to get out
- Unable to do hobbies
- Lost job

**Functioning**
(n=30)

- Reliance on others for transport or help
- Loss of mobility
- Loss of functioning in limb
- Isolated - unable to go anywhere alone
- Loss of fitness
- Time to heal

**Health**
(n=29)

- Physical symptoms
  - Constant pain
- Secondary problems
  - Prognosis
- Non-healing of fracture
- Putting weight on
  - Spasms
  - No one listening re: problems

**Other**
(n=1)

- Changed life completely

**No effects / back to normal**
(n=10)
The main effects for this group were related to their physical functioning abilities and the effects of this on their social and work roles in society. Being unable to do hobbies or go to work meant there were a number of emotional effects associated with this such as boredom and being fed up with the enforced inactivity. Psychologically, there were mixed problems with depression including mood changes and mental scarring whilst two were actively seeking counselling for the effects of the crash and their reluctance to drive. At six months, one participant could not get into a car to drive and having to be a passenger to attend appointments also caused him distress. He was adamant that he would never go in a car again and would walk or catch public transport if he had to go anywhere. He was undergoing counselling for his phobia of driving. In terms of finance implications, one participant stated it was the last month they could pay their basic mortgage even after selling a life insurance policy. He had no mortgage protection and also was stretched to the limit on his repayments. To have a shorter mortgage length he was reliant on the permanent overtime he earned. His injuries are expected to keep him off work (as a maintenance engineer) for at least one year suggesting that he will continue to incur debts and remain in mortgage arrears for a further six months.

The health category included five participants who stated they had put weight on since the crash because of their enforced inactivity, which was not a factor that one would necessarily expect to be considered as a problem. Secondary problems at six months included someone having a frozen shoulder which was not part of the original injury but induced from having a sling to keep his fractured humerus in position. He was still receiving hydrotherapy treatment and applied for incapacity benefit as was unable to perform his normal job as a gas engineer. Another heating engineer who suffered a fracture to his cervical spine was still suffering with pain in his shoulder and weakness in his right arm. He had informed the doctors on numerous occasions but no investigations had been carried out to date for which he was angry and felt that ‘no one was listening to him’. He could not perform his job fully and was losing wages by having to take light duty jobs instead. He had attended a medical for his personal injury claim however they were not happy with the
problem shoulder and therefore recommended an MRI scan. This person feels strongly this should have been done at the time of the crash as even then he told the doctors this was of more concern to him than the fracture to his neck.

Another person had lost her job as an agency lorry driver as a result of the crash. She wanted other work just to get paid as she had bought a new house two weeks before the crash. Unfortunately, she was unable to find employment even as a bar worker because they considered her to be a risk if she slipped and damaged her leg again. Emotionally she was cross about this and again fed up with being enforced to be at home. Her need to get out was partly because the other party to the crash put her at fault and working would take her 'mind off things'.

Many were still surprised how long it was taking for their original injuries to heal and enable them to return to 'normal'. Those with fractures often had the preconceived notion that they would be in plaster for 6 weeks and then be 'right as rain'.

Many of the reactions and effects at six months are things which would not necessarily be considered when looking at the problems associated with injuries such as the need to be at work or active to help with dealing emotionally with the effects. Much is considered regards impairment and disability although there is no real definitive way of measuring such implications and emotional factors are not generally considered at all.
12.4: Health Outcome Measures

12.4.1: EQ-5D (+cognition)

At six months, five (12%) had a profile of 11111(1) three more than at three months, no participants had a floor effect of a 33333(3) profile at six months. There were 11 people scoring at least one three on their health profile at six months; 10 less than at three months. As can be seen from figure 12.2, the performance of usual activities was where the most severe problems were found at six months. Over half of the sample stated they had some problems with pain, usual activity and mobility with 7% stating they were extremely anxious.

The visual analogue scores for the EQ-5D were found to be significantly higher at six months compared to three month scores (Wilcoxon rank sum test \( p < 0.0001 \); mean scores 67 and 55.2, range 20-100 and 10-100, median 70 and 53). The utility scores were also significantly different at six months compared to three months (Wilcoxon rank sum test \( p < 0.0001 \)). Mean value
scores at six months 0.63 (range .09 - 1) and 0.48 (-.18 - 1) at three months, median scores .69 and .59. At six months no scores were below 0 on the index scale indicating that no one considered their current health state at six months to be worse than death.

12.4.2: SF-36v2

The SF-36v2 health dimensions at six months post crash were assessed and are presented below in figure 12.3. From the graph it can be seen that there was an increase in all of the health domains from three to six months although all were still below the UK norms. There were statistically significant increases at the p=0.006 level (p=0.05 corrected for 8 multiple comparisons) using Wilcoxon rank sum test for the physical functioning, role physical and social functioning dimensions.

Figure 12.3: SF-36v2 health dimensions at 6 months

![Chart showing SF-36v2 health dimensions at 6 months.](chart)

PF- physical functioning, RP-role physical, BP-bodily pain, GH-general health, VT-vitality, SF-social functioning, RE-role emotional, MH-mental health.
For each of the dimensions the floor and ceiling effects were considered at six months.

Table 12.10: SF-36v2 floor and ceiling effects at 6 months

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%) (N=43)</th>
<th>CEILING (%) (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>19%</td>
<td>21%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>0%</td>
<td>19%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Vitality</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>2%</td>
<td>28%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>0%</td>
<td>44%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>0%</td>
<td>7%</td>
</tr>
</tbody>
</table>

12.4.2.1: SF-36v2 Component Scores

At six months both the PCS and MCS scores had improved from the three month scores, figure 12.4. The six month physical component scores remained below the norm of 50 indicative of a below average physical states however the MCS had improved to settle at the UK norm value of 50. The physical component scores were significantly increased at six months from the three month period (Wilcoxon rank test, p=<0.0001).

Figure 12.4: SF-36v2 component scores at 6 months

PCS-physical component score; MCS-mental component score
12.4.3: CES-D

At six months the mean CES-D score was 14 (median 9) the highest score being 48 and lowest was 0, of which 37% (n=16) scored 16 or above - indicative of depression. This was a decline since three months (mean 17.5, median 17) although not a significant decline.

Of these 16, classed as depressed at six months, only three were not depressed at three months, compared to nine not depressed at baseline. This suggests that the injury and its consequences have a longer term effect on psychological health. The MCS scores for 81% of these 16 classed as depressed were below the UK norm of 50 at six months. In the EQ-5D anxiety and depression domain; 14 out of these 16 indicated they had a moderate to severe problem with two stating no such feelings. This again suggests that there is some consistency with measuring mood in both the SF-36v2 and EQ-5D scores.

Good correlation was found between the CES-D score at 6 months and the MCS at 6 months (0.67, p<0.001) and a weaker correlation with the EQ-5D utility score (0.5, p<0.001) (Kendalls Tau).
Chapter Thirteen: Study 2
Twelve Month Follow-up Data
13.1: Introduction

All participants were contacted at twelve months following the crash to ensure comparability with data from other studies. These interviews were conducted by telephone and followed the same interview protocol as the baseline interview to ensure continuity and to minimise any bias in the interview questionnaire order. The majority of participants were contacted within one week of the twelve month date however a further two weeks was allowed on top of this to maximise the opportunity.

13.2: Data Analysis

Data were analysed using descriptive statistics and also non-parametric tests as the data were not normally distributed and therefore not suitable for parametric tests. The participants who were lost to follow-up or drop outs were compared to the remaining sample at 12 months to ensure the data being analysed were from the same sample. The statistical methods used were the Chi-squared or Fishers exact tests for nominal data and the Mann-Whitney U test for independent samples at ordinal level. The Wilcoxon signed rank sum test for two related samples at the ordinal level was used to compare the overall scores for the EQ-5D and SF-36v2 dimension and component scores between six and 12 months. Content analysis was used to categorise interview responses into a format for data analysis.

13.3: Results

13.3.1: Attrition

At 12 months there were 38 people who were contactable, a further six people had dropped out at 12 months since the six month follow-up giving an overall attrition rate of 32%.

The drop-outs at 12 months were compared to the remaining sample using Fishers exact test or Chi-squared for nominal data and Mann-Whitney U test
statistics for independent groups for ordinal data. There were no significant differences found for gender, education, wage brackets, injury (MAIS) and age. Thus the groups could be said to be drawn from the same sample and therefore should not affect any data analysis at this stage.

Table 13.1: Drop outs at 12 months

<table>
<thead>
<tr>
<th></th>
<th>BASELINE (N=50)</th>
<th>12 MONTHS (N=38)</th>
<th>TEST STATISTIC</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>78% male</td>
<td>79% male</td>
<td>Fishers exact</td>
<td>.7</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>36 years</td>
<td>37 years</td>
<td>Mann-Whitney U</td>
<td>.3</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.4</td>
</tr>
<tr>
<td>School</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage brackets (median)</td>
<td>£16-£20,999</td>
<td>£16-£20,999</td>
<td>Mann-Whitney U</td>
<td>.9</td>
</tr>
<tr>
<td>MAIS</td>
<td></td>
<td></td>
<td>Chi-squared</td>
<td>.3</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4+</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data were examined for any changes in lifestyle, personal circumstances, employment, health and any knock on effects of the crash or injury. A summary of the changes from six months to 12 months that are a result of the crash are presented below and discussed.
13.3.2: Personal circumstances

There were no changes recorded for marital status at 12 months that were different to six months. At 12 months the changes to living arrangements had changed for two people; one who was living with their parents at six months had moved back out on their own and the other who was back in army barracks at six months was now at a military rehabilitation centre. This was for an assessment of his physical and mental state for a return to full time work as a soldier.

Social contact also changed for this group with less contact at 12 months with friends. On the whole there were changes in the amount of contact with friends, six people saw less of their friends (16%) and spoke to their friends less (21%). The reduction in social contact was down to either less than once per week or weekly only. Compared to six months, seeing the family was similar at 12 months and baseline contact. There was an increase at 12 months for speaking to the family with 4 stating contact had increased to 2-3 times a week compared to less than once a week.

Lifestyle

General house and garden chores were still affected for some at 12 months with 21% of the 25 who did house duties at baseline unable or having to 'cut down' on what they were capable of doing prior to the crash. Of those 35 who did general gardening / shopping duties at baseline, 29% had stopped doing them altogether or had cut down depending on capabilities.

Of the 38 participants in the 12 month follow-up group, 22 (58%) had at least one regular hobby that was affected by their injury. The hobbies that these 22 participants were unable to pursue included; sports or involved the need to bend or kneel down such as DIY and car restoration. Six people were unable to or had stopped riding their motorbikes due to injuries and fear or pressure being applied by family members to stop because of the risk.
Table 13.2: Changes in lifestyle from 6 to 12 month follow-up.

<table>
<thead>
<tr>
<th>LIFESTYLE ACTIVITY</th>
<th>PERCENTAGE CHANGE</th>
<th>NUMBER (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage daily routine</td>
<td>24%</td>
<td>9</td>
</tr>
<tr>
<td>Hobbies</td>
<td>58%</td>
<td>22</td>
</tr>
<tr>
<td>House duties</td>
<td>21%</td>
<td>8 (25)</td>
</tr>
<tr>
<td>General duties</td>
<td>29%</td>
<td>10 (35)</td>
</tr>
</tbody>
</table>

At 12 months 76% (n=29) of the sample stated they could manage their daily routine whilst 24% (n=9) stated they could not.

At 12 months those two people who had previously had their houses adapted at three months were the only ones in the study who had adaptations. The one participant who was down stairs in one room was still accommodated downstairs in the living room. However, she could now get upstairs on 'very good' days and was also able to get out in the car with the aid of a wheelchair. Even so, she still did not like to go far, due to the difficulty of going to the toilet and needing a 'bed pan' as she could not get upstairs at friends' houses, and was also fearful of people knocking her foot whilst out in her wheelchair.

13.3.3: Employment

At 12 months, 10% (n=4) of the sample were unable to return to work at this point due to their injuries as compared to nine people at six months. These four were normally employed as the following; gas engineer, lorry driver, sales and marketing executive and soldier (vehicle maintenance). Of the remaining six people whose employment hours had changed at 12 months, one had returned to full time work, two to part time work, one had become a student and two were unemployed at 12 months.

Overall, 34% of daily activities were altered from baseline with change towards less active roles. On the whole most people were still engaged in the same level of activity as six months, mainly semi active or sedentary. Of those with changes from six to 12 months (n=6, 16%) four were semi active, two of whom were normally in physical or active work. The remaining two had become students as a result of their injuries instead of having office based or active employment as at baseline.
As a result of being off sick or performing light duties, the wages for 21% (n=8) of the group had changed at 12 months. There were six people who were still not earning a wage at 12 months with two people earning less than £10,999. At baseline, one person earned less than £10,999, one earned between £11-15,999, two earned between £16-20,999 and two earned between £21-25,999. This illustrates the loss of earnings experienced by some people even one year after receiving an injury. Out of these eight, five were normally the main wage earners in the household but at 12 months they had not returned to this role of main wage earner.

Table 13.3: Changes in employment at 12 month follow-up.

<table>
<thead>
<tr>
<th>EMPLOYMENT ACTIVITY</th>
<th>PERCENTAGE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment hours</td>
<td>26%</td>
<td>10</td>
</tr>
<tr>
<td>Typical activities</td>
<td>34%</td>
<td>13</td>
</tr>
<tr>
<td>Wage changes</td>
<td>21%</td>
<td>8</td>
</tr>
<tr>
<td>Main wage earner</td>
<td>13%</td>
<td>5</td>
</tr>
<tr>
<td>Benefits</td>
<td>18%</td>
<td>7</td>
</tr>
<tr>
<td>Off sick</td>
<td>13%</td>
<td>5</td>
</tr>
<tr>
<td>Received sick pay</td>
<td>3%</td>
<td>1</td>
</tr>
<tr>
<td>Received statutory sick pay</td>
<td>11%</td>
<td>4</td>
</tr>
<tr>
<td>Returned to work / duties*</td>
<td>71%</td>
<td>38</td>
</tr>
</tbody>
</table>

* includes light duties

As a result of the injury, seven people had changes in benefit status (18%), six of whom were receiving incapacity benefit at 12 months of whom one was also receiving disability benefits. A further person was receiving income support as he was unable to find suitable work at 12 months.

13.3.4: Health Implications

At 12 months, 58% of the sample (n=22) had some form of physical impairment different from baseline. There were six people (17%) who listed two types of physical impairment. The types of impairment perceived by the sample are listed below in table 13.4.
Table 13.4: Types of physical impairment at 12 months

<table>
<thead>
<tr>
<th>TYPES OF IMPAIRMENT</th>
<th>NUMBER (N=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*SECONDARY PROBLEMS</td>
</tr>
<tr>
<td>Can’t straighten limb</td>
<td>4*</td>
</tr>
<tr>
<td>Kneeling difficult</td>
<td>7*</td>
</tr>
<tr>
<td>Reduced range of movement</td>
<td>3</td>
</tr>
<tr>
<td>Weakness in limb</td>
<td>3</td>
</tr>
<tr>
<td>Impotence</td>
<td>1</td>
</tr>
<tr>
<td>Unable to weight bear</td>
<td>2</td>
</tr>
<tr>
<td>In wheelchair</td>
<td>1*</td>
</tr>
<tr>
<td>Limp</td>
<td>7*</td>
</tr>
</tbody>
</table>

These physical impairments remained similar to those at six months and are those stated by the participants and not necessarily classic impairments.

To assist with any perceived physical impairments, 18% (n=7) of the sample used at least one aid to help with their mobility. There were five people who used walking sticks, four people used crutches and one still needed a wheelchair when out of the house. At 12 months, three people (8%) had a splint to support an injured limb and one participant (3%) had a plaster of paris.

Sensory impairments were found in 11% of the sample (n=4), the problems were; numbness for two, mood swings for one person, and short term memory loss for one person.

Pain remained a major factor at 12 months for 63% of the sample group (n=24) of which 18% were taking regular analgesics. Five (13%) were taking other medication at 12 months; these were antibiotics and warfarin for one, antibiotics for two, one was on heart tablets, and one person was on multiple medications.

Seven (18%) participants were re-admitted in the six month period from six month to 12 month follow-up of which six had surgery. One person was also expecting to be admitted for further surgery in the future.
Table 13.5: Changes in health status at 12 months

<table>
<thead>
<tr>
<th>HEALTH IMPLICATIONS</th>
<th>PERCENTAGE</th>
<th>NUMBER (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical impairment</td>
<td>58%</td>
<td>22</td>
</tr>
<tr>
<td>Sensory impairment</td>
<td>11%</td>
<td>4</td>
</tr>
<tr>
<td>Pain</td>
<td>63%</td>
<td>24</td>
</tr>
<tr>
<td>Medication</td>
<td>32%</td>
<td>12</td>
</tr>
<tr>
<td>Walking aids</td>
<td>19%</td>
<td>7</td>
</tr>
<tr>
<td>Splints / plaster</td>
<td>11%</td>
<td>4</td>
</tr>
<tr>
<td>Readmitted</td>
<td>18%</td>
<td>7</td>
</tr>
<tr>
<td>Required further surgery</td>
<td>16%</td>
<td>6</td>
</tr>
<tr>
<td>Receiving rehabilitation at 12 months</td>
<td>26%</td>
<td>10</td>
</tr>
<tr>
<td>Attending hospital outpatients</td>
<td>50%</td>
<td>19</td>
</tr>
<tr>
<td>Carers</td>
<td>5%</td>
<td>2</td>
</tr>
</tbody>
</table>

Of those receiving rehabilitation at 12 months, physiotherapy was the main type for 42%; the others were receiving occupational therapy, hydrotherapy, pain management and one person was at a rehabilitation centre for intensive physiotherapy and anger management following recommendations from work.

**13.3.5: Insurance and Litigation**

At 12 months those 15 who were expecting their insurance company to pay out had received their monies. At 12 months 23 (61%) were involved in court compensation claims, of which 53% were expecting a pay out. One person had been paid fully for a personal injury claim at 12 months. He received £40,000 in an out of court settlement to compensate for his injuries which were fractures to the neck of femur, patella, fibula and ribs plus minor grazes to his face and head. He was a semi-retired driver therefore no loss of earnings was taken into account in the calculations. At six months he stated that his financial burden was £2,500 but obviously at 12 months he had no financial burden but major limitations in activity. Five people had also received interim payouts at 12 months, ranging between £2,000 and £10,000. All but one of these however still had some level of financial burden at 12 months ranging between £2,000 and £1,000. The person who had been
compensated at six months with £2,000 was still waiting for his final settlement and the other who had received £7,500 at six months had dropped out of the study at 12 months.

Table 13.6: Compensation

<table>
<thead>
<tr>
<th>PERCENTAGE</th>
<th>NUMBER (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Court proceedings</td>
<td>61%</td>
</tr>
<tr>
<td>Expect compensation</td>
<td>53%</td>
</tr>
</tbody>
</table>

Compensation progress was charted at 12 months and can be seen below for the 23 participants involved in court proceedings (table 13.7). In some cases there was more than one reason for the wait. Waiting for medical examinations or second medical examinations was the main reason for the delay. On talking to the sample it was noted that the injuries sustained determined whether a second medical was undertaken and at what time point post-injury. This is obviously due to the physical and psychological outcome the injury was likely to cause. For instance, if a case was heard at six months then compensation would only be dealt with at this time point and an expectation made that they would recover in one year. However, if the medical examination was done at six months and then repeated at one year, or even two years, a fuller assessment could be made as to the long term effects.

Table 13.7: Compensation progress at 12 months

<table>
<thead>
<tr>
<th>COMPENSATION PROGRESS</th>
<th>NUMBER (N=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting for medical examination</td>
<td>13</td>
</tr>
<tr>
<td>Waiting for solicitors</td>
<td>7</td>
</tr>
<tr>
<td>Waiting for police</td>
<td>1</td>
</tr>
<tr>
<td>Waiting for other party to admit liability</td>
<td>2</td>
</tr>
<tr>
<td>Waiting to be charged</td>
<td>1</td>
</tr>
<tr>
<td>Waiting court decision</td>
<td>1</td>
</tr>
<tr>
<td>Waiting final payment</td>
<td>2</td>
</tr>
<tr>
<td>Complete settled out of court</td>
<td>1</td>
</tr>
<tr>
<td>Turned down initial offer</td>
<td>1</td>
</tr>
</tbody>
</table>
13.3.6: Financial Burden

Seventy six percent of the sample (n=29) stated they were still experiencing financial burden as a result of the crash / injury. Seven (24%) stated they were not suffering from any financial burden as a result of the crash. The range of financial losses ranged between £300 to £17,600 with a mean loss of £5,712 and median loss of £4,320. These mean and median losses were higher at 12 months compared to six months by £885 and £320 respectively. The person who had a financial burden of £30,000 at six months was now out of burden. This was as a result going back to work and re-establishing his business and working long hours to recoup the money lost.

On the whole, financial burden was as a result of losing earnings by enforced sickness with some vehicle and insurance related debts. There were other losses such as one person stated he now had to pay someone to do his DIY jobs compared to previously and another stated local shopping rather than supermarket shopping now involved higher costs. This person was unemployed at baseline and shopping locally was normally not affordable, having to shop locally because of mobility problems was a financial drain.

13.3.7: Major Effects

At 12 months, 16% (n=6) of the sample stated they were back to normal, however, the remaining 84% stated that the crash or injury still had at least one effect on them. These effects were categorised into distinct groups which are illustrated below in figure 13.1.
Figure 13.1: Major effects of the sample

Financial
(n=6)
- Stress - money worries
- Loss of earnings
- Compensation dragging on

Psychological
(n=17)
- Apathy
- Depression
- Mood changes / irritable
- Memory affected
- Flashbacks
- Seeking counselling
- Loss of focus and commitment
- Psychologically affected
- Feels angry and has tempers

Emotions
(n=7)
- Relationship problems
- Frustrated and fed up with enforced inactivity
- Tired and drained all the time
- Stuck can't move on
- Wife clinically depressed / suicidal

Driving
(n=6)
- Nervousness about going on bike
- Nervous driving
- Can't and won't drive car / bike again

Social
(n=16)
- Unable to do normal everyday activities
- Unable to do hobbies
- Lost job

Functioning
(n=16)
- Reliance on others for transport or help
- Loss of mobility
- Loss of range of movement in limb
- Isolated - unable to go anywhere alone
- Loss of fitness
Chapter 13: Study 2 - Twelve month follow-up data

Health
(n=32)

- Time to heal
- Physical symptoms
- Constant pain
- Secondary problems
- Prognosis
- Non-healing of fracture
- Putting weight on
- Sex life

Other
(n=9)

- Changed life completely
- Had another crash
- Being sued
- Taught to live life to the full

No effects / back to normal
(n=6)

13.4: Recovery

At 12 months the sample was asked to state whether they considered themselves fully recovered. Only 12 (32%) stated that they were, four (10%) stated they were on the whole but there were still a few problems and the remaining 22 (58%) stated that they had not recovered for a variety of reasons, table 13.8.

Table 13.8: Reasons for non recovery at 12 months

<table>
<thead>
<tr>
<th>REASONS FOR NON RECOVERY</th>
<th>NOT RECOVERED (N=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>7</td>
</tr>
<tr>
<td>No hobbies</td>
<td>7</td>
</tr>
<tr>
<td>Loss of movement</td>
<td>4</td>
</tr>
<tr>
<td>Nervous</td>
<td>1</td>
</tr>
<tr>
<td>Long term adjustments to life</td>
<td>2</td>
</tr>
<tr>
<td>Secondary injuries / health problems</td>
<td>6</td>
</tr>
<tr>
<td>Injury not healed</td>
<td>6</td>
</tr>
<tr>
<td>Loss of fitness</td>
<td>3</td>
</tr>
<tr>
<td>Still reliant on others</td>
<td>2</td>
</tr>
<tr>
<td>Still under doctors waiting discharge for injury claim</td>
<td>1</td>
</tr>
</tbody>
</table>
Those four who stated they had recovered on the whole gave reasons such as pain, unable to do hobbies and having to make long term adjustments in life as the reason why they hadn't quite recovered.

### 13.5: Health Outcome Measures

#### 13.5.1: EQ-5D (+cognition)

A total of 10 (26%) had a profile of 11111(1) at 12 months; no one had a floor effect of a 33333(3) profile at 12 months. There were six people scoring at least one three on their health profile at 12 months, five less than at six months. As can be seen from figure 13.2 the performance of usual activities remained the most severe problem with 66% stating a problem with this dimension. Pain also remained a problem for half of the sample at 12 months with other areas such as anxiety and depression also scoring highly (39%).

![EQ-5D (+ cognition) health domains at 12 months](image-url)
Chapter 13: Study 2 - Twelve month follow-up data

The visual analogue scores for the EQ-5D had not changed significantly since six months. The mean and median scores at 12 months were 72.5 and 77.5 respectively, range 20-100.

The utility scores were also not significantly different at 12 months compared to six months. The mean and median value scores at 12 months were .72 and .78 respectively (range -.07 to 1). One person at 12 months considered their state to be worse than death this was as a result of scoring three in the health profiles for usual activities and pain.

13.5.2: SF-36v2

Overall, 76% (n=29) of the sample considered themselves to be in 'good' or higher states of health at 12 months, with 5% (n=2) rating themselves as having a 'poor' state of health and 18% (n=7) 'fair'. Participants were asked to rate their health compared to one year ago. This caused some confusion as many asked whether this meant before or after the crash; if 'after' some would rate themselves as 'much better'; however if 'before' they would rate themselves somewhat worse. Therefore they were asked to answer this question for before and after the crash, table 13.9.

<table>
<thead>
<tr>
<th>HEALTH STATUS</th>
<th>POST CRASH (n=38)</th>
<th>%</th>
<th>PRE-CRASH (n=38)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much better</td>
<td>14</td>
<td>37</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>8</td>
<td>21</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>About the same</td>
<td>9</td>
<td>24</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>6</td>
<td>16</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>Much worse</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>16</td>
</tr>
</tbody>
</table>

From table 13.9 it can be seen that in comparison with events directly after the crash suggest they remember their health as being in a generally poor state thus rating themselves to be 'much better' than a year ago. However, this is somewhat reversed if the pre-crash health state is considered; some 64% considered their health to be worse now than before the crash.

The SF-36v2 health dimensions at 12 months post crash were assessed and are presented below in figure 13.3. From the graph it can be seen that there
was an increase in all of the health domains from six to 12 months with three achieving levels equal to or close to the UK norms. These were the health domains of vitality, emotional role and mental health. However, none of the changes were statistically significant at the corrected p=.006 level, (Wilcoxon rank sum test).

For each of the dimensions the floor and ceiling effects were considered at 12 months, table 13.10. The role emotional dimension had a high percentage of participants at the ceiling effect, although the distribution for the other dimension was spread.
Table 13.10: SF-36v2 floor and ceiling effects at 12 months

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>FLOOR (%)</th>
<th>CEILING (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>3%</td>
<td>10%</td>
</tr>
<tr>
<td>Role Physical</td>
<td>5%</td>
<td>32%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>3%</td>
<td>18%</td>
</tr>
<tr>
<td>General Health</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Vitality</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>2%</td>
<td>34%</td>
</tr>
<tr>
<td>Role Emotional</td>
<td>0%</td>
<td>58%</td>
</tr>
<tr>
<td>Mental Health</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>

13.5.2.1: SF-36v2 Component Scores

From figure 13.4 it can be seen that the 12 month physical component scores remained below the average UK physical health state although it had significantly improved since the six month follow-up period (Wilcoxon rank sum test $p=0.001$). The MCS at 12 months had improved slightly since six months to be above the norm but not significantly.

Figure 13.4: SF36 component scores at 12 months

PCS-physical component score; MCS-mental component score
13.6: CES-D

At 12 months, the mean CES-D score was 11 (median 7), the highest score being 47 and lowest was 0, of which 26% (n=10) scored 16 or above, indicative of depression. Again, there seemed to be a reduction in the mean and median scores compared to 6 months, however, these were not significant changes.

Of these 10 classed as depressed at twelve months, three were not depressed at six months or at baseline. All but one of these participants scored below the UK norm for MCS and stated they had problems with anxiety and depression on the EQ-5D health domain, identifying a consistency in measuring mental health across these outcome measures.
Chapter Fourteen: Study 2
Analysis of Data from Baseline to
Twelve Month Follow-up
14.1: Introduction

The aim of this study was to examine quantitative data as a whole from baseline to 12 months to chart the changes and analyse the data and identify the main factors of change over time.

14.2: Data analysis

Analysis of the data was undertaken using Friedman analysis of variance by ranks. This tests whether at least one of the conditions differ from at least one other condition. However, this only tests that there are differences but not which one is different. Thus a further test was applied to test the critical difference between the rank sums, (see equation below). If the difference exceeds a corresponding critical value then it can be concluded that the two conditions are different (Siegal and Castellan 1988).

\[
| \bar{R}_u - \bar{R}_v | \geq z \alpha / k (k-1) \sqrt{\frac{k(k+1)}{6N}}
\]

\( \bar{R} \) = sum of ranks  
\( z \) = probability of normal distribution  
\( k \) = number of groups  
\( N \) = number of participants

Thus if the critical value is achieved then it can be determined where the most changes over that time period are made.

14.3: SF-36v2 Data

There were significant changes in the PCS over the follow-up period using the Friedman test (p=<0.0001). The test was applied to the PCS data for baseline, three months, six months and 12 months. The critical value was achieved indicating a significant difference for all but the baseline to 12 month comparison which when compared to figure 14.1 is not surprising as the 12 month figures are approaching the original baseline figures for this sample. The largest effects were identified in the baseline to three month data and
again between three months and 12 months. Examining figure 14.1 reflects these results as there is a steep decline from baseline to three months and a sharp rise between the three month and 12 month data. There were fewer significant effects between three and six months, six and 12 months and baseline to six months.
The three month period for many was a 'bad' point as injuries had not healed and the expectation was that they would be much better. Furthermore, long term problems were being considered and participants advised of these, such as, the prospect of arthritis in the injured joint, inability to walk for a long time and (for some) if at all. This three month point is probably a crucial point at which sudden and acute depression and realisation of the implications had set in. After this point things appear to improve.
In this sample the MCS was found not to have significant differences over time using the Friedman test (p=0.29). Figure 14.1 illustrates the gentler curve of the MCS compared to the PCS curve.

The eight health dimension scores were converted into normalised scores using the developer's algorithm, and are presented in figure 14.2 (Ware et al. 2002). This normalisation is such that the norm is 50 and the standard deviation is 10.
At baseline it can be seen that all the dimensions follow a similar line to the norm with some noticeable differences for physical function, bodily pain and social functioning. These dimensions are linked to the calculation of the physical component scores. Similarly to Study 1, general health did not differ substantially from the norm. The obvious problem point for all dimensions was three months post injury. At six months the physical dimensions (PF, RP BP) were moving toward the norm but were still lower than those mental health dimensions. At 12 months an improvement in the physical dimensions is observed from six months but remains below the norm or average physical health state for the UK.

14.3.2: SF-6D

The SF-6D scores were calculated from the SF-36v2 data using Braziers standard algorithm (personal communication). Friedman analysis was significant at the p<0.001 level and the test applied to the results to calculate a critical value to determine where the significant changes occurred. It was found that the main significant effect in the SF-6D was between baseline and
three months (figure 14.3). There was also a moderate affect between three and six months and three and 12 months.

**Figure 14.3: Mean SF-6D scores over time**

The downward slope reflects the baseline assessment period for this sample group as it incorporated a pre-injury health assessment which at three months had considerably worsened. The baseline and 12 month scores were not statistically different and would suggest that this sample group at 12 months were achieving pre-injury health states.

**14.4: EQ-5D (+cognition)**

The Friedman test was applied to the EQ-5D value scores which were also found to be significant at the p<0.001 level. The significant changes in utility scores, which are directly related to the profile score were from baseline to three months, baseline to six months and baseline to 12 months. This indicated that there was considerable impact in scores over the whole follow-up time period which would be as expected, with some further large impact of change from three to 12 months. The effects between three and six months and six and 12 months were not significant. The utility score is a combination
of both physical and mental health assessment rather than the separation of its components like the MCS and PCS from the SF-36v2 forms.

Figure 14.4: EQ-5D utility scores

Considering the improvement in the utility scores over time for this sample group there remained significant differences between the EQ-5D norm, matched for age and gender, and the 12 month utility score (Wilcoxon rank sum test p=0.001). This indicates that this population had experienced considerable health problems at baseline and constant improvement had occurred. There remained some deficit between an injured population and the expected norm; the deficits can be observed in Table 14.1 where at 12 months there were problems in all of the health domains with over 50% experiencing moderate to severe problems in performing their usual activities and pain.
Table 14.1: EQ-5D health profiles over time

<table>
<thead>
<tr>
<th>EQ-5D PROFILE (+COGNITION)</th>
<th>BASELINE (N=50)</th>
<th>3 MONTHS (N=46)</th>
<th>6 MONTHS (N=43)</th>
<th>12 MONTHS (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>No problems (%)</td>
<td>2</td>
<td>28</td>
<td>49</td>
<td>63</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>16</td>
<td>70</td>
<td>51</td>
<td>37</td>
</tr>
<tr>
<td>Confined to bed (%)</td>
<td>82</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Self care</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>No problems (%)</td>
<td>12</td>
<td>57</td>
<td>79</td>
<td>84</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>42</td>
<td>39</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Unable to (%)</td>
<td>46</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Usual activities</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>No problems (%)</td>
<td>0</td>
<td>11</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>Some problems (%)</td>
<td>14</td>
<td>50</td>
<td>51</td>
<td>53</td>
</tr>
<tr>
<td>Unable to (%)</td>
<td>86</td>
<td>39</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Pain/discomfort</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>None (%)</td>
<td>7</td>
<td>22</td>
<td>33</td>
<td>50</td>
</tr>
<tr>
<td>Moderate (%)</td>
<td>60</td>
<td>69</td>
<td>67</td>
<td>47</td>
</tr>
<tr>
<td>Extreme (%)</td>
<td>33</td>
<td>9</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Anxiety/depression</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>None (%)</td>
<td>44</td>
<td>44</td>
<td>53</td>
<td>61</td>
</tr>
<tr>
<td>Moderate (%)</td>
<td>49</td>
<td>52</td>
<td>40</td>
<td>34</td>
</tr>
<tr>
<td>Extreme (%)</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Cognition</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>No impairment (%)</td>
<td>93</td>
<td>91</td>
<td>95</td>
<td>92</td>
</tr>
<tr>
<td>Some impairment (%)</td>
<td>5</td>
<td>9</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Severe impairment (%)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The EQ-5D utility scores and the SF-6D scores are presented in figure 14.5. The difference in the baseline scores is noticeable and reflects the variation in the assessment period for the health outcome measures. The SF-36v2 asks the person to rate themselves over the previous four weeks whereas the EQ-5D asks them to rate themselves for that particular day only. This highlights one of the main differences between the two scales; that of ‘baseline’ data as it incorporates different time periods for the baseline data.
14.4.1: Visual Analogue Scores

There was a similar pattern for the visual analogue results where the participants had to assign themselves to a point on a 0-100 scale for assessment of health status at each follow-up time point. The main significant effect in the results was the overall change from baseline to 12 months, with a moderate effect between three and 12 months and three and six months. The scores at baseline for both the VAS and utility scores were lower than at any other point in the follow-up period thus it was not too surprising that the baseline to 12 month change had the largest effect. During the actual follow-up period between three and six months there were significant changes from the previous time points in the overall scores for this sample group. Thus, the overall effect takes into consideration that recovery is a constant changing event which has to take place over time.
Figure 14.6: Visual analogue scores over 12 months

14.5: CES-D Scores

Using the CES-D enabled the researcher to formally assess levels of depression in the sample as compared to self-reported levels (figure 14.7). Scores of 16 and above infer depression which is identified at the three month follow-up period in this sample group. Twenty four participants were classified as depressed at three months (48%) using the CES-D scale. Over the twelve month period there were a number of participants classed as depressed (34% at baseline, 32% at six months and 20% at 12 months), however it was a particular problem at three months as compared to the other time periods.
14.6: Gender Differences

The scores for the MCS, PCS, CES-D and EQ-5D were examined for differences between the 2 genders. Both genders had a median MAIS of 3 and mean ISS of 12.5 for males (n=39) and 11.45 for females (n=11); both had a median ISS of 10. It can be seen that throughout the study period females had consistently worse scores than the males, particularly for the mental health assessments using the CES-D (figure 14.8) and the MCS (figure 14.9). The CES-D figures were initially low (below 16) at baseline and peaked at three months for both genders, although males did not have mean scores of 16 at any point of the follow-up period. However, females after the baseline assessment, scored consistently high although there is a decline after a three month peak the scores do not drop below the cut off point for depression (16 and above), indicating a high level of depression present for females in this study. The CES-D incorporates the previous weeks’ feelings and experiences rather than a report of that particular day's feelings which are expressed in the EQ-5D health domain of anxiety and depression. The EQ-5D reports of anxiety and depression were examined although this is not the
usual way to present these results (figure 14.10); again higher percentages of
the females reported more levels of moderate or severe anxiety and
depression than the males. This was not constant with noticeable peaks and
troughs in scores compared to the males. The males, however, had a
consistent decline from baseline to 12 months in the percentage with
moderate to severe anxiety or depression.

The MCS mean scores were noticeably different between the two genders
again with the males apart from three months having consistent above
average scores for the UK population for MCS (figure 14.9). The females only
had average MCS scores compared to the UK population at baseline reaching
a low period at three months and then increasing towards the norm by the 12
month follow-up.

**Figure 14.8: Mean CES-D scores by gender**
Figure 14.9: Percentage of hospitalised participants reporting levels of moderate and extreme anxiety and depression by gender (EQ-5D)

Figure 14.10: Mean normalised MCS by gender

The physical differences were also examined with the PCS mean scores presented in figure 14.11. At baseline, males reported worse physical ability compared to females. Both genders experienced a drop in physical health at three months prior to an increase in scores at six and 12 months, although
males appear to have had a sharper increase in physical health towards the UK norm at 12 months compared to females.

Figure 14.11: Mean normalised PCS by gender

The EQ-5D utility scores calculated from the health profile also showed differences between the genders, again with females scoring consistently lower scores apart from baseline compared to males although both genders improve steadily over time (figure 14.12).
Chapter 14: Study 2 - Analysis of Data From Baseline to 12 Month Follow-up

Figure 14.12: Mean EQ-5D utility scores by gender

The data were analysed for PCS, MCS, EQ-5D utility scores and the CES-D for differences between the genders. It is recognised that dividing the sample into males and females creates a small sample for the females. The Mann Whitney U test was used for independent groups and a significance level of p=0.05 was used. The MCS showed significant differences between the genders at three months (p=0.04), six months (p=0.01) and 12 months (p=0.49), but not at baseline. On the CES-D scale there were significant differences between the genders for three months (p=0.023), six months (p=0.014) and 12 months (p=0.026). The EQ-5D utility scores found a significant difference at 12 months only (p=0.045). Finally the PCS found significant differences between the genders at baseline (p=0.027) and 12 months (p=0.018). These results suggest that females have the worst perceived outcomes following traumatic injury, compared to males. The reasons for this, however, are not clear and may relate to their stereotypical 'societal' roles with the need for males to regain health to continue as the main provider for the family. In comparison, females may suffer with greater feelings of isolation if they are 'stuck' at home as a result of their injury whilst their partner continues to work, which can lower mood and have an impact on physical recovery.
14.7: Injury Differences

The data were examined for differences between the MAIS level of injury and the PCS, MCS and EQ-5D utility scores. The MAIS distribution was biased towards the MAIS 3 and MAIS 2 groups and the participant with MAIS 1 injury was excluded. The physical ability distribution shows that those with a lower MAIS had better PCS scores compared to the higher MAIS injuries (figure 14.13). The high MAIS 4 injuries can represent severe chest and internal injury however all of these MAIS 4+ participants had substantial pelvic fracture.

The MCS scores were interesting in that they showed this sample group to have above average mental health after the three month follow-up period (figure 14.14). The MAIS 2 participants had a substantial drop in MCS scores at three months from the baseline assessment.
A similar trend in the CES-D scores was noted with a peak at three months for all injury groups from baseline indicating depression (scores 16 and above), figure 14.15. The scores then fell below the cut off of 16 at six months continuing to 12 months although this does not mean there were no participants with depression at these time points.

**Figure 14.15: Mean CES-D scores by MAIS**
Over the study period the EQ-5D scores showed a steady increase of scores for all MAIS groups; although the MAIS 3 and MAIS 4+ groups had consistently lower scores than the MAIS 2 groups (figure 14.16). These results identify an ability of the EQ-5D to differentiate between the MAIS groups for orthopaedic injury.

**Figure 14.16: Mean EQ5D utility scores by MAIS**

![Graph showing mean EQ5D utility scores by MAIS groups over follow-up period.]

**14.8: Major Effects Over Time**

It can be seen that the percentage of the reported major effects changed over the period of time (figure 14.17). These effects relate to the participants with reported effects and not those who have stated they had no effects at each time period.

The main reported problems for participants at three months related to social, functional and health effects. Socially the injury had affected both work and leisure activities, with many reporting functional problems, such as being reliant on others for transport and an overall loss of mobility. Health problems were also a major reported factor for this sample group relating to pain, prognosis, time to heal and problems with the healing process. These health problems continued through six months and remained an issue at 12 months. The social effects became less of a problem as time progressed as did
functional effects. Those reported effects which increased slightly in number were psychological and driving problems.

**Figure 14.17: Reported major effects over a 12 month period**

These effects identify the main issues reported by participants who remained affected by the injury at the varying follow-up periods. The fluctuations are interesting as they represent 'self-reported' main effects the injury or crash had had on a participant' rather than those measured by health outcome measures.
Chapter Fifteen: Study 2
Discussion and Conclusions
15.1 Introduction

This discussion is based on the findings of Study 2 and any discussion regarding the methodology is presented in Chapter 18.

15.2 Recruitment

Study 2 comprised higher AIS severity injuries (than Study 1) which predominantly required surgery to repair the damage. This study aimed to recruit all orthopaedic injuries so as not to restrict the study and its findings to one injury type. The majority of the injuries were to the lower extremities including the pelvis suggesting a high incidence of such injuries similar to that of whiplash in Study 1. This is reflective of the 54% of the sample who were vulnerable road users rather than car occupants, and as such the lower extremities were more exposed and prone to injury.

15.3: Injury

Lower extremity injury has predominated much of the follow-up literature because of its impairing capabilities and associated high costs (Mock, MacKenzie et al. 2000; McCarthy, MacKenzie et al. 2001; Butcher, MacKenzie et al. 1996). Few of the follow-up studies that exist have examined all injuries sustained in road traffic accidents with many concentrated on particular injury type, such as leg injuries as above. The impact on everyday life appeared to be more apparent in this study with more participants having changes to their living arrangements on discharge from hospital as a result of needing assistance for some of the basics of every day living such as having a shower, making a drink and doing the shopping. These changes were mainly a result of having injury to both upper and lower extremities, however those with lower extremity injury had more problems undertaking simple activities of daily living. The return to work rate was lower at three months with only 54% returning at this point, 58% at six months and 90% at 12 months. This is a high return to work rate compared to Read et al's (2004) study which found a 70% return to work rate following traumatic road injury. Their study also had high levels of lower extremity injury at 78%,
somewhat higher than this study of 64%. The impact of lower extremity injury is not difficult to comprehend on everyday activity and return to work but it was apparent in this study that occupation was an important factor in the return to work process. Three participants with fractured shafts of femur (AIS 3) treated surgically and all had differing return to work rates. Two of the participants had office based jobs one of whom had returned at three months and the second by four months. These two participants were paid by their companies for any sick leave taken. Both returned because of the need to get back to work as soon as they could drive. Their activities were limited to driving to work and sitting behind their desks, however all social activity had ceased because physically they could not play football, run around with the children or hill walk. The third participant did not return until six months, despite his fracture healing, because he was physically unable to perform his job as a cargo handler 'shifting heavy weights around all day'. Unfortunately he only earned statutory sick pay and during the enforced period off sick lost six months of full wages and had relied on his wife to work overtime to assist with the bills. He admitted to drinking 'a lot' in the first two months after the injury to 'get over the depression and the feeling of not being able to do anything'.

15.4: Financial Burden

The reliance on partners to become the main wage earners in this study was noticeable. The variation in company policies regarding sick pay was interesting as were those who did and did not have insurance against accidental injury if self-employed. Those with less financial worries were those whose companies paid basic salary as sick pay compared to those who only fulfilled their statutory obligation of providing the minimum amount. Of those who were self employed, two had insurance and were able to live comfortably during their time off sick but others less fortunate relied on statutory sick pay and, where applicable, incapacity benefit. One of the latter participants had to sell his wife's insurance policy to pay the mortgage and bills because having this money disqualified him from claiming incapacity benefit. Another participant had no mortgage insurance cover and as such
was relying on others to pay his mortgage. He could only afford to live in his house because he normally worked permanent overtime to cover the mortgage payments. He did not return to work albeit part time light duties until 11 months after the crash and was heavily in debt although he was expecting a 'decent compensation' award. Financial worries impacted on these participants considerably and had an effect on mood and well being. Financially, this sample group appeared worse off than Study 1 because of the time spent off sick and also the imposed physical limitations on normal work activities. This sample group had higher pay out awards compared to Study 1 and more interim compensation payouts. It would appear that the compensation procedure in this study was somewhat faster than Study 1 with more receiving an interim payout however this could be related to the severity of the injury. It is assumed that the severity of these injuries renders an interim payout more readily available knowing that the injuries sustained will incur higher compensation awards once the claim is settled.

15.5: Pain

Pain was a consistent problem throughout the follow-up period for this participant group and was again one of the main reasons for non-recovery at 12 months. At 12 months 63% still reported pain which might have knock-on effects on the level of physical impairment reported by this sample group of 58% at 12 months. The physical impairments over the period of the study were mainly the inability to bend or bear weight on the affected limb, resulting in a reduced level of functioning. These impairments again are not surprising due to the type of injuries sustained, however, there were some unexpected 'impairments'. One participant believed that they were impaired because of the need for catheterisation and also the effect the experience had on 'his sex life'. This participant was older and in his own words 'vain' and being scarred from the accident and also the limitations imposed on his everyday activity had had an effect on his self esteem. He had become impotent and had been prescribed viagra for this condition which at 12 months had become less of a problem as his self esteem had increased at this point. A second participant
Chapter 15: Study 2 - Discussion and conclusions

expressed fears that he would be infertile as a result of his injuries although this would be explored further at a future point in time and was not an immediate 'impairment' to consider. The issue of impotence for the males with severe pelvic fracture was of concern for all of them as this is a known risk of the restorative surgery for the injury. All participants are 'counselled' prior to their surgery where possible and afterwards they are normally monitored for the effects. These participants were relieved during the follow-up interviews once this side effect of surgery had been ruled out.

15.6: Psychological Impact

The psychological impact for the participants in this study was varied with a definite decline in mental health at three months. The EQ-5D responses for anxiety and depression throughout the study period identified a consistent problem from baseline through to 12 months (56%, 56%, 47% and 39%). The MCS however only identifies a real problem at three months post crash with scores found to be below the UK average. This was also reflected in the CES-D with a simultaneous peak in scores above the cut off point of 16, indicative of depression. This suggests that the MCS and CES-D measure levels of depression which affect actual behaviour and the EQ-5D may be measuring higher levels of anxiety on any given day rather than actual depression. Anxiety can be brought on by numerous external factors, for instance financial worry or impending court cases which will only impact on a participant for a short but intense period. There were a number of anxieties expressed by this study group related to driving / passenger behaviour and guilt at having caused an accident. One participant had shown no symptoms of anxiety or depression throughout the study but at eight months post-crash she had been prescribed anti-depressives because of an impending court case where she was 'being made a scapegoat' for the company for which she drove, as the vehicle had been found to be defective and she was at fault for the crash. A second participant with a minor injury resulting in two days in hospital for exploratory surgery had recovered well, however, his wife had become seriously depressed and suicidal following his accident. The impact of what could have happened to her husband precipitated her illness, however
there were other potential factors which also contributed to the onset. He was extremely anxious about his wife and had to take a considerable amount of time off sick to look after her as opposed to his injury. He also had to sell his motorbike because of the distress it caused his wife. These factors outside of the 'direct injury consequences' contribute to the levels of anxiety experienced by the participants.

In contrast there were positive effects for some as a result of the crash and injury. One participant who had sustained serious pelvic fractures and recovered well from the injuries had become family oriented and believed in 'living life to the full, making time to do things rather than just exist'. He normally worked overtime for extra money but stopped this to spend time with his family instead. The experience had reinforced the notion that 'we only have one life'; thus should fulfil it. Another person who sustained a hand injury as well as a back injury had enrolled at college by 12 months to undertake a training course, something he had always wanted to do but could not afford it. His injuries meant that he could not return to his normal physical job and was supported by incapacity benefits which gave him access to college courses.

The peak at three months for poor mental health was interesting as it also coincided with a poor physical state measured by the PCS. The EQ-5D utility at this point was also low at 0.4. At the three month assessment most participants had been given their prognosis and were also at a point where there was an expectation of having recovered completely. The majority of participants with injuries involving joints had all been told to expect to have arthritis at a later date. One participant had been told that he was lucky not to have lost his leg and this was still a possibility and another participant was told she may never walk again. At this point many were aware of how long they would be off sick and what that meant financially. The issues of compensation and who was at fault were also being considered at this time causing concern for some participants.
15.7: Physical Impact

The physical capabilities of this sample were noticeably reduced compared to those of Study 1. The PCS as measured by SF-36v2 was consistently below the UK norms throughout all of the follow-up periods and even at baseline it was below the norm. The reported physical impairment by the participants in this study is evident in the restriction of the majority of activities by this sample group. The changes in the PCS over time were noticeable for this group of participants with consistently lower average scores throughout the study period. At three months a dip in the PCS scores was also apparent and the reason is unclear. However, crutches were being used and the more complicated fractures had not healed at this point rendering the majority of participants physically impaired. The improvement in scores after three months was noted, however, they did not reach baseline or UK norm values.

The baseline scores for the majority of this study group incorporated pre-crash assessments using the SF-36v2. The EQ-5D in contrast had poor baseline scores as this only assessed that day's health and abilities, all of these assessments being post-injury. The low EQ-5D scores at baseline ensured that only improvements were made from this point onwards although they remained lower than matched UK norms for age and gender. Conversely the SF-6D had high baseline scores which dropped at three months and improved after this point (figure 15.3). The difference between the two utility scores was marked at baseline only, with a similar trend over the remaining follow-up period. One participant had found herself in a situation where her injuries (fractured pelvis) had reduced her mobility and she was reliant on her husband to take her out of the house. She had become isolated because her husband worked full time and she had to wait all day for his return to do anything. She had also lost her job at a factory because of the injury and had become depressed as a result of this isolation. Her husband who found her depression difficult to cope with, arrived home later each day rather than see his wife. Unfortunately she was in a cycle of not doing anything for herself, relying on others and accepting the situation taking on 'the sick role' and not accepting the fact it was up to her to make a difference to the situation. It is
debateable whether this was an actual gender difference as it is only one example although females have been found to fare worse when assessing outcomes (Holbrook, Hoyt et al. 2001). This is despite the disproportionate higher number of males to females in many trauma studies, including this one.

15.8: Gender Differences

In this study the difference between genders was also noted on the health outcome measure scores, indicative of females having worse outcomes than males. The marked difference in the genders was found in the MCS and CES-D scores with females having consistently worse scores in both with baseline as the only point where they were not depressed (CES-D <16, MCS >50). Even in the EQ-5D anxiety and depression domain over 50% of women consistently expressed either a 'moderate' or 'extreme' problem in this domain. Males, however, had a steady decline of these symptoms from baseline reporting of 76% to a 12 month level of 30%. On the CES-D and MCS, apart from a slight drop in mental health reporting at three months at all other times males were considered either not depressed on the CES-D or above the UK average. Suggesting a real difference in mental health between the genders although it has to be remembered that this sample is small and the females made up just under a quarter of the sample itself. Physically females scored better at baseline and at three months compared to the males they tended to plateau well below the UK norm of 50 for PCS at 31-32. The males who had notable increases in PCS scores from three months (PCS=28) to 12 months (PCS=45) (figure 15.11).

15.9: Injury Severity and Outcome

The severity of injury was also explored in relation to the health outcome measures with a definite difference observed for MAIS and PCS scores (figure 15.13). All PCS scores dropped from the initial baseline assessment in line with the MAIS categories such that MAIS 4+ injuries recorded the worst PCS scores for all follow-up periods and MAIS 2 the best scores whilst those with MAIS 3 sat between these injury groups. Again the three month period was the worst point in time for all of the MAIS groups. The mental health of the
MAIS groups, however, was not as easily isolated as the physical scores. Although there was variation between the actual scores and the MAIS groups there was not a clear cut division between the MCS and MAIS groups (figure 15.14) although the CES-D scores had a wider spread (figure 15.15). At three months there was a wider spread of CES-D scores above the 16 cut off point indicating depression. Those with MAIS 4+ injuries had higher scores at this point, than the MAIS 2 group and finally the MAIS 3 injuries with a mean score of 17 at three months. The variation in the EQ-5D scores followed a pattern of those with MAIS 4+ scores having lower utility scores compared to MAIS 3 and MAIS 2. It would appear that there are differences in outcome dependent on injury severity particularly the physical impact and overall scores however the MAIS 2 and MAIS 4+ groups had small numbers of participants with the majority having MAIS 3 injuries.

15.10: General Health

General health, as measured by the SF-36v2, also remained consistent throughout this study although it was below the norm for all follow-up points from three months onwards. It had less variation throughout the study compared to all other health dimensions in the SF-36v2 indicating that general health was again a separate factor compared to actual physical and psychological impairment. Sixty four percent of the participants at 12 months stated their health was worse now than before the crash, usually as a result of restricted abilities causing loss of fitness and weight gain and the prospect of arthritis. These tended to have an impact on the perceived general health of the participants as the prospect of arthritis rendered them 'less healthy' than previously. There were also a number of participants who were re-admitted for problems or further surgery after the initial admission. These secondary problems ranged between developing deep vein thrombosis, identifying secondary injuries not found at initial investigation or breakdown of wounds. Interestingly, it was these health issues which remained a constant effect for the participants as reported in the major effect assessment.
15.11: Financial Burden

Financial problems were identified for a number of participants with various amounts being stated as being a 'burden' to them. The personal costs incurred were related to a variety of reasons; replacing the car was the predominant cost as were the loss of wages which was substantial for a couple of participants being £30,000 and £20,000 respectively. The loss of wages was recouped by the former participant at 12 months once he had returned to work in his own business, the latter participant had recovered some of his losses and debt at 12 months from an interim personal injury award. Other lesser costs incurred were also of major concern for some as many were not high earners and could not afford to lose even moderate amounts such as £100. Other participants were resigned to the fact that they would have higher insurance premiums in the next year and were determined to deal with this when needed.

15.12: Head Injury

In this study there were two participants with head injury as well as suffering other injuries during the crash. It was not expected to recruit any participants with substantial head injury because the head injury unit for the East Midlands was not one of the study hospitals. One participant had sustained a substantial head injury and was in a coma for a week prior to being transferred to the study hospital for treatment of his extremity and other injuries. The effects of the head injury had altered his moods and at points he admitted to being more aggressive. He had returned to work at six months undertaking light duties, however, he was aware of his anger and stated he 'just got a white light' and became angry very quickly. He was employed in the army and as such was required to fulfil his role without detriment to others. He was originally passed fit to work by the army but after the six month follow-up had been admitted to a rehabilitation centre for 'aggressive physiotherapy' on his arm and 'anger management' prior to being accepted back on full duties or retired out of the army on health grounds. There was one other participant who had sustained a brain injury but this was minor in comparison
with no period of unconsciousness. She suffered with forgetfulness after the crash and in her occupation as a receptionist 'wrote everything down' so she did not forget any information. She also sustained bilateral clavicle fractures which were surgically plated and was able to return to work by the three month follow-up period. This is in contrast to the participant in Study 1 who had a clavicle fracture treated conservatively with a sling and still had not been able to return to full work duties by six months and was waiting for surgery to plate the fracture. This appears to be a problem for orthopaedic surgeons - whether to operate immediately post crash or act conservatively incurring high numbers of sick days and also prolonging the need to attend outpatient appointments.

15.13: Complications of Treatment

The 'wait and see' approach, adopted by some orthopaedic surgeons, was identified in those with upper extremity fractures-usually to the humerus or clavicle. One of the participants who had a fractured humerus was treated with a sling and at six months was waiting for surgery to plate the fracture. During this period he was off sick without sick pay and no other income. At 12 months this participant had returned to work for a short period and was working overtime to pay off his debts but suffered a heart attack leading to further sick time and debts. He was again waiting for heart surgery and although there is no evidence to support this he believed that the delay in his initial treatment on his fractured humerus had contributed directly to his heart attack due to the strain. The implication of the 'wait and see' approach to the participants is illustrated by these particular examples, however, what this suggests when measuring the outcomes is that the result of 'procedures' and their consequences are being measured rather than the original injury itself. Thus, to make any judgement on the effect of early surgery versus conservative treatment requires a larger study examining the health outcomes of a particular injury for example proximal humerus fractures. It cannot be determined from this study whether any of these participants would have made a rapid full recovery if they had surgery in the initial period rather than a later date but the participants believe this would have been the case.
15.14: Recovery

The recovery process for Study 2 was somewhat different to Study 1 as a result of the severity of the injuries sustained. The impact on physical health was the overriding factor in this study. The mental health impact was not a major factor for the whole participant group which was a surprise as many reported feeling anxious or depressed during interviews but measurable mental health did not reflect these findings. The positive aspect of mental health may be a result of many participants stating 'it could have been worse' meaning their injuries were of no consequence compared to dying.

15.15: Summary

In summary, this study identified that those with serious injury had poor physical outcomes although mental health outcomes were variable across time and measure. It was noted that these participants had high numbers of lower extremity injury which logically have an effect on mobility and levels of physical ability. Similar to Study 1 the three month post crash was a 'down point' for the participants in this study. It can only be proposed that the effects of the injury and the consequences of time off sick, loss of earnings and poor social activity levels become apparent at this time and participants have to adjust to these changes. The greater amount of sick time and the lower return to work rate for participants in this study would suggest that more impairing injuries were sustained, creating a wide reaching effect on all areas of everyday activity both including work and leisure.

The main findings from the study are further summarised below;

- Sample of 'serious' orthopaedic injury
- 54% were vulnerable road users
- High incidence of lower extremity injury
- There were significant effects on physical outcomes, with hobbies and work activities grossly affected
Chapter 15: Study 2 - Discussion and conclusions

- Perceived outcomes were poor for those initially treated conservatively rather than surgically which was still required at a later date
- Injury severity was shown to have an effect on physical outcome with higher MAIS injuries having a poorer outcome
- Return to work rate was 90% at 12 months
- Pain was a major factor throughout the study and was a reason for poor perceived recovery
- Overall the psychological outcomes were worse for this sample group specifically noted in females.
- Gender differences were evident in this sample with females having poorer measurable physical and psychological outcomes
- Greater financial burden experienced by this sample as a result of longer periods of sick
- The compensation process was slow and contributed to the financial burden

15.15.1: Methodological Implications

The recruitment process in this study was valuable for the researcher because of the ability to explain the study and answer questions at the time of recruitment. This recruitment process also allowed participants to talk about the crash in general, which for some was a valuable experience rather than a detrimental one. It also was valuable to see the participants 'at their worst' from which to identify what the problems were at first hand. It also allowed immediate access to medical notes and X-rays as well as having some contact with their family. This baseline assessment identified the differences between the two health outcome measures where one takes either a 'snapshot' of health for that day recording very poor health (EQ-5D) or a four week assessment which combines pre-injury with post-injury health as an average state of health (SF-36v2). This reinforces the fact that these measures are not interchangeable but complementary to each other.

There were limitations to this recruitment procedure because of the reliance on the trauma coordinators to provide the relevant information to the researcher and this was only available three times a week. One of the trauma
coordinators had changed the admission sheets so that she could reply immediately when the researcher rang to check whether there had been any admissions. Unfortunately, at the second hospital the trauma coordinator who knew all of the units’ admissions left the post and the researcher had to rely on ad hoc information from the main admissions unit. This created problems as many were discharged prior to the researcher visiting the hospital because they were only overnight stays or had been missed in the latter hospital as a road accident victim.

In this study two contact numbers were taken for follow-up purposes, however, there was still a high level of attrition (24%). The use of mobile phones was a main problem when contacting participants for follow-up interviews as some had changed their number or chose not to answer the phone. The second contacts were useful if they were aware of the reason for the phone call, however some refused to give a contact number out. Letters were also sent out requesting contact but none were replied to. One of the participants did not complete the whole study as a result of being imprisoned and therefore non-contactable.

Using a third measure to assess depression formally was of value to this study as it formalised an aspect of mental health. It also highlighted that both the MCS and EQ-5D included other items in their mental health assessment other than depression. Further studies of this nature would benefit from an inclusion of a depression measure if it was considered to be an expected outcome of the study.

This highlights the difficulties of undertaking a follow-up study even with small numbers of participants. Ideally a study to explore the outcomes of all road trauma requires a multi-centred study with ‘in-house’ recruitment procedures to ensure a larger more robust sample.
Chapter Sixteen: Study 3
The Burden of Injury
16.1: Introduction

The previous studies in this thesis were examining the outcomes of injury at an individual level and how it affects everyday lifestyle and activity. One aspect that was considered was the individual financial burden and what costs are incurred but did not address the issue of societal costs. This study examines the societal effects of injury in terms of financial costs and injury burden. This study addresses methodological issues to assess societal burden and presents results of injury costs as measured by a willingness to pay approach and injury burden measured as impairment and quality adjusted life years (QALYs) elicited from preference measures (EQ-5D, SF-6D). The methods are applied to the samples from the previous two studies to examine differences between relatively 'minor' injury (Study 1) and those with 'serious' injury (Study 2).

The burden of injury can be measured in various ways, including monetary costs, impairment and disability and more recently the metrics of disability adjusted life years (DALY’s) and quality adjusted life years (QALYs), as well as others. This study aims to use existing methods to measure the burden of injury with particular emphasis on injury cost, impairment and QALYs. The specific aims of which are;

- Explore the use of the willingness to pay approach to cost road traffic injury
- Explore the use of QALYs to express the burden of injury of road traffic injury
- Examine the use of existing injury impairment scales

16.2: Injury Costs

Costing of injury is a complex and diverse subject since it is necessary to establish 'what' costs are being calculated and 'how' they have been derived and furthermore 'what type', if any, of economic evaluation they are being used for.
Since 1988, the UK valuation of fatal road accident casualties has been based on a consistent willingness to pay (WTP) approach. This approach is where individuals place a value on a decrease in the risk of a fatal accident. The theory is that decisions in the public sector which improve safety reduce the risk of an individual being killed or injured so that a safety improvement can be considered to be avoiding a ‘statistical injury’. For small reductions in risk, the total value which society as a whole is willing to pay to avoid a 'statistical injury' is equivalent to the marginal rate of substitution of wealth for the probability of being injured. The average of individual values for the population affected by the safety improvement represents the Willingness to Pay for that group as a whole.

In 1993, a ‘Willingness to Pay’ approach was adopted to revise the values for non-fatal road accident casualties (Hopkin and Simpson 1994) and incorporated a series of costs as presented below. These costs valued the prevention of casualty types ('Slight', 'Serious' and 'Fatal').

- **Lost output** due to injury calculated as the ‘present’ value of the expected loss of earnings plus any non-wage payments (NI contributions) paid by the employer;
- **Medical costs** including Ambulance costs and hospital treatment costs;
- **Human costs** based on WTP values representing pain, grief and suffering to the casualty, relatives and friends and for fatal casualties, the loss of enjoyment of life over and above the consumption of goods and services.
- **Casualty Costs**
  When further calculating the costs of individual accidents, further costs are added to reflect the following:
  - **Police costs** including time in dealing with and investigating road accidents
  - **Insurance administration** based on average handling cost per road accident claim
  - **Damage to property** including damage to vehicles, cost of replacement vehicles and engineers/assessors reports.
The individual cost per casualty and per accident for each of these elements (for 2003) can be seen in tables 16.1 and 16.2 below.

The UK’s road casualty prevention costs can be derived by multiplying the number of casualties in each category by the cost of prevention for each category. Thus the total costs for prevention of each casualty type for 2003 were £5.2 billion for ‘Fatal’ casualties, £5.9 billion for ‘Serious’ casualties and £4.4 billion for ‘Slight’ casualties giving a total cost for casualty prevention of £15.5 billion. The total costs for prevention of all accidents (including ‘Damage Only’ accidents) is calculated at £18.1 billion (Hopkin and Simpson 1994; Simpson 1996)

<table>
<thead>
<tr>
<th>CASUALTY SEVERITY</th>
<th>LOST OUTPUT</th>
<th>HUMAN COSTS</th>
<th>MEDICAL AND SUPPORT COSTS</th>
<th>TOTAL COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>£451,110</td>
<td>£860,380</td>
<td>£770</td>
<td>£1,312,260</td>
</tr>
<tr>
<td>Serious</td>
<td>£17,380</td>
<td>£119,550</td>
<td>£10,530</td>
<td>£147,460</td>
</tr>
<tr>
<td>Slight</td>
<td>£1,220</td>
<td>£8,750</td>
<td>£780</td>
<td>£11,370</td>
</tr>
<tr>
<td>All casualties</td>
<td>£9,060</td>
<td>£31,880</td>
<td>£1,910</td>
<td>£42,850</td>
</tr>
</tbody>
</table>
Table 16.2: Summary of Accident Related Costs (per accident) 2003

<table>
<thead>
<tr>
<th>ACCIDENT SEVERITY</th>
<th>DAMAGE TO PROPERTY</th>
<th>INSURANCE ADMIN</th>
<th>POLICE COSTS</th>
<th>COSTS PER CASUALTY*</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>£9,030</td>
<td>£240</td>
<td>£1,530</td>
<td>£1,482,110</td>
<td>£1,492,910</td>
</tr>
<tr>
<td>Serious</td>
<td>£4,110</td>
<td>£150</td>
<td>£210</td>
<td>£170,060</td>
<td>£174,530</td>
</tr>
<tr>
<td>Slight</td>
<td>£2,410</td>
<td>£90</td>
<td>£50</td>
<td>£15,000</td>
<td>£17,550</td>
</tr>
<tr>
<td>All injury</td>
<td>£2,740</td>
<td>£100</td>
<td>£90</td>
<td>£58,190</td>
<td>£61,120</td>
</tr>
<tr>
<td>Damage only</td>
<td>£1,520</td>
<td>£50</td>
<td>£3</td>
<td>-</td>
<td>£1,573</td>
</tr>
</tbody>
</table>

*comprises sum total of Police costs, insurance admin and damage to property on an accident rather than casualty basis

Notes;

- For fatal crashes, lost output is based on loss of future production and consumption and takes into account average earnings, morbidity rates and average consumption per capita.
- Medical costs were estimated from Department of Health figures based on assumptions of use of hospital facilities.
- The human cost elements are a simple calculation of subtracting the lost output and medical costs from the total cost.

Costing of Individual Injuries

The UK's willingness to pay approach has been adapted at the VSRC by Morris et al. (in press) by mapping the AIS90 to the injury state descriptors presented in Hopkin and Simpson (1994) and the resultant data will be used as the basis to examine the monetary costs of injury for this study.

16.3: Impairment

Impairment is of particular concern to the victims of road traffic injury as reduction of numbers of fatalities is at the core of the UK Government's road safety strategy (DETR 2000). However there is little emphasis on the survivors of road injury who may be left with impairing injury.

The true levels of impairment in the survivors of road trauma are not known but it is assumed to be high, particularly for lower extremity, spinal cord and brain injuries. Despite the lack of resources to follow-up survivors of road trauma a need still exists to quantify such impairments based on the available
injury data to road safety researchers to establish the true socio-economic consequences of crashes.

16.3.1: The Injury Impairment Scale (IIS)

One of the earliest formal predictors of impairment following injury was developed by the Association for the Advancement of Automotive Medicine (AAAM) in 1994. This was published in response to various previous attempts by researchers to examine the long term outcomes of injury (Bull 1985, Mackenzie, Shapiro et al. 1986; Hirsch 1983. The Injury Impairment Scale (IIS) was developed in collaboration with a number of medical specialist and researchers in North America and Europe. It defines impairment as 'the loss of function or abnormal function of an organ, tissue or organ system resulting after healing has occurred'.

Disability was also defined by this group as 'the effect or consequences of an impairment of multiple impairments on the whole person that restricts an individual from performing at, or near the pre-injury capability. Age, education, family and community support, personal financial resources, the availability of rehabilitation programmes, and pre-existing conditions are determinants of disability relative to the impairment'.

The IIS framework is based on six health dimensions of mobility, cognitive, cosmetic interfering with function, sensory, sexual /reproduction and pain. An overall six point impairment code was developed and assigned to every injury code in the AIS90.

0 - Normal function: No impairment
1 - Impairment detectable but does not limit function
2 - Impairment level compatible with most but not all function
3 - Impairment level compatible with some normal function
4 - Impairment level significantly impedes some normal functions
5 - Impairment precludes most useful function
6 - Impairment precludes any useful function
The impairment score relates to the whole body, not organ or system dysfunction at one year post 'single' injury. States and Viano (1990) provide a more detailed description for all of the above states. The IIS has not been adopted on any scale for use by medics or researchers in road safety research and has not been validated to any degree (Yates 1994; Waller et al. 1995; von Koch et al. 1994; Bradford et al. 1994). The ease of use of this scale is apparent, however, the simplicity of assigning just one score to every injury does not take into account the fact that some will recover without impairment and also does not consider the cumulative effect of the injuries sustained on any impairment.

16.3.2: The Functional Capacity Index (FCI)

In the similar time period that IIS was being developed, work had commenced on developing the FCI in response to a request by the National Highway Traffic Safety Administration in the U.S (NHTSA) to develop a measure to evaluate the consequences of road traffic injury (MacKenzie, Damiano et al. 1996). The FCI was designed to predict the outcome of the injury at one year post injury based on the AIS 90 injury code. The work was first published in 1994 and based on the assessment of 10 health dimensions these being: excretion; eating; sexual function; ambulation; hand/arm movement; bending/lifting; visual function; auditory function; speech, and cognitive function (Appendix A). Its development was in three stages with the initial stage identifying the 10 health dimensions via medical specialists and the published literature. Secondly, a group of raters from varying backgrounds had to categorise the items within the dimensions on a 0-100 scale. Then, using a multiplicative model, weights were assigned to these dimensions and items. The AIS90 codes were subsequently assigned an item level for each of the dimensions; for example, the bending and lifting dimension has four items ranging from A 'no limitations' to D 'cannot bend or lift'. This stage resulted in the AIS90 codes having a profile consisting of 10 letters, one for each domain thus AAAAAAAAAAA is no problem at all. From these profiles a 'look up table' is used to obtain the FCI weight, ranging between 0.0 and 1.0. However, the FCI has not been validated at length and has been shown to
have only moderate correlation between the FCI and the outcome impairment at one year post injury (Mackenzie, Sacco et al. 1996; Schluter, Neale et al. 2005, McCarthy; MacKenzie et al. 2001). Work has continued with the FCI and at present there is an expectation that it will be published in the near future in the AIS2005 dictionary. The FCI has not been released widely and attempts by the researcher to access the weights for AIS98 have not been successful for use within this study.

16.4: Quality Adjusted Life Years (QALYs)

Simplistically, the health utilities are values assigned to a health state on a 0 - 1 scale incorporating the states 'dead' and 'healthy'. This value reflects the quality of the health states and allows morbidity and mortality improvements to be combined into one single measure of QALYs gained (Torrance 1986). Conversely, it can also reflect the loss of health states using QALYs lost. Thus, if someone was treated for a condition which improved their health state from 0.50 to 0.75 over a one year period then they have a total QALY gain of 0.25. If the same person were to live for 10 years at the increased QALY level then the overall QALY gained for that treatment for that person would be 0.25 * 10 years, thus 2.5 QALYs will be gained overall. The main benefit of using QALYs is that they are non-monetary units that can be used in cost-utility analysis.

Their value in injury studies is their systematic ability to indicate loss of quality of life as a result of reduced functional capacity over a period of time (Nagi 1991). A lifetime QALY loss due to health problems is determined by problem duration and severity. To calculate the QALY loss, one estimates the fraction of perfect health lost (the QALY loss) during each year that a victim is recovering from the problem, or living with a residual disability, then sums the present value of these fractions.

To achieve the goal of estimating QALYs an assessment tool to measure the changes in physical and psychosocial functioning is needed to allow for the conversion from functional loss to health related utility losses (that is the economical viewpoint of loss related to changes in health status). The assessment tools have to be based on sound economical principles for the
transfer from a health assessment to cost utility analysis, including standard gamble and time trade-off techniques.

16.5: Methodology

16.5.1: Injury Costs

The Department for Transport's methodology based on the Willingness to Pay approach was used to apply costs to the injury states sustained in this study. In their study, a number of Injury State Descriptors were determined to cover a range of serious injuries from a fractured finger to those involving permanent disability or death more than 30 days after the accident (Hopkin and Simpson 1994). The descriptors covered different aspects of the consequences of injuries, including: extent and duration of pain, period of treatment (in hospital or as an out-patient), recovery period and social and professional consequences. These injury state descriptors are shown in table 16.3.
<table>
<thead>
<tr>
<th>INJURY CODE</th>
<th>INJURY STATE DESCRIPTION</th>
<th>SUMMARY DESCRIPTION</th>
<th>% OF CASUALTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>No overnight stay in hospital (seen as an out-patient); experience slight to moderate pain for 2-7 days followed by some pain/discomfort for several weeks; some restrictions to work/leisure activities for several weeks/months, return to normal health with no permanent disability.</td>
<td>Recover 3-4 months (Out-patient)</td>
<td>19</td>
</tr>
<tr>
<td>W</td>
<td>In hospital 2-7 days in slight to moderate pain; after hospital, some pain/discomfort for several weeks; some restrictions to work and/or leisure activities for several weeks/months; after 3-4 months, return to normal health with no permanent disability.</td>
<td>Recover 3-4 months (In patient)</td>
<td>13</td>
</tr>
<tr>
<td>X</td>
<td>In hospital 1-4 weeks in slight to moderate pain; after hospital, some pain/discomfort, gradually reducing; some restrictions to work and leisure activities, steadily improving, after 1-3 years, return to normal health with no permanent disability.</td>
<td>Recover 1-3 years</td>
<td>36</td>
</tr>
<tr>
<td>V</td>
<td>No overnight stay in hospital (seen as out-patient) moderate to severe pain for 1-4 weeks; thereafter, some pain gradually reducing but may recur when you take part in some activities; some permanent restrictions to leisure and possible some work activities.</td>
<td>Mild permanent disability (Out patient)</td>
<td>5</td>
</tr>
<tr>
<td>S</td>
<td>In hospital 1-4 weeks in moderate to severe pain gradually reducing, but may recur when taking part in some activities; some permanent restrictions to leisure and possibly some work activities.</td>
<td>Mild permanent disability (In patient)</td>
<td>12</td>
</tr>
<tr>
<td>R</td>
<td>In hospital several weeks, possibly several months in moderate to severe pain; after hospital, continuing permanent pain, possibly requiring frequent medication; substantial and permanent restrictions to work and leisure activities; possibly some permanent scaring,</td>
<td>Some permanent disability with scarring.</td>
<td>13</td>
</tr>
<tr>
<td>N</td>
<td>In hospital several weeks, possibly several months; loss of use of legs and possibly other limbs due to paralysis and/or amputation; after hospital, permanently confined to a wheelchair and dependant on others for many physical needs, including dressing and toileting.</td>
<td>Paraplegia/quadriplegia</td>
<td>2</td>
</tr>
<tr>
<td>L</td>
<td>In hospital several weeks, possibly several months due to head injuries resulting in severe brain damage; after hospital, mental and physical abilities greatly reduced permanently; dependant on others for many physical needs, including feeding and toileting.</td>
<td>Severe head injuries</td>
<td>2</td>
</tr>
</tbody>
</table>
Chapter 16: Study 3 - The Burden of injury

The next stage involved quantifying the value of avoidance of each of these non-fatal injury states and Hopkin and Simpson’s approach involved deriving this by calculating the value relative to the injury state of ‘fatality’. Thus a ‘fatality’ state was the maximum state and a monetary value was available for this state which was based on a combination of human costs (£510,880 at 1994 prices) plus the value of consumption (£217,480 at 1994 prices). Thus, the overall value of the ‘fatality state’ in 1994 was calculated to be £728,360. Using the same approach, the corresponding values for 2003 would be £860,380 for human cost and £451,880 for consumption giving a total of £1,312,260.

Respondents were asked to provide an estimate of the value of the different injury states as a percentage of the injury state of ‘fatality’ and the results from this survey were used to apply a value for each injury relative to the value of death. These figures are as shown in table 16.4.

### Table 16.4: Estimates of Relative Value of Serious Injury

<table>
<thead>
<tr>
<th>INJURY STATE</th>
<th>% VALUE OF DEATH</th>
<th>VALUE (1994 PRICES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recover 3-4 months (Out-patient): F</td>
<td>2.0</td>
<td>£14,570</td>
</tr>
<tr>
<td>Recover 3-4 months (In patient): W</td>
<td>2.0</td>
<td>£14,570</td>
</tr>
<tr>
<td>Recover 1-3 years (in-patient): X</td>
<td>5.5</td>
<td>£40,060</td>
</tr>
<tr>
<td>Mild permanent disability (Out patient): V</td>
<td>5.5</td>
<td>£40,060</td>
</tr>
<tr>
<td>Mild permanent disability (In patient): S</td>
<td>15.1</td>
<td>£109,980</td>
</tr>
<tr>
<td>Some permanent disability with scarring: R</td>
<td>23.3</td>
<td>£169,710</td>
</tr>
<tr>
<td>Paraplegia/quadriplegia: L and N</td>
<td>100</td>
<td>£728,360</td>
</tr>
<tr>
<td>Severe head injuries L and N</td>
<td>100</td>
<td>£728,360</td>
</tr>
<tr>
<td>All Serious injuries</td>
<td>9.7</td>
<td>£70,910</td>
</tr>
</tbody>
</table>
It was also necessary to determine costs specifically for injuries that were not judged as ‘Serious’ (i.e. ‘Slight’ including cuts and bruises) and also ‘Whiplash’. The value for ‘Whiplash’ injuries was derived in a similar way to that of ‘Serious’ casualties. The respondents indicated that whiplash injuries were on a par with injuries in the ‘X’ category (i.e. recover in one to three years) but worse than the ‘W’ category (recover in three to four months). Therefore, the researchers made an assumption that half of the injuries should be rated as ‘X’ and half as ‘W’ but a slight adjustment was made for injuries in the ‘X’ category effectively reducing the value of this injury to 5% of the value of death (from 5.5%). Therefore, to derive the overall value of Whiplash, the following formula was effectively used;

\[
\frac{W}{2} + (728,360 \times 0.05/2) = \text{value of Whiplash} (\text{\pounds 25,490})
\]

Where \( W \) was the value of injury state ‘W’ (\pounds 14,570)

For ‘Slight’ injuries, the Willingness to Pay study included a question which asked about the sum of money that would ‘just make up’ for an injury involving a quick and full recovery (such as a cut or bruise). The respondents’ best initial estimate of this amount was \pounds 120. However, it was further assumed that some 20% of ‘Slightly’ injured casualties would have ‘Whiplash’ as their main injury and therefore the value was weighted up to \pounds 5,190 for each injury.

This approach does allow for several injury states (i.e. those described in table 16.4) to be calculated at 2003 prices by adjusting the overall cost of a fatality to the 2003 value (\pounds 1,216,394) and then calculating the value of each injury state relative to the value of death. Thus, the revised cost of injury state at the 2003 value is as shown in table 16.5. The values for Whiplash and ‘Slight’ injuries have also been re-calculated at 2003 values.
Table 16.5: Estimates of relative value of serious injury adjusted to 2003 prices

<table>
<thead>
<tr>
<th>INJURY STATE</th>
<th>% VALUE OF DEATH</th>
<th>VALUE (2003 PRICES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recover 3-4 months (Out-patient): F</td>
<td>2.0</td>
<td>£24,328</td>
</tr>
<tr>
<td>Recover 3-4 months (In patient): W</td>
<td>2.0</td>
<td>£24,328</td>
</tr>
<tr>
<td>Recover 1-3 years (In-patient): X</td>
<td>5.5</td>
<td>£66,902</td>
</tr>
<tr>
<td>Mild permanent disability (Out patient): V</td>
<td>5.5</td>
<td>£66,902</td>
</tr>
<tr>
<td>Mild permanent disability (In patient): S</td>
<td>15.1</td>
<td>£183,675</td>
</tr>
<tr>
<td>Some permanent disability with scarring: R</td>
<td>23.3</td>
<td>£283,420</td>
</tr>
<tr>
<td>Paraplegia/quadriplegia: L and N</td>
<td>100</td>
<td>£1,216,394</td>
</tr>
<tr>
<td>Severe head injuries L and N</td>
<td>100</td>
<td>£1,216,394</td>
</tr>
<tr>
<td>Whiplash</td>
<td></td>
<td>£43,604</td>
</tr>
<tr>
<td>Slight injuries</td>
<td></td>
<td>£8,693</td>
</tr>
</tbody>
</table>

However, although a value for the 'injury states' can be calculated, cost of individual injury types (for example a skull fracture or a ruptured spleen) can not easily be calculated according to this model. Therefore, it was deemed necessary to map individual trauma injuries to the injury states. The trauma injuries that were mapped to the injury states were those listed in the AIS 1998 revision. The mapping was undertaken by the researcher who determined an appropriate injury state for each of the injuries sustained by the sample group. This mapping was verified by a second injury data coder at the VSRC.
All AIS 1 injuries (with the exception of cervical, thoracic and lumbar spine injuries which were classified as ‘Whiplash’) were valued as ‘Slight’ injuries. Therefore, each of the AIS injuries that were subjected to the mapping process was allocated an injury cost depending on the determined injury state. An analysis of the data was then undertaken to determine overall injury costs and costs for different body regions.

16.5.2: Impairment

The IIS severity codes were assigned to all of the AIS98 injury codes identified in this study. There was only one AIS98 code not found in the IIS dictionary; the descriptor was examined in both the AIS90 and AIS98 dictionaries and was found to be an added but similar code to that contained in the AIS98 and therefore the appropriate IIS was assigned to that injury.

16.5.3: Quality Adjusted Life Years (QALYs)

The SF-6D and EQ-5D utility scores obtained in Study 1 and 2 were used to calculate the QALYs lost in the one year period following injury. The population norms were available for the EQ-5D data and lost QALYs at 12 months were calculated from these norms using the algorithm.

\[ \text{QALYs} = \text{EQ-5D norm} - \text{EQ-5D utility score}. \]

However there were no SF-6D norms available therefore an assumption was made that everyone would have been in perfect health scoring 1.0 on the utility scale, thus;

\[ \text{QALYs} = 1 - \text{SF-6D utility score}. \]

This assumption was also made for the EQ-5D to ensure comparability between the health outcome measures and QALYs obtained.
16.6: Results

16.6.1: QALYs

The QALYs for the EQ-5D (\textit{norm} - utility value) were calculated for each of the follow-up time periods and are presented in tables 16.6 and 16.17. At 12 months it can be seen that the QALYs lost were 6.16 which is the actual QALY calculation recommended by Torrance (1986) i.e. utility score at 12 months compared to baseline utility score * 1 year.

For the postal recruitment sample however using the calculation \textit{norm}-utility it can be seen that actual health gains occurred 3.21 (table 16.7).

<table>
<thead>
<tr>
<th>Table 16.6: QALYs lost over a 12 month period for a hospital inpatient sample (\textit{norm}-utility score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ-5D (NORM-UTILITY)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Baseline (n=50)</td>
</tr>
<tr>
<td>3 months (n=46)</td>
</tr>
<tr>
<td>6 months (n=43)</td>
</tr>
<tr>
<td>12 months (n=38)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 16.7: QALYs lost over a 12 month period for a postal recruitment sample (\textit{norm}-utility score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ-5D (NORM-UTILITY)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Baseline (n=70)</td>
</tr>
<tr>
<td>3 months (n=62)</td>
</tr>
<tr>
<td>6 months (n=56)</td>
</tr>
<tr>
<td>12 months (n=48)</td>
</tr>
</tbody>
</table>

For the postal sample group the mean QALY losses were noticeably less than the hospital sample group (table 16.6). The postal recruitment sample also indicates that there were improvements in health state at six and 12 months. The positive QALY gain suggests that at some point participants regained their previous baseline health states and surpassed it to some degree. The reasons are not known although the health state on the ‘day’ is considered
unlike the SF-36v2; thus someone could be having a 'really good day' and rate themselves highly whereas the four week assessment in the SF-36v2 will incorporate the 'good' with the 'bad' days. It also has to be considered that the baseline scores were somewhat lower than they would normally be because of the delayed baseline assessment.

The QALY losses were higher for the same sample if calculating the QALY as 1-utility score QALYs, table 16.8. These were calculated as this was the method necessary to calculate the SF-6D QALY losses in the absence of UK norms for these utilities.

Table 16.8: QALYS lost in 12 month period for the hospital inpatient sample using 1-utility score

<table>
<thead>
<tr>
<th></th>
<th>EQ-5D (1-UTILITY) QALYS LOST</th>
<th>MEAN QALY LOSSES (EQ-5D)</th>
<th>SF-6D (1-UTILITY) QALYS LOST</th>
<th>MEAN QALY LOSSES (SF-6D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (n=50)</td>
<td>55.58</td>
<td>1.1</td>
<td>11.8</td>
<td>.24</td>
</tr>
<tr>
<td>3 months (n=46)</td>
<td>24.13</td>
<td>.52</td>
<td>19.29</td>
<td>.42</td>
</tr>
<tr>
<td>6 months (n=43)</td>
<td>15.71</td>
<td>.36</td>
<td>14.19</td>
<td>.33</td>
</tr>
<tr>
<td>12 months (n=38)</td>
<td>10.66</td>
<td>.28</td>
<td>11.62</td>
<td>.31</td>
</tr>
</tbody>
</table>

The loss of QALYs identifies the large differences between the two utility measures at baseline. This difference at baseline is accounted for by the timing of the initial interview. The hospital sample were interviewed in the acute phase following injury using the EQ-5D and SF-36v2 from which these QALYs are derived, however the EQ-5D asks for an assessment of 'health today' compared to the SF-36v2 which asks for an assessment over the previous four weeks, and therefore incorporates some of the pre-injury health state. However at the one year assessment it can be seen that both the EQ-5D and SF-6D yield similar QALY losses due to road traffic injury 10.66 and 11.62, assuming participants were in perfect health.

The postal recruitment sample follow similar reductions in QALY losses as recovery continues; even at baseline the QALY losses are similar between the
two utility scores (table 16.9). This again can be accounted for by the timing of the initial interview as this took place a number of weeks after the crash and as such the acute phase of the injury had passed. However at the one-year period the SF-6D showed a higher number of QALYs lost at 12 months (8.26) due to road traffic injury compared to the EQ-5D (3.05). This indicates that the utility measures are not necessarily measuring the same outcomes.

Table 16.9: QALYs lost for the postal recruitment sample in the 12 month period using 1-utility score

<table>
<thead>
<tr>
<th></th>
<th>EQ-5D (1-UTILITY) QALYS LOST</th>
<th>MEAN QALY LOSSES (EQ-5D)</th>
<th>SF-6D (1-UTILITY) QALYS LOST</th>
<th>MEAN QALY LOSSES (SF-6D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (n=70)</td>
<td>22.43</td>
<td>.32</td>
<td>24.66</td>
<td>.35</td>
</tr>
<tr>
<td>3 months (n=62)</td>
<td>12.95</td>
<td>.21</td>
<td>16.89</td>
<td>.27</td>
</tr>
<tr>
<td>6 months (n=56)</td>
<td>7.13</td>
<td>.13</td>
<td>12.07</td>
<td>.22</td>
</tr>
<tr>
<td>12 months (n=48)</td>
<td>3.05</td>
<td>.06</td>
<td>8.26</td>
<td>.17</td>
</tr>
</tbody>
</table>

The QALYs were broken down to examine the differences that may be expected between those who stated they had recovered at 12 months (table 16.10 and 16.11) and also those that stated they had some form of physical impairment at 12 months, tables 16.12 and 16.13.

Table 16.10: EQ-5D QALY losses for the levels of recovery in the hospital sample group (n=38)

<table>
<thead>
<tr>
<th></th>
<th>RECOVERED (N=12)</th>
<th>NOT RECOVERED (N=22)</th>
<th>ALMOST RECOVERED (N=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ-5D</td>
<td>Mean QALYs</td>
<td>Mean QALYs</td>
<td>EQ-5D</td>
</tr>
<tr>
<td>Baseline (n=38)</td>
<td>11.02</td>
<td>25.41</td>
<td>4.04</td>
</tr>
<tr>
<td>3 months (n=38)</td>
<td>3.21</td>
<td>15.42</td>
<td>1.27</td>
</tr>
<tr>
<td>6 months (n=38)</td>
<td>2.43</td>
<td>10.15</td>
<td>.81</td>
</tr>
<tr>
<td>12 months (n=38)</td>
<td>.94</td>
<td>8.43</td>
<td>1.29</td>
</tr>
</tbody>
</table>
Table 16.11: SF-6D QALY losses for the levels of recovery in the hospital sample group (n=38)

<table>
<thead>
<tr>
<th></th>
<th>RECOVERED</th>
<th>NOT RECOVERED</th>
<th>ALMOST RECOVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=12)</td>
<td>(N=22)</td>
<td>(N=4)</td>
</tr>
<tr>
<td>SF-6D Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline (n=38)</td>
<td>3.2 .27</td>
<td>5.03 .23</td>
<td>1.33 .33</td>
</tr>
<tr>
<td>3 months (n=38)</td>
<td>3.88 .32</td>
<td>10.24 .46</td>
<td>1.63 .4</td>
</tr>
<tr>
<td>6 months (n=38)</td>
<td>2.72 .23</td>
<td>8.72 .4</td>
<td>1.04 .26</td>
</tr>
<tr>
<td>12 months (n=38)</td>
<td>2.54 .21</td>
<td>7.82 .35</td>
<td>1.27 .32</td>
</tr>
</tbody>
</table>

From tables 16.10 and 16.11 it can be seen that those who considered themselves not to be recovered at 12 months had higher mean QALY losses compared to those who had recovered at 12 months. Those who considered themselves 'almost recovered' had slightly lower mean QALY losses compared to the 'recovered' group. This suggests that the two utility measures can discriminate between levels of recovery, although, the SF-6D utilities are higher for the recovered group (2.54) contradictory to the almost recovered group (1.27). This discrepancy, however, may be a result of the number of individuals in each group rather than an absolute difference.

The QALYs were also examined for those who stated they had some physical impairment compared to those who did not. Tables 16.12 through 16.15 show that those in the hospital sample group had higher losses on the EQ-5D and SF-6D for physical impairment compared to the postal sample group at 12 months.

Table 16.12: EQ-5D QALY losses in the hospital sample group and stated impairment at 12 months

<table>
<thead>
<tr>
<th></th>
<th>PHYSICAL IMPAIRMENT (N=23)</th>
<th>NO PHYSICAL IMPAIRMENT (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EQ-5D</td>
<td>Mean QALYs</td>
</tr>
<tr>
<td>Baseline (n=38)</td>
<td>24.9</td>
<td>1.08</td>
</tr>
<tr>
<td>3 months (n=38)</td>
<td>14.44</td>
<td>.63</td>
</tr>
<tr>
<td>6 months (n=38)</td>
<td>9.84</td>
<td>.43</td>
</tr>
<tr>
<td>12 months (n=38)</td>
<td>9.12</td>
<td>.4</td>
</tr>
</tbody>
</table>
Table 16.13: SF-6D QALY losses in the hospital sample group and stated physical impairment at 12 months

<table>
<thead>
<tr>
<th></th>
<th>PHYSICAL IMPAIRMENT (N=23)</th>
<th>NO PHYSICAL IMPAIRMENT (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SF-6D</td>
<td>Mean QALYs</td>
</tr>
<tr>
<td>Baseline (n=38)</td>
<td>5.94</td>
<td>.26</td>
</tr>
<tr>
<td>3 months (n=38)</td>
<td>10.19</td>
<td>.44</td>
</tr>
<tr>
<td>6 months (n=38)</td>
<td>8.48</td>
<td>.37</td>
</tr>
<tr>
<td>12 months (n=38)</td>
<td>7.99</td>
<td>.35</td>
</tr>
</tbody>
</table>

Table 16.14: EQ-5D QALY losses for the postal recruitment sample and stated physical impairment at 12 months

<table>
<thead>
<tr>
<th></th>
<th>PHYSICAL IMPAIRMENT (N=8)</th>
<th>NO PHYSICAL IMPAIRMENT (N=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EQ-5D</td>
<td>Mean QALYs</td>
</tr>
<tr>
<td>Baseline (n=48)</td>
<td>3.95</td>
<td>.49</td>
</tr>
<tr>
<td>3 months (n=48)</td>
<td>2.95</td>
<td>.37</td>
</tr>
<tr>
<td>6 months (n=48)</td>
<td>2.14</td>
<td>.27</td>
</tr>
<tr>
<td>12 months (n=48)</td>
<td>1.31</td>
<td>.16</td>
</tr>
</tbody>
</table>

Table 16.15: SF-6D QALY losses for the postal recruitment sample and stated physical impairment at 12 months

<table>
<thead>
<tr>
<th></th>
<th>PHYSICAL IMPAIRMENT (N=8)</th>
<th>NO PHYSICAL IMPAIRMENT (N=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SF-6D</td>
<td>Mean QALYs</td>
</tr>
<tr>
<td>Baseline (n=48)</td>
<td>3.57</td>
<td>.45</td>
</tr>
<tr>
<td>3 months (n=48)</td>
<td>3.21</td>
<td>.4</td>
</tr>
<tr>
<td>6 months (n=48)</td>
<td>2.76</td>
<td>.35</td>
</tr>
<tr>
<td>12 months (n=48)</td>
<td>1.84</td>
<td>.23</td>
</tr>
</tbody>
</table>

The above tables 16.12 to 16.15 further suggest that the utility measures have some discriminatory power between those with residual impairment and no impairment. However, the results from the SF-6D are contradictory between
those with physical and no physical impairment in the postal sample (table 16.15). This again, may be a factor of the number of participants in each group.

**16.6.2: Impairment**

The IIS scores were applied to the sample from Study 2 which was overall a higher injury severity group than Study 1. Only three people in this sample group did not sustain any impairing injury according to the IIS classification. The total number of impairing injuries sustained were 103 with half sustaining only one such injury (50%, n=25) (table 16.13). Overall there were 75 IIS 1 injuries, 20 IIS 2 injuries and eight IIS 3 injuries sustained by this sample group.

<table>
<thead>
<tr>
<th>NUMBER OF IMPAIRING INJURIES</th>
<th>NUMBER OF PARTICIPANTS (N=50)</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

The three participants who did not sustain an IIS impairing injury had sustained the following ‘main’ injury; laceration to their thigh, fracture shaft of femur and fracture to the elbow (ulna fracture). The latter participant had limited range of movement in his elbow at one year post injury and ‘could feel it sticking all the time’ thus he stated he effectively had some impairment when asked at 12 months.

One person sustained 10 IIS impairing injuries and these were related to the lower extremity, including total disruption of the posterior and anterior cruciate
ligaments in both knees and dislocated patella. Unfortunately, this person was lost to follow-up and 12 month impairment and utility scores could not be assessed.

Figure 16.1: Distribution of body region injuries and IIS scores for the hospital sample group

<table>
<thead>
<tr>
<th>AIS body region</th>
<th>Number impairing injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>head</td>
<td>1</td>
</tr>
<tr>
<td>face</td>
<td>0</td>
</tr>
<tr>
<td>neck</td>
<td>1</td>
</tr>
<tr>
<td>thorax</td>
<td>1</td>
</tr>
<tr>
<td>abdomen</td>
<td>0</td>
</tr>
<tr>
<td>spine</td>
<td>0</td>
</tr>
<tr>
<td>upper extremity</td>
<td>3</td>
</tr>
<tr>
<td>lower extremity</td>
<td>5</td>
</tr>
</tbody>
</table>

The postal recruitment sample sustained fewer IIS impairing injuries with the majority having IIS 1 injuries attributed to the 'spine' for whiplash injury (n=28) (figure 16.2). The IIS coding dictionary is somewhat confusing with regard to whiplash; in its introduction the dictionary states that whiplash injury will incur an IIS of 0 however an IIS of 1 has been assigned in the actual user pages. Of 28 participants with whiplash injury in this sample three stated they had some impairment at 12 months but only one stated that this impairment was due to the whiplash injury.
16.6.3: Costs

Using the DfT willingness to pay methodology and the adaptations to AIS the individual injury costs were calculated and summed to give a total cost of injuries for the sample group. The total costs for the hospital inpatient sample group were £9,742,322 (mean £194,846.4, median £148,413.5, range £17,386 - £944,280). The majority of the costs were attributed to the lower extremity which also had a high number of impairing injuries.
Using the WTP approach adapted for AIS, the total cost of injury for the postal recruitment group was £3,996,387, mean £57,091, median £43,604) (figure 16.4).
Forty two percent of the total costs for the postal recruitment sample were attributable to minor AIS 1 injuries such as bruising, abrasions and lacerations. A further 31% of these AIS 1 minor costs were attributable to whiplash injury. The remaining 27% of costs were distributed across the other body regions with the lower extremity incurring most of these costs, figure 16.5.

These costs are at the societal level and are difficult to equate back to the person, although it was evident from previous studies that injury had a considerable financial impact on a number of participants.
Chapter Seventeen: Study 3
Discussion and Conclusions
Chapter 17: Study 3 -Discussion and conclusions

17.1: Introduction

This study attempted to examine the outcome of injuries from a wider societal perspective in order to determine the actual impact of traumatic road injury; the results of which are discussed in this chapter.

17.2: QALYs

The use of QALYs to express the outcomes of injuries allows for comparisons of treatments or diseases to be undertaken using the same unit of measurement. QALYs however, are quality of life measures and not costs per se although they can be converted to, and used as, economic measures. This study identified that there were associated QALY losses from traumatic road injury using the EQ-5D at baseline (in both studies) and gradually declining to the 12 month follow-up period. There was the same pattern for the SF-6D for Study 1 (postal recruitment) but Study 2 had fewer QALY losses at baseline which then peaked at three months before declining in number to similar losses at baseline. These variations are a product of the initial baseline interview schedule following the crash. Normally, the scores at 12 months are used to provide the final value for the one year period and as such this equates to 10.66 years of perfect health lost. Unfortunately, using this method does not reflect the variance of QALYs lost over the one year period, only the residual loss at 12 months.

The QALY losses at 12 months can be further extrapolated using the mean age of 38 years and assuming the participants would live until 80 years of age then 447.72 years will be lost as a result of traumatic road injury over the participants' lifetime (10.66 * 42 years). Using the SF-6D the losses are higher at 488.04 years (11.62 * 42 years). This is a considerable amount and even for Study 1 (postal recruitment) where the injuries were relatively minor, assuming the average age and life span, a total of 128.1 years will be lost due to minor traumatic road injury (3.05 * 42 years). In contrast, for this study group, using the SF-6D shows that the losses will be higher at 346.92 years (8.26 * 42 years). The variances between the two samples could be expected
because of the differences in injury severity. However, the variation in the actual measures is interesting considering they are both providing a QALY figure. The SF-6D has an inflated figure for both the study groups, particularly the postal sample, compared to the EQ-5D suggesting that it is either measuring different qualities to the EQ-5D or that the weights attributed to the utility scores are higher. The methodology behind the development of these two utility scores would have to be examined prior to the selection of a utility measure. The developers of the EQ-5D designed it specifically as a utility measure using sound economic principles in its development, unlike the SF-6D which has its roots in a profile measure. Therefore, the use of the SF-6D has to be questioned as a utility measure because of its design. However, as a derivative of the most popular profile measure one would assume it will be used widely within the clinical field but not for economic studies. The EQ-5D has integrity as a utility measure because of its design, although it is limited in what health domains are assessed and also to what level as there is no allowance for the 'in between' responses such as a 'little bit'.

Breaking the QALY losses down into groups for levels of recovery, the EQ-5D QALYS better demonstrated a difference between those recovered at 12 months (0.94 QALYs), not recovered (8.43 QALYs) and almost recovered (1.29 QALYs). The SF-6D at 12 months did not discriminate between the recovered (2.54 QALYs) and the almost recovered (1.27 QALYs) at 12 months; one would expect the QALY losses to be reversed for these two groups.

The pattern for those with stated impairment in the hospital sample group, followed what would be expected and both the EQ-5D and SF-6D identified higher QALY losses for those with physical impairment compared to those without. For the postal sample there were fewer participants who reported any physical impairment (n=8) and as such the results for this study may not reflect accurately the QALY losses. Those with physical impairment recorded lower QALY losses compared to those with no reported physical impairment (figure 16.15).

Impairment is a difficult concept to measure with any certainty and this study did not attempt to formally assess impairment as this would require high cost attendance at hospitals to perform a series of tests for muscle strength, gait
analysis, bending and so forth. The facilities and the need for experienced assessors such as physiotherapists was unfortunately outside of this study's remit and therefore it was necessary to rely on the participants' perception of impairment. However, the Injury Impairment Scale (IIS) which is a guide to the expected impairment of any injury in the AIS manual can be used as an assessment tool. The development of the IIS involved medical specialists and researchers attributing the impairment level to the injuries. However they did not examine the impairment from an injured population.

17.3: Impairment

17.3.1: Impairment in Study 2

The majority of participants in Study 2 had sustained at least one impairing injury with the majority of these injuries (73%) at IIS 1 level which relates to a 'detectable impairment but does not limit function'. Nineteen percent of the injuries were considered 'compatible with most but not all normal function' (IIS 2) and 8% were 'compatible with some normal function' (IIS 3). Of note was the distribution of these injuries with a considerable number occurring in the extremities which supports much of the literature with regard to the impairing ability of extremity injury (Mackenzie, Morris et al. 1998; Mock, MacKenzie et al 2000; Read, Kufera et al. 2004). Those participants with impairments at 12 months had a range of IIS scores with the majority at IIS 1 level which as such should not limit function. The main impairments expressed at 12 months included problems with straightening limbs or kneeling or loss of range of movement all of which might not impair normal function but this is somewhat dependent on the participants' occupation. In isolation, the application of an IIS score does not warrant an injury alone to be impairing. This is also applicable to the formal muscle strength tests which would assess a weakness but in isolation this does not render someone impaired unless occupation and lifestyle is considered. The combination of formal assessment and judgement based on a scoring method would appear to have more relevance to the actual prediction of whether an injury is impairing in combination with the details of the occupation of that participant.
17.3.2: Impairment in Study 1

It is difficult to determine the impairment outcomes from Study 1 as the majority were whiplash type injuries and the IIS prediction of these was a '1' therefore not affecting normal activity (although there is mention that whiplash carries an IIS of 0). Using the data from Study 1 the whiplash injury group on the whole had no problems at 12 months suggesting that an IIS of 0 is more appropriate as only one participant had some impairment at this stage as a result of the whiplash injury.

17.4: Injury Costs

The costs of injury were interesting with the hospital sample group having costs in excess of £9 million for just 50 participants. The costs for Study 2 were just under £4 million for 70 participants, a high cost considering the majority of participants did not incur a hospital stay. The willingness to pay approach incorporates hospital stay and impairment, plus other costs which would inflate the costs for Study 2 as all had hospital stays and according to the IIS all but three had some level of impairing injury. This is a new methodology which adapts this approach to AIS level and further study would be beneficial to examine the accuracy of such a method. In its favour this method is based on the UK's preferred economic model of willingness to pay and can be simplistically transferred to individual AIS injuries, although the mapping process of the extracted UK accident costs would benefit from a larger panel of experts to include those in rehabilitation.

The costing of whiplash injury also requires some review as it would appear to be high at £43,604. The majority of the costs incurred in Study 1 were for a whiplash injury but the outcomes are varied from pain for a few days for some to pain and limitations for others at 12 months. Whiplash injury traditionally incurs high cost in proportion to the very high incidences of these injuries occurring. In the UK alone the insurance company Direct Line report costs at £800 million (EEVC 2005) and for Germany these costs were in excess of 2 billion Euros (Hell, Hopfl et al. 2003), contributing to the estimated costs for Europe at 10 billion Euros.
There were also substantial costs for the lower extremity in Study 1 which remained high once minor injuries and whiplash were removed from the data supporting the attachment of high costs in the literature to these injuries (Dischinger, Read et al. 2004).

The AIS injuries mapped for this study further illustrate the benefit of using this costing method as it allows for the body regions to be separated and makes it possible to explore where the costs are being incurred. As would be expected in Study 2 the majority of the costs were incurred by the lower extremity which reflects the high percentage of this type of injury in the sample. However, a substantial database of injuries which provides the ability to separate body regions in terms of costs would be of benefit to manufacturers of vehicles and safety systems in order to target the reduction of particular costly injuries.

17.5: Summary

The findings from this study support what is known about lower extremity injury with regard to such injuries being impairing and costly in nature. Whiplash also has the reputation of being an impairing injury but at the 12 month point this study did not find any substantial support for this. In terms of financial implications whiplash costs were substantial compared to other body regions injured in Study 1.

The value of using predictive impairing scales comes to the fore when analysing large injury databases when scale scores can be applied to provide a best estimate of the extent of impairing injuries occurring in car occupants for example. Unfortunately the IIS and the FCI have not been used extensively and not been validated for use. Both of these predictive measures would benefit from large scale follow-up studies to correlate the predictions with the actual impairments identified in a sample of participants. The FCI has been developed based on weighting factors of the injuries using specialists, lay people and disabled people to weight the expected impairment of a number of health states; this is in contrast to the arbitrary assigning of a 0-6 scale used in the IIS. One problem with these impairment predictions is that they are based on single injuries and do not include an assessment of the impact of multiple injury.
Chapter 17: Study 3 -Discussion and conclusions

It has to be remembered that the study sample is small and the results obtained have to be interpreted with caution. As an initial exploratory study it has identified numerous societal issues in outcome for a group of injured participants as a result of road trauma using the methodology in Study 3. It is apparent that the cost to society and quality of life losses are substantial even for such a small sample which reflects the global losses expected from road injury in the next decade. The ability to examine the data on a wider perspective for economic and societal losses would suggest that the focus of road injury research should be on the prevention of these costly and impairing injuries and not solely on the prevention of fatalities.

The main findings from Study 3 are summarised below:-

- These findings suggest that utility measures have some value in assessing the societal burden of road injury.
- The utility measures were able to discriminate between injury severity, reported impairment and recovery in a seriously injured sample group.
- There were discrepancies in the number of QALYs calculated between the EQ-5D and SF-6D measures.
- These discrepancies suggest they are measuring different attributes of health and may also be a product of the methods used to calculate the utility weights.
- Using a WTP approach identified the high costs attributed to serious injury attributable to the hospital stay and impairment for lower extremity injury in Study 2.
- Whiplash injury incurred a high proportion of costs for AIS 1 injuries in Study 1.
- Considering the small sample numbers the costs appeared to be high using the WTP method (>£9 million for Study 2 and >£4 million for Study 1).
- The methods used to explore societal burden were of value and provided quantitative data, however, these methods require further study to determine their contribution to road injury research.
Chapter Eighteen:

General Discussion and Limitations
18.1: Introduction

This study has explored the wider effects of road traffic injury and the outcomes of survivors. Its focus was on the ramifications of the injury and how this affected a person's life and their ability to function as they did pre-injury. It is evident that injury sustained in road trauma has a considerable impact on everyday life for the victims and to their family. Its impact is probably heightened by the fact that it is a 'sudden' occurrence without pre-warning to develop coping mechanisms with the after effects. The combination of using interview methods and health outcome measures allowed for greater exploration of the participants and enabled the quantification of the problems without losing the qualitative content of the participants' perceptions.

There are very few studies which have used health outcome measures and population norms to capture the effects of road traffic injury on health related quality of life (Read et al. 2004) and it is thought that this method has not been used on road crash survivors in the UK. The benefit of using health outcome measures enables the identification of the actual areas where participants experience problems. Throughout this study it was noted that the areas most affected were physical activities which included work, leisure activity and pain; these functional limitations are not uncommon following trauma (Read et al. 2004; Holbrook, Hoyt et al. 1994; Holbrook, Anderson et al. 1998; 1999; Butcher et al. 1996; Jurkovich, Mock et al. 1995; Mock et al. 2000).

18.2: Return to Work Rate

'Return to work' has been used as an outcome measure in a number of studies to assess the impact of trauma and 'return to work rates' vary considerably in the literature ranging between 55% to 82% in trauma victims (Vles et al. 2005; Read et al. 2004; Mock et al. 2000; Butcher et al. 1996; Morris 1991; Michaels et al. 2000; Glancy et al. 1992). Study 1 had a 100% return to work rate at 12 months and Study 2 95% at 12 months both much higher than in the published literature. Read et al's (2004) study of RTA survivors found a 72% return to work rate at 12 months, some 20% lower than
this study. However, they had higher numbers of head injury in their sample compared to Study 2. The majority of the other studies in the literature also had high proportions of lower extremity injuries in the sample which appeared to preclude higher return to work rates. However, some included other disabling injuries such as head or spinal injury. The higher return to work rates in this study may be a result of the smaller sample sizes and absence of serious head and spinal cord injuries and may also be a component of when the return to work status was assessed. The noted return to work rates in the literature are all reported at varying time points ranging between months and years for the respective studies thus making direct comparisons difficult. One epidemiological study found that those who were not admitted to hospital following injury had a 95% return to work rate at two months and those admitted to hospital by nine months had a return to work rate of 90% similar to this study, although this included all injuries (Meerding et al. 2002).

18.2.1: Compensation and Return to Work

There is some suggestion that those receiving compensation payments (including work insurance and social security benefits) had no incentive to return to work (MacKenzie, Morris et al. 1998). In contrast to this, the participants in this study considered the minimum statutory payments to be an incentive to return to work as debt was being incurred for those who were normally in work. Actual compensation claims particularly in Study 2 were considered by some to be 'their right' to have to make up for the pain and suffering and to alleviate the debts incurred. One participant, however, insisted he would 'not accept anything less than £1 million as he would need to move to the US where 'the climate was warmer'. This participant had sustained serious pelvic fractures with urethra damage and was still off work at 12 months.

Even in these few studies reporting on return to work rates following trauma it is apparent that there are large variations and this makes comparisons difficult between study populations. Vles et al. (2005) actually suggest that return to work rates should not be used as outcome measures because of the variability of social security systems between countries. This would impact on
the assessment of return to work rate and therefore a better approach is to use quality of life outcomes instead.

### 18.3: Leisure and Social Activities

Leisure activities in this study were predominant in the follow-up periods with 32% in Study 1 and 58% in Study 2 having lost at least one leisure activity as a result of the injury with resultant loss of social contacts. This study identified social interaction to be of concern when sports activities were undertaken as hobbies. Although overall this was not an area to have a large impact on recovery, this was a similar finding to Holbrook (1998). However, others considered social support to be a major contributor to recovery (Anke and Fugi-Meyer 2003; Richmond, Thompson et al. 2000). The assumption for loss of leisure activity is the impairing nature of the injury on such tasks as running or the occurrence of pain when performing activities. These were noted in this study with many participants avoiding activities causing pain, such as swimming and others were restricted in performing an activity, such as playing football, due to injuries including fractures to the tibia and fibula.

### 18.4: Impairment

Impairment was not formally assessed in this study and where other studies have attempted to measure impairment in lower extremity injury using physical ability tests, range of motion and strength tests there were flaws in some of the tests (McCarthy et al. 1998). For example, no assessments were made of the participants’ ability to run or squat as a result of their injury, which for some would be impairment associated with occupational tasks. There is no consistency in how impairments should be assessed formally and where correlations between say the SIP score and a functional test are assessed there are correlations between SIP impairment and ability to perform tasks, which is no surprise considering these would be assessing the same thing. Others have used different measures to assess impairment and disability. Often it is based on a health outcome measure such as the SIP or QWB; in one study the Glasgow Outcome Score (GOS) was used (Van der Sluis, ten Duis et al. 1995).
18.5: Pain

Pain appears to be a consistent problem for road crash survivors and affects everyday activities and because of this, the debate is raised as to whether a real physical impairment actually exists or is it because the pain is preventing the movement. Mackenzie et al. (1996) in the development of the FCI specifically did not include pain as a health dimension as it was not perceived to be a real impairment but a hindrance to the activity being performed. However, it would appear to be a real problem following traumatic injury (Anke et al. 2003; Read et al. 2004) particular to this study where many stated pain to be a factor as to whether they considered themselves recovered or not at 12 months. The role of pain for the participants meant the difference between undertaking activities or not and acted as a self limitation for the participant. The presence of chronic pain has been considered to be in a circle of events contributing to poor health-related quality of life which in turn exacerbates depression and further pain (Mayou 1995).

The impact of pain on activity and actual expression of pain was captured by both the EQ-5D and SF-36v2 throughout this study as were the notable effects on physical performances such as mobility and undertaking 'usual everyday activities' including work and leisure activity.

18.6: Psychological Effects

The psychological effects of traumatic road injury were detected using the health outcome measures and interviews in this study and were similar to those in the literature (Mayou, Bryant et al. 1993; Holbrook et al. 2001; Holbrook et al. 1999; Blanchard and Hickling 1996; 1999; Mayou and Bryant 2002; Michaels et al. 1999). The psychological impact was varying between the two study samples and it was obviously an 'individual problem' for many rather than a whole effect. The postal sample group were found to have better mental health than the UK average for most of the time-points compared to the hospital sample group which had lower mental health at three and six months only using the MCS. These individual impacts were noted with some participants reporting flashbacks, depression and anxiety
during the various follow-up periods. For some, the depression required medication. This was not an issue exclusively associated with 'serious' injury either; of note was a cyclist knocked off of his bike sustaining AIS 1 injuries. He became withdrawn from both his family and his social life which involved cycling. He became depressed and was on prescribed antidepressants he also had a fear of being alone cycling based on the circumstances of his crash as a large truck had knocked him off of his bike without stopping and he believed he had 'been left for dead'. At one year he had returned to work but he 'very rarely' went cycling with his friends. These experiences with 'minor injury' of depression and anxiety are not uncommon and have been found in a number of studies examining psychosocial outcomes and PTSD (Blanchard, Hickling et al. 2004; Mayou and Bryant 2003). The importance of being able to recognise anxiety and depression in crash victims is evident in this study, and using such measures as the EQ-5D, SF-36v2 and CES-D as well as general conversations with the participants can help identify these problems. Although not all participants experiencing anxiety and depression require intervention, the importance of recognising that it is a problem that makes them aware of the need to find strategies to deal with this. One of the hospital sample group was referred for psychological assessment and counselling because of his fear of being in a car. He found it 'nerve-racking' to go for outpatient appointments in a taxi but this was his only option for transport at the time. As soon as he was mobile enough, he caught the bus until eventually he could walk to hospital. This avoidance of being in a car is not uncommon (Mayou and Bryant 1994) but is at the extreme end of the travel anxiety continuum compared to many of the participants in the study who reported being nervous passengers or more aware when driving (Mayou et al. 1993). There did not seem to be any apparent differences between the severity of injuries in this study and the experiencing of some form of travel anxiety. This study did not attempt to assess levels of post traumatic stress disorder (PTSD) although injured populations are at risk of developing PTSD (Mayou and Bryant 2002; Holbrook et al. 1999; 2001). Read et al. (2004) noted that their study sample had a high incidence of pre-injury depressive illness and at 12 months 36% of the participants were depressed. This study was able to identify the psychological affect of injury on a number of levels.
However, one drawback is that pre-injury mental health was not assessed formally and any psychological effects such as depression, travel anxiety and for a few flashbacks in the first few months could not be separated from the pre-accident state of mind (Malt and Olafsen 1992). During interviews it was noted that many felt 'down' were worried about money, or were generally 'exhausted' - all of which are isolated psychological problems but in culmination can precipitate a psychological illness. For many, talking about the crash and their feelings at the follow-up period to a 'stranger' actually helped them and where it was felt that the participants would benefit from further medical attention they were encouraged to visit their GP. One of the participants with only an AIS 1 injury in the hospital sample recovered very quickly. However, the effect on his wife was traumatic. This participant had had a low speed fall off of his motorbike but his wife became seriously depressed and suicidal as a result of this. This illustrates that the effects on others not involved in the crash cannot be ignored and are not uncommon (Lehman, Wortman et al. 1987; Harris, Schweitzberg et al. 1989). The participant appreciated talking to a stranger about his problems and he stated that it helped him 'express his feelings without appearing weak in front of family or friends'.

The post accident ability to cope with the effects is related to personality and how they deal with situations on a daily basis (Mason, Wardrope et al. 2002). There were many reported factors in this study which affected psychological health such as feelings of 'isolation' due to lack of mobility or loss of transport, reliance on others, financial worries and the need to 'prove their innocence'. This latter problem was compounded by the length of time court cases and compensation claims take to settle. The need for the case to go to court was a real issue for four people because they believed they were not at fault and the only way they could satisfy themselves and others was to have it proved in court and obtain compensation for their injuries. However, the compensation process was long with only a small proportion having any settlement at 12 months. The compensation process also meant that financial losses were accrued on a daily basis but would not be recompensed for at least a year exacerbating the financial burden and associated anxiety. Compensation acted in two ways; 1) to prove innocence and 2) to relieve financial worry due
to the injury preventing normal work activity. The slowness of the system would appear to create greater problems even when interim payments could relieve some of the financial worry. Interim payments took between six and 12 months to be awarded even when fault was determined early and obvious impairing injuries sustained had prevented work. For all of these participants, payments were used to pay off the liabilities accrued and for some where blame could not be apportioned, or the other person was denying their responsibility in the crash, it made them angry that they were left with the question 'was it my fault?', although they knew it not to be. Mayou (1995) found similar problems relating to compensation and identified that payments were also modest in relation to the affect in everyday life, particularly psychological and social problems created by the injury.

18.6.1: Positive Psychological Effects

There were also positive findings relating to mental health in this study, particularly when participants were faced with a sudden realisation of their mortality and accepted that it could have been worse. One particular participant stated that he had 'taken life by the horns and was living it, rather than just going through the motions of work and home'. The effect the injuries had on him was the realisation than he could have died from his injuries (a serious pelvic fracture and ruptured spleen) and that his children would be without a dad.

18.7: Gender Differences

Of note in this study were the gender differences noted for mental health particularly when assessing depression using the CES-D. Females had significantly lower scores than males in Study 2 on the CES-D as well as the MCS and EQ-5D measures although median injury severity was the same between genders. These gender differences have also been found elsewhere although the explanation for their occurrence is not known (Holbrook et al. 2001; Meerding et al. 2004; Vles et al. 2005).
18.8: Data Collection Tools

The CES-D was only used in one of the studies but has been used elsewhere in the literature and is a known diagnostic tool for depression (Holbrook et al. 1998). In this study it identified changes in depression over the course of the follow-up period and followed closely the MCS in the SF-36v2 indicating they were measuring the same construct. The CES-D and the SF-36v2 incorporate an assessment over a time period one and four weeks respectively, unlike the EQ-5D which is a statement of the fact of the presence of depression or anxiety. This combination of factors may inflate the presence of depression because of its inability to determine this symptom from anxiety.

The SF-36v2 and EQ-5D outcome measures were selected for use in this study because of their applicability to the UK. However, their limited use in trauma outcome was a drawback with few studies reported in the literature (Badia, Diaz-Preto 2001; Vles et al. 2005; Read et al. 2004; Kopjar 2000; Meerding et al. 2004). Other studies using these measures have identified a broad agreement between the measures although the EQ-5D is often less discriminating and accordingly should be used in conjunction with broader measures (Brazier, Jones et al. 1993; Dorman, Slattery et al. 1998; Essink-Bot, Krabbe et al. 1997; Bouillon, Kreder et al. 2002). The absence of a cognitive dimension has been criticised in both of these measures and Mackenzie et al. (2002) recommends the addition of further dimensions particularly when assessing head injury participants. These recommendations have been taken on board by some (Meerding et al. 2004; Krabbe, Stouthard et al. 1999; Read et al. 2004), and were used to distinguish between those with and without loss of cognitive function. The cognitive dimension was added to this study but its value could not be assessed due to the number of head injury participants in the study. The two participants with a head injury in Study 2 did register problems on the added EQ-5D cognitive dimension and this would indicate there is some value to its addition. At this stage the cognitive dimension is not included in the overall calculation of the utility score.
In both of these studies it was noted that at some point in time, all health dimensions were affected in both the SF-36v2 and EQ-5D, indicative of them assessing the important aspects of health related quality of life in road crash victims. Read et al. (2004) found similar changes in health dimensions using the SF-36 with predominant effect on the physical health of participants, which is not unexpected as they studied examined lower extremity injuries in crash survivors. Thus, similarities existed between Study 2 and Read et al's (2004) study although the general health dimension was affected to a larger extent than in this study. This study suggests that participants consider general health to be unrelated to the effects of the injury relating more to symptomatic illnesses such as flu or colds. Similarly, Brenneman, Redelmeier et al. (1997) found consistency in this dimension in their study. There was more variation in Study 2 than Study 1 related to the level of 'uncertainty' a serious injury has on future health. Thus, when asking participants about their future health they could not answer with a positive response due to the expectation of arthritis or basically the unknown effects of the injury.

This study identified two predominating injuries (excluding minor skin lesions) these being whiplash in Study 1 and lower extremity injury in Study 2. Whiplash was found to disrupt everyday life for all of those affected from anywhere between two and 52 weeks. The factors which determine an individual's severity of a whiplash injury are largely unknown, although many studies state that it is the most debilitating injury. In contrast, Michaels et al. (2000) identified those with orthopaedic injury to have worse outcomes in the physical dimensions of the SF-36 than non orthopaedic injuries. The latter is more reflective of the associated changes in health dimensions between Study 1 and 2 although this would have to be formally determined from a larger sample population. However, the debilitating reputation of whiplash may be a result of its cumulative effect on society because of the vast number of occurrences of whiplash injury from car crashes. Unfortunately, it was not possible to compare the severity of injury between the studies using MAIS. This was because of the different sample populations and hence it was not practical to test any assumptions between whiplash and lower extremity injury. The outcome measures used in this study performed well enabling the identification and extent of problems across the range of health dimensions.
The SF-36v2, in its favour, assesses not just the problem but the impact it has on everyday activity compared to the statement of fact in the EQ-5D; for example participants are asked 'how much pain have you got today' on the EQ-5D with a limited 3-level response compared to the SF-36v2 which asks 'how much pain has been experienced over the past four weeks' and also questions how much has the pain affected work and social activity. The EQ-5D has the practical administrative benefits whilst still capturing some assessment of health outcome in the two minutes it takes to administer. Studies comparing the outcome measure of SF-36 and EQ-5D often identify very different pictures of outcome in specific study populations (Jenkinson et al. 1997; Brazier et al. 1993; Brazier et al. 1996). It has to be remembered that these two measures are in effect assessing different aspects of outcome, with the SF-36 providing a very broad assessment of health across eight dimensions allowing for 'a little' to 'a lot' to be measured. This is in contrast to the EQ-5D which has five dimensions with only three levels; therefore by its design it is less sensitive to the range of levels in each domain. However its design intention was to be simple, to generate utility scores and to be used in conjunction with other generic measures. Although these measures differ, they both identified real problems in the physical dimensions, pain and mental health and one would have to consider at what level the information is required and the purposes of the study.

This study aimed to explore what the actual outcomes were in road crash survivors and it is obvious that the effects are predominantly in the physical aspects of recovery, thus either scale could be used. However on a practical level one would possibly select the simpler form to complete that of the EQ-5D. The EQ-5D can contribute at the societal level of study because of its original design for economic evaluation in health outcomes. The results of the EQ-5D clearly identified a discriminatory attribute when comparing groups of survivors for example between recovery or physical impairment. This is not to say that the SF-6D does not have these qualities but there are no population norms at present from which to make any comparisons and its actual roots as a psychometric measure does not lend itself for use in rigorous economic studies. The EQ-5D has been criticised for lack of sensitivity although this study found that it was able to pick up changes in health state over time for a
crash injured population (Meerding et al. 2000). One area of concern, however, is the restrictive levels in the domains for not allowing intermediate responses such as 'a little' or 'some'. This forces participants to either over-inflate their pain response, as they have to select 'moderate' or conversely underestimate the pain and select 'none' as it is not severe enough to warrant a 'moderate' response. This limited response options in the health domains could have affected the outcomes measured in this study as either they were assessed to be better or worse than their actual current experience. This problem was raised with one of the EuroQol group and it was noted that there is further work to incorporate 'in between' categories in each of the domains to increase them from three to five levels.

The benefit of the SF-36v2 in this study identified the variation between the follow-up periods experienced in each of the dimensions over the 12 months. In an exploratory study such as this it was possible to focus on those areas of concern for an injured population. The difference was noted between the 'minor' injury postal sample and the hospitalised sample; the postal sample had higher values across all of the dimensions compared to the hospitalised sample. Thus, it would seem that the SF-36v2 was able to differentiate between the two groups of injury severity and also over time as recovery progressed. However, its length requires a longer administration time upwards of 20 minutes and the restrictions by the developers does not allow explanations of the questions to clarify the point being addressed. Thus, its use is questioned in a postal survey due its length and sometimes ambiguous questions.

Considering the differences between these two measures both were able to distinguish variances between the two study samples and also across time within the studies. Those participants admitted to hospital were shown to have lower scores at 12 months which is consistent with other injury studies and other health outcome measures (Holbrook et al. 1999; Watson, Ozanne-Smith et al. 2004; Read et al. 2004). However, it was noted that one problem with follow-up studies is the timing of the follow-up interviews and whether pre-injury data are obtainable for comparisons to be made. The suddenness of injury makes it impossible to obtain a pre-injury status although some measures do incorporate an assessment period pre-injury depending on the
initial interview timing. How reflective of the real health status pre-injury is questionable as the event has happened prior to being asked about health and there is the potential for the pre-injury state to be inflated (Michaels et al. 2000). The limitations imposed by injury as a participant group is the same for all injury studies and using certain health outcome measures such as the QWB and SF-36 would provide a better estimation of pre-injury health.

Meerding et al. (2004) suggest that follow-up for minor injuries should be at two weeks as they identified a stalemate in recovery terms at five months to nine months and many had recovered at two months; thus follow-up for these was not able to yield any further results. The shorter follow-up period for the postal recruitment group would have been beneficial because many stated that the first week after the injury was the worst and after that recovery had progressed. Thus at baseline interview, these problems were not captured in this study due to the recruitment process. Ideally, it would seem that capturing a sample of 'minor injuries' following a crash should be undertaken during the Accident and Emergency Department (A and E) visit or as a postal survey using the attendance records to obtain names. This, however, was outside of this study's capabilities requiring a greater compliance with the hospital and using others to recruit participants in the A and E department. This method would be ethically questionable as participants will be in a distressed state having just been involved in a crash and the question of how long someone should be given before consenting would be an issue.

The inconsistent follow-up periods in the literature renders it difficult to make true comparisons with other studies and would suggest the need to standardise the follow-up period for data collection. This study recognised the need for a baseline assessment that incorporates pre-injury health as necessary including a depression assessment to allow for any pre-to-post injury comparison. The three month follow-up period in this study identified a decline in health status which again would not be captured if moving from discharge to six month follow-up, such as that by Holbrook et al. 1998. Meerding (2002) purports the need for a follow-up of two weeks for minor injury because of the rapid recovery of minor injury when effects are not captured at three months for example. In reality, there would be arguments to
when the 'best' follow-up periods are but there has to be some semblance of reality particularly if capturing both 'minor' and 'serious' injuries in one study. There is also a need to capture 12 months data for the purposes of predictive outcome measures such as the FCI as well as long term outcome such as disability at yearly time points up to five years. This study used two health outcome measures and it was shown how they differed considerably at baseline particularly for the hospital sample group because of the initial assessment period. The interesting dip at three months in health status identified this time period to be a 'bad' time in the recovery process because many had the expectation of being recovered or well into their recovery and were disappointed to still be experiencing problems. One of the main themes in the interviews was the notion that fractured bones go into plaster for six weeks and then everything is then back to normal. The reality for the hospital sample group was the complexity of their fractures and the need for surgery with a subsequent longer recovery time. Whatever the time points selected there remains the need to have population norms against which comparative assessments of for example QALYs can be undertaken.

The QALY losses over the follow-up period identified a loss at various time points even relatively minor injuries, indicative of the extent of the affect traumatic injury has on participants. However, at 12 months there were actual QALY gains of 3.21 which is difficult to explain as it would suggest that a traumatic injury from a crash improves overall health (which is not a sensible finding). This gain in health might be related to the person having particularly 'good' days on the interview date or that the perceived health now was far better than prior to the crash. This perception of better health is relative to how the injury might have affected them and also whether there is some level of acceptance of 'being at the best state' they can be in despite the injury.

The SF-6D has been found to have higher scores compared to other utility measures for the same health states. The QWB and SF-6D showed that the lowest possible utility for a living person to be 0.32 and 0.30 respectively and for the EQ5D -0.59 and HUI3 -0.36. This suggests that the utilities for the former two scales are too high for persons in very poor health, when 'dead' is
grounded at 0. There is no direct link between the utility measures and the same health state as assumptions have to be made for example 'uses a walking stick' would map to 'moderate difficulty with mobility'. Each of these utility measures are suitable dependent on the health states being studied because of the variation between them (Kopec and Willison 2003). Again it is recommended that utility measures be used in combination with more generic measures as the latter are more likely to identify significant changes between groups and changes over time.

18.9: Predicting Outcomes

The subjectivity of using health outcome measures is of overriding appeal for outcome research because only the participant can determine whether their particular injury is having any effect on their life if at all. This is evident from studies attempting to validate the Functional Capacity Index (FCI). The FCI is a predictive tool determining loss of functional capacity at 12 months based solely on the anatomical injury descriptor of the Abbreviated Injury Scale and the opinion of experts. This has not performed well in any study and has shown consistently poor agreements at 31% for lower extremity injury actual ambulatory function and the predicted function (McCarthy et al. 2001). One of its problems is that it deals with single injury such that where multiple injury occurs the highest FCI is used ruling out the 'combination effect' of injury. Using the FCI in a wider study Schlucter et al. (2005) again found poor agreement between the predicted versus observed FCI and one area of concern was that it appeared to systematically underestimate multiple injury outcomes which include a lower extremity injury and that of head injury. The inability to discriminate between personality was also apparent where predicted bad scores were not found on observation due to positive attitudes accepting the consequences of the injury. In contrast the predicted low scores were hampered by observed high FCI which were identified to be the effects of psychosocial factors not included in the FCI. Other areas which could affect injury outcomes would be the consistent finding of the effect of pain on participants. This study identified pain to be a problem throughout all of the follow-up periods and other studies have identified pain as contributing
to loss of leisure activity and resulted in worse outcomes (Anke and Fugl-Meyer AG 2003; Michaels et al. 2000). However, this is not included in the FCI as it is considered that pain is 'not an impairment in itself', although for many it will render it difficult or impossible to perform activities which will be seen to be affecting ones functional capacity (MacKenzie et al. 1996).

The absence of the assessment of mental health may contribute to the poor prediction of the outcome following injury using the FCI. However, this could not realistically be incorporated into any such measure as the question arises as to who would determine the extent of the anxiety or depression one would attribute to any injury. Thus to have any such prediction of outcome there has to remain some basic grounding from which to extrapolate and to date that is the AIS (1990 revision) which to date has not performed well in this respect. However, the new AIS 2005 has included 'better' more detailed descriptions of orthopaedic and head injuries which possibly may have some effect on the predictive ability of the FCI.

The appeal of having a predictive score for impairment / functional capacity losses is one that could make a great difference to outcomes research particularly epidemiological study where it is impractical to undertake such large follow-up studies. The FCI has been used hypothetically by Luchter (1995) to examine life years lost to injury. He analysed the NASS data and identified that lower extremity injury was responsible for 42% of LLI but only 17% of costs and upper extremity injury 45% of LLI and 10.6% of costs using extrapolated costs from Blincoe and Faigin (1992). The minor injuries incurred 33% of societal costs incurred in road crashes using this methodology. This study identified high costs associated with whiplash in Study 1 and lower extremity injury in Study 2; removing whiplash from the overall costs identified lower extremity injury having the highest costs. However, because of the prominence of lower extremity injury this may not be a true representation of costs for all injuries.

18.10: Recovery

The fear of the unknown was another factor in Richmond et al's (2000) study that did not aid recovery. This, in retrospect, was identified in this study as
many 'wished they'd known it would take this long to get better'. It is apparent there is a general lack of information provided to victims of injury whilst in hospital regards 'what happens next'. It would be beneficial for those victims to be given guidance that injuries can take a long time to heal and sick time may be considerable, thus finances become a concern. Even the basic fact that some may be reliant on others for everyday activity such as bathing, shopping for food and other activities could be a significant benefit. This study identified many basic activities for which easy solutions can be provided whilst in hospital. For example, buying and filling a flask with hot water, thus making drinks in the chair without having to carry hot liquids and run the risk of sustaining burns. The sudden transfer to victim status is not supported in the initial period following a crash. No support group exists in hospital, although support groups exist for many other adverse situations (e.g. crime, disease etc). Participants need to have coping mechanisms in place to deal with the immediate consequences of injury, however, these have to be continued throughout the recovery period. During the interviews in this study it was apparent that some participants almost required permission to express pain or experience any problems with activities or even compensation claims.

One website has recently been identified that provides help and support to victims of road traffic crashes, however, this is not widely advertised in hospitals (www.roadpeace.org).

18.11: Summary

In summary, within the confines of time and cost, this study has contributed to the limited body of knowledge of the impact non-fatal injury has on the lives of individuals. One of the problems associated with the collection of such data is the measurement of the outcomes (Mock et al. 2000). However, this has been addressed by the available body of health outcome measures to assess functional and health status in individuals. This thesis used two such outcome measures both of which were suitable for use in the UK with available population norms for comparative purposes. It is apparent there is no outcome measure of choice and as such the methodology chosen for this study was based on the accessibility, practicality
Chapter 18: General discussion and limitations

and suitability to such a study in the UK. No attempt was made to analyse the actual vehicles or crash characteristics as these were only available for Study 1 and not Study 2. Also, no attempt was made to formally assess the levels of impairment again because of the practicalities associated with assessing impairment using telephone interviews. The health outcome measures were able to identify differences between the minor and seriously injured sample groups from the studies and showed that there is a difference in recovery and health outcomes for injuries sustained in road trauma dependent on the initial injury severity. However, the study samples were small and therefore there would be benefit in undertaking a larger prospective study with recruitment and initial interviews conducted whilst in attendance at A and E prior to discharge or during the inpatient episode of treatment. This would ensure a comparative sample of minor and serious injury from the same population. Working outside of the health service it was also necessary to identify tools which are acceptable in the community and useable by road safety researchers to examine the outcomes of road trauma in relation to the impact that these findings can have on vehicle manufacturers. The focus of most manufacturers is to prevent fatal injury which may imply greater preponderance of serious injuries in the survivors of road crashes. Creating higher rates of survivable injuries this ensures that targets are met for the reduction of fatalities but the impact of injuries to survivors is a relatively new study area. This research has identified the effects these survivable injuries have on individuals' quality of life and also the societal impact related to cost and QALYs.

18.12: Limitations

The main limitations of the study involve issues of methodology. The accessibility of the participants meant that the study had to recruit participants using two different methodologies which affected the ability to combine the data for analysis to be able to explore any real differences in those with 'minor' and 'serious' injury. The method of postal recruitment made the recruitment slow and with initial interviews not being conducted for some time after the
crash itself. This was addressed in the second study having access to the participants immediately after their crash. This method again suffered due to the restrictions imposed by the trauma co-ordinators at the two hospitals in the study and the fact that the researcher was not based at the hospital. The benefit of being onsite would have meant direct access to all participants admitted to hospital and the potential to recruit those participants who get admitted for 'observations only' overnight and are discharged early the next day.

The actual study samples were small in each of the studies and allowed for analysis, however, no inferences can be made as to the applicability of the results to the general population of survivors of crashes. To add power to the analysis of the data would require substantial numbers of participants in each analysis group; for example, injuries in each body region with varying AIS severity, road user group and gender. Greater numbers would allow for analysis of variance between these groups to be explored to estimate statistical differences between them.

As an exploratory study, however, the results from this study identified there were real effects of road crashes on individuals and had comparisons with findings from the few studies in the literature. One limitation was the sample itself which had very few head injuries and no serious spinal injuries which incur obvious physical effects and potential psychological and mental health problems.

One area of concern was the high attrition rate at all time points for both studies despite the researcher attempting numerous contacts at varying times of day. Letters were also sent to the participants when no contact could be made by telephone but none actually elicited a response. It was hoped that in Study 2 by obtaining a second person who could be contacted at the follow-up periods to ascertain change of telephone number for example, would have improved the level of attrition but this only had an effect for two participants. Attempts were made to improve the attrition rate but it is obvious that a large sample size would be required for a follow on study to incorporate the potential problem of attrition.

The follow-up periods were considered prior to the study and appeared to work well particularly the three month follow-up period. However, long term
effects cannot be studied in this short time thus a yearly assessment for up to five years would be required to really establish these problems. It was recognised that the postal recruitment was slow and by using this method missed important time points in recovery particularly for the minor injuries. Thus there is an apparent need to recruit participants immediately after the crash to obtain baseline data and therefore allowing follow-up at two weeks to capture the effects of minor injury. The six week point post-injury would perhaps have been a follow-up period of choice particularly using the SF-36v2 as at this time point as the 'post injury' health would be captured as the SF-36v2 has a 4 recall. These two follow-up periods on top of a baseline assessment would require intensive effort and more than one person to collect the data, which was not practical to undertake in this study and itself coupled with the limitations imposed by the hospitals probably limited the sample size. The loss of baseline assessment in the postal group was a further limitation as there was no potential to compare follow-up results with pre injury health. This is an important consideration for the understanding of the variances in minor and seriously injured participants and stresses the importance of using the same recruitment procedures to obtain a comparative sample. The area of pre-injury mental health appears to have some effect on post injury mental health stressing the importance of the need for CES-D measures at baseline which was not used in Study 1. This study did not make any attempt to use psychological assessments for PTSD or risk factors for such which in hindsight would have added further distinction to those with stated poor mental health versus those with actual symptoms of the fact.
Chapter Nineteen:

Conclusions and Future Work
19.1: Introduction

The overall conclusions for this study are formatted in response to the original aims and study questions posed at the beginning of this thesis. Recommendations for the further work are made based on the findings of the three studies undertaken here.

19.2: Conclusions

- To determine the effect of the injury or crash event has on an individuals life

This research has identified that there are real effects for the individual lasting longer than the initial crash event itself. There were broad areas identified which were affected by the injury and crash such as physical, psychological and financial impacts. Within these broad areas were specific problems identified, such as; leisure activities, work, mobility, anxiety and depression. These effects were measurable using established health outcome measures normally used in clinical settings that allowed for subjective assessments to be made of participants' perceptions of their current health state.

- To pilot the methods used to assess road traffic injury from a vehicle safety perspective

This thesis used two existing health outcome measures selected on their merits and usability in the UK, namely the SF-36v2 and the EQ-5D. These health outcome measures were found to be easy to administer during face to face and telephone interviews. They identified the effects across a range of health dimensions which could be analysed using non-parametric statistics to show the main affected health areas following an injury. These two measures also had added merits that provided utility scores which allowed for societal impacts to be measured that can be used to compare these findings with other injury studies. The third measure that was used (i.e. CES-D) measured
depression, again at an individual level. This was easy to administer and was a more direct approach to identifying psychological depression compared to the SF-36v2 and EQ-5D measures.

Two methods of participant recruitment were used and had obvious limitations in both methods, namely the response rates. Two types of data collection methods were also used; face to face interviews at baseline in Study 2 and telephone interviews throughout. These methods worked well for the participant and the researcher, it was considered that the initial face to face interview actually assisted further telephone interviews as the participants knew who they were talking to and could relate back to the inpatient episode assuming the researcher would know what they were talking about.

Societal burden was also considered and two methods were used to assess this QALYs and a WTP injury cost approach. These methods have potential to be expanded and further developed in a larger study before they can be considered to be reliable in the assessment of societal burden of road injury.

19.3: Research Questions

- Are the effects of similar types of injury the same for all individuals?

It is apparent that injury has varying effects on the individual's quality of life dependent on a number of factors. Overall it was evident that the physical impact of injury on everyday life was varied dependent on the participant, occupation and leisure activities. Thus it is difficult to determine whether similar injuries have the same effects. Those with similar injuries, for example 'whiplash', had similar patterns of physical recovery although residual problems can exist for some. Psychologically, however, the stated effects varied as did other factors such as time off sick and associated financial burden. Those with serious pelvis fractures also had varying recovery patterns even when treated with similar surgical procedures, with one participant returning to full health and work activity within six months from the crash compared to two others with substantial problems remaining at 12 months. Those with clavicle fractures varied in recovery dependent on the
initial treatment for instance one participant with bilateral fractures treated surgically had returned to work at three months compared to another treated conservatively who had not returned fully to work and was waiting for surgical repair at six months due to non-healing of the fracture. Even from this small sample it is evident that associated impairment and outcomes are different at 12 months and not all participants recover to the same extent and rate. The effects of injury in this thesis have the benefit of being assessed from the individuals' perspective using the health outcome measures; thus one would not presume that similar injuries will have the same effect because of the way they were being measured. Other factors which could influence the outcomes were not studies such as the role of personality and coping strategies.

- What are the factors which render an injury as having a greater impact on life?

One of the main factors that render the injuries as having a greater impact on life included the occupation of the participants; those with active jobs were restricted to a larger degree than for example those with desk jobs. Another factor included individuals' level of activity pre-crash. Although Study 2 was biased towards lower extremity injury it would appear that this type of injury had a greater debilitating effect on the individual which impacted on other areas of life. For example, the implications of a lower extremity injury meant loss of sporting hobbies, ability to play effectively with children and long term sickness with a knock-on effect on finances and family. Pain was a constant problem throughout the thesis and had a large impact on the individual and subsequent activities were hampered by the level of pain experienced by the participant. Those injuries which were 'life threatening' such as the pelvic fractures in Study 2 had a large impact on these participants, with one being seriously impaired at 12 months, a second with limitations and unable to work and the third with a good recovery back at work and taken the crash as a life affirming experience. All therefore had varying psychological effects as well as physical
effects and may possibly reflect that those with serious injury have the greater limitations imposed on their lifestyle and potentially a greater impact on life.

- **What is the recovery time for road traffic injury?**

There was no set recovery time identified in this thesis as this would require a large prospective study to examine which injury types recover rapidly and those that are long term. The inference would be that the majority of minor injuries are healed within the first three months and the more serious injuries recover between six and 12 months but this is only indicative at this stage. Not all participants recover to their pre-injury health state and some accept that they have recovered to their maximum potential and will state they have recovered whereas other will expect a full recovery even though this may not be possible in all situations. There was some evidence to suggest that those with more serious injury (Study 2) appeared to get worse before getting better identified by the health outcome measures. Thus at three months when the majority of minor injuries have improved those with serious injury are at their 'worst'. Thus, it is difficult to state a defined recovery period as it is evident from the studies that recovery and effects of injury are individual and would require a large sample to explore expected recovery rates against real recovery times as defined by the sample.

- **What are the factors which have an effect on recovery time?**

Recovery is often determined by the individual's expectations of recovery and not just the healing of an injury. Although healing of the bone in complex injuries had a major factor on the recovery time of participants. The main effect on recovery time was influenced by pain and physical impairment; both were reported as reasons for non-recovery at 12 months. The complexity of the injury and also the presence of multiple injuries cannot be ignored as factors influencing recovery time. There was some degree of accepting a level of recovery in some participants whose injuries had healed but they were left with pain and some activity limitations, however, for some they expected
Chapter 19: Conclusions and future work

recovery to be when they reached their pre-injury health state. Thus recovery was linked to participants’ expectations influenced by the level of pain experienced.

- Are the effects of injury wider reaching to family and friends?

Initially there was an impact on family and friends with friends having less contact compared to an increase in family contact. The family contact increased for some as either they moved back home to be looked after post injury, or telephone contact increased obviously due to concern for the participant. Friendships, however, were often associated with hobbies or work and naturally suffered as the participant was removed from these activities due to the injury. No participant considered these variations in contact to be of concern to their well being. Two participants were 'fed up' because they could not just get up and go shopping with friends (these were younger participants). One participant's wife had serious psychological problems precipitated by his crash, although this was not the only contributing factor to her depression. Other areas affected by the injury were relationships with partners which were put under strain as a result of enforced immobility, pain and blame for the crash. These meant that the partners were being relied on to undertake all activities such as becoming the main wage earner and doing all of the housework and chores associated with running the home. Where pain was a problem this had consequences on participants' sex life with their partners and for one had become a big issue for her partner as he could not understand the level of pain as being a reason to avoid this activity. Three participants split up from their partners as a result of the injury one because he caused the crash and was sentenced to prison for driving offences as a result.

Thus the implications of sustaining a road injury are not just at the individual or societal level but appear to have an impact on close relationships. In a small number of participants friends were more understanding of the problems than partners.
• Is there a psychological effect as well as a physical effect?

The physical impact was observed to be the main effect of road traffic injury and the main problems were loss of mobility and functioning. However, there was an overall psychological impact of road traffic injury particularly at three months. Females had worse psychological health compared to males, particularly those with serious injury. There were cases where anti-depressive medication was prescribed as a result of newly diagnosed depression following the crash; interestingly these were observed in males rather than females. Other females expressed their problems during follow-up interviews although had not sought medical help for these new current feelings except one female in Study 2.

It was evident that the health outcome measures identified problems in psychological health however they appeared to measure different attributes of mental health. Actual depression was measured formally in Study 2 where it was found to be a real problem not necessarily discernable from the other health outcome measures. In the stated major affects there were a number of reported psychological problems but these were less than the 'emotional' reported affects which did have some cross over with the former affect.

• What measurable outcomes are there - such as return to work, length of sick leave, return to social activity and recovery status at 12-months?

Return to work was the main outcome apart from the quality of life measures as this was apparently the activity that dominated the recovery process because of the financial implications of having time off sick. The variation in return to work rates was noticeable between the two study samples with a longer return rate recorded for the participants in Study 2 compared to Study 1. At three months Study 2 had a return to work rate of 54% compared to 87% in Study 1; with the 12 month return to work rate for Study 2 of 95% which was similar to the 6 month rate of 96% in Study 1. Recovery status at 12 months identified those who had and had not
recovered and the reasons for this and would be of great benefit in a large prospective study to analyse the reasons for recovery status. Study 1 had a recovery rate of 75% (including the 'almost' recovered category) compared to 42% in Study 2. The length of time off sick influences the recovery process and would probably predict poor recovery in a large study. The number of sick days taken in 12 months for Study 1 was 2,061 compared to Study 2 of 7,250; the mean days were 39.6 and 181.25 respectively. Return to social activity however was an activity which participants hoped to regain but was not seen as important to the participants as returning to work.

These outcome measures reflect the differences between the two studies and how they could be used to discriminate or predict recovery in a large prospective study.

- What are the financial implications of sustaining a road traffic injury?

The financial implications in the thesis suggest that participants can have considerable losses as a direct result of the crash due to car and insurance costs. The total financial burden at 12 months for Study 1 was £95,050 compared to £165,739 in Study 2 with maximum individual losses of £2,100 in Study 1 and £17,600 in Study 2. The additional costs were associated with alternative travel, loss of wages, prescriptions and so forth and all had an impact on the participants. Obviously, some were affected more than others depending on basic wages, sick pay arrangements and outgoings on a monthly basis. One participant faced his home being repossessed as a result of long term sickness, substantially lower income from sick pay and also not having adequate mortgage insurance. Thus, the financial implications were a real issue for some participants that were not helped by the apparently long time to settle any interim payments of a compensation claim, even when it was evident that the injuries were impairing and long term sickness a matter of course.
• Do health outcome measures address the main outcomes in a road traffic injury sample?

This research has identified the value of using health outcome measures in road traffic injury as it enables the quantification of the effects of road crashes for analysis purposes. The tools used were selected for their suitability to a UK population and the production of a health profile and a utility score which can be used to calculate societal costs and burden of injury. These measures identified the differences between the physical and psychological recovery and were applied to observe gender and injury differences. This suggests that in a large population, their potential for providing pertinent burden of injury information would be invaluable for comparisons between countries. It would also contribute to the development of predictors of impairment which could be utilised across countries in the road safety research field.

• Which are the most effective methods for evaluating outcomes in road injury survivors?

Establishing a sample in this research used a postal and face to face interviews sue to the nature of the available population samples. The postal method did not provide baseline data from which to infer changes in health status from baseline onwards. It was slow and even with changes to the approach letter for potential participants did not improve the interview rate. The face to face interviews whilst in hospital provided baseline data and some indication of pre-injury health status beneficial for assessing the changes over time in the sample. The practicalities of this recruitment method were an issue as the researcher was reliant on others to provide the relevant information which did not always work to any advantage. Despite this a face to face recruitment process immediately after or as soon as practically possible following injury is the preferred method for obtaining a sample. This would have to be expanded to include patients who attend A and E only to ensure a representative sample of minor and serious injuries is obtained.
Telephone interviews for follow-up were as they allowed for elaboration when necessary but ensured that the interview protocols were consistently adhered to and also allowed for some freedom of interview time to maximise response rates. This method also avoided the problems of having missing data as the researcher could control the actual interview.

Having a second contact for participants in Study 2 worked well for the researcher in a few cases when participants had moved or changes telephone numbers, this again maximised the potential response rates and would have to be incorporated into any future studies. The attrition rate was high for the studies in the thesis and would need to be considered prior to further research and accommodated in a larger sample.

The actual data collection tools used here provided the researcher measurable effects of the injury effects at the subjective level. It was anticipated that the health outcome measures would provide similar findings, however, it is evident that these two measure actually assess different aspects of health and provide two different outcomes of an individual's assessment. Thus it would not be of benefit to any further similar studies to select one measure over the other as the descriptive ability of the SF-36v2 outweighs the EQ-5D, however the latter measure provides the quantative data to calculate QALYs, an area which is becoming popular in the clinical literature and should not be ignored. The responder burden to participants is not greatly increased by adding the EQ-5D because its very brevity ensures it can be completed within five minutes, particularly if participants have seen these health outcome measures during the recruitment process. Again the addition of a depressions scale was of value to Study 2 as it was able to demonstrate that the health outcome measures incorporate other psychological issues other than depression in their relevant health dimensions. Depression on its own was an important finding and one would consider this a requirement for further studies.

The use of semi-structured interviews and the study questionnaire allowed for elaboration of pertinent points which arose such as the issue of the compensation progress, complications of treatment, rehabilitation treatment and social support. These are all factors important post crash which can have a detrimental affect on the individual's recovery following an injury.
• Is there potential for further research?

This research was determining the methods and examining the outcomes of injury which road safety researchers tend not to address in any detail. It is evident there is potential to conduct further research in this area and could be divided into subjective and societal impacts of injury dependent on the need to demonstrate these effects to the road safety audience. The data collection tools used; particularly the EQ-5D, because of existing translations, has potential to be used across Europe to assess the societal burden using QALYs as an outcome of road injury in varying countries. At a more individual level there is potential to incorporate a larger range of injury types to determine the differences between them in the outcome effects as well as associated burden.

Other potential studies that could be addressed using this methodology with additional assessments would be to use the AIS and the measured injury outcomes to examine the predictive ability of the FCI and IIS on a large scale across injury types. Thus, if they can be shown to be valid measures then the implications to existing study databases such as the CCIS and OTS are great as this would enable the data to be explored for injury impairments associated with crash types for example.

• What should a larger regional or national study take into account?

An essential requirement for further study would be the need to have a sample drawn from the same population from the Accident and Emergency Department. This would enable the differences between injury severities to be studied in more depth. To suggest the use of only one measure would remove either the descriptive health profile from the SF-36v2 or the utility attributes of the EQ-5D. The EQ-5D has been translated into many European languages and already has been used in studies throughout Europe and would benefit any road safety research examining outcomes across the EU. The SF-36v2 has also been translated into other languages but not to the
same extent. Until the SF-6D has proven its utility attributes the economic analysis would invalidate any findings. The calculation of QALYs using the EQ-5D has the ability to enable the benefits from new road safety initiatives to be measured within and between countries. The loss of QALYs for some countries may be higher compared to others and using such a metric would enable this analysis to be undertaken using the same consistent measure.

The choice of health outcome measures would remain the same for a large prospective study because of the different qualities they contribute in the assessment of health outcomes. The EQ-5D was selected here by virtue of its brevity, UK norms and its ability to provide QALY losses based on economic methodologies. However, its brevity only allows for overall scores to be generated and compared statistically as individual health domains can only be represented as percentages, removing the ability to present the 'problem' health domains. In contrast the SF-36v2 has the ability to present and allow for statistical analysis of its health dimensions and the component health scores. Although there is the potential to calculate a 'utility' score the base methodology is not sound for economic purposes and until it is validated the need remains to use a psychometric and preference based measure.

19.4: Future Work

It was apparent from the results of this research that survivors of road crashes are affected by the consequences of their injury and that those with 'minor' injury have different effects compared to those with 'serious' injury. One area which needs further exploration is those who were 'not injured' in a crash but still may suffer as a consequence of the crash. However to be able to determine these differences a further large scale study using the 'same' recruitment method from an Accident and Emergency Department would be necessary. This would provide a sufficient sample size to make inferences to the population of road users.

One further consideration would be to obtain local population norms for the health outcome measures used to ensure comparability between the sample.
and population under study. There would be financial implications of this as such a study would need the input of several experienced researchers in order to derive a robust sample.

The need for further research in this area is necessary in order to determine the burden of road injuries on the person and at a societal level. This would raise the awareness of road safety stakeholders on the necessity to focus on the prevention of high incidence, high cost and high impairing injuries as cumulatively they cost both the individual and society millions of pound per year.

In response to the real issue of the effects of road trauma on individuals a large scale study would be required to both estimate their impact and to direct future injury prevention strategies. A study of this nature would need to take on board the intensive follow-up of participants at the minimum of baseline, two weeks, six weeks, three months, six months, 12 months and then yearly up to five years to obtain the immediate, short and long term effects of the injuries. This would require involvement from a number of trauma hospitals and onsite recruitment of participants to ensure the comparability of the data between the 'minor' and 'seriously' injured groups.

One major consideration is research tools such as the FCI which have the potential to enhance current road safety databases. Validating such tools on a large scale would enable mapping to existing injury databases to provide functional outcomes and potentially, cost assessments without the further need for expensive follow-up studies. This is a very real possibility, however, the developers have been reticent for it to be used in research studies to date.

One area for improvement that could be immediate is the provision of information to survivors of road crashes. From the work in this thesis it was noted that participants had little or no information as to 'what happens next' or that their injury may mean more than a few weeks off sick as this often entails implications on finances, family, insurance or the compensation process. Information leaflets available to crash survivors available at hospitals and GP surgeries could help participants deal with the 'fall out' from an injury even at the basic level. For example, information that pain may last longer than expected or feeling tired may be normal following an injury would be enormously beneficial. In so doing it could help some survivors of road
crashes recognise the 'normality' of what they are experiencing although it could be argued that this could assist participants to exaggerate their symptoms for any compensation purposes. Recognition that crash survivors are actually victims of a traumatic event could alleviate some of the consequences experienced by the participants by providing access to psychologists and relevant practical information such as where to access support at a later date. These basic interventions for an inpatient could have an impact on recovery. However, a further study would be required to assess the variance in outcome of those who do and do not receive this intervention in a randomised controlled trial!

**19.5: Overall Conclusions**

It is considered that this research achieved its aims of identifying the effects of road injury and also examined the methodologies that can be used to assess outcomes of road injury. Each of the research questions has been addressed by the methods and findings from the three studies presented. Overall, this body of research has contributed new knowledge to the area of road safety research by examining the road injury outcomes from a quality of life perspective, new to this area of research. Using health outcome measures out of the clinical setting has enabled the assessment of any outcomes on a formal basis. It is evident that the crash / injury have an effect longer lasting than the immediate crash event itself. Using this new methodology to explore the outcomes of survivors of road injury has enabled the identification of the real issues that effect individuals after sustaining an injury, at the subjective and societal level. This work has provided a basis from which further research can be developed to explore these impacts of road injury at the individual and societal level in the UK and potentially across Europe. The impacts to individuals have a wider reaching effect than just the physical restrictions imposed on everyday life that include psychological and emotional effects as well as implications to personal finances. All factors which in isolation have an effect on an individual but together the impact is potentially greater.
This research identified the impact of lower extremity injury in Study 2 on quality of life in all road user types, not just car occupants. The focus in the literature is often on lower extremity injury however this work also identified that upper extremity injuries were not without implications for work and leisure activities and would benefit from further study. This again raises the need to recruit participants from A and E as upper extremity injury, dependent on severity, are treated, discharged and followed up in the outpatient clinics or have an overnight stay but discharged prior to the recruitment visit.

This research, although not without limitations, has shown there is potential to study this subject further and incorporate any recommendations and minimise the limitations to broaden the sample to accommodate all injury types in a larger sample. This would enable the differences across injuries to be identified and examine the societal burden for each type on a wider scale. The impact of this on road safety researchers would highlight the injuries needed to be addressed and reduced in vehicle design and road safety legislation as costly and impairing to the individual.
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