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June 2008

Quality of life after injury: an IPD meta-analysis

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A thesis submitted for the degree of

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Abstract

Purpose

There is a need for information on the Health Related Quality of Life (HRQoL) of injury populations. HRQoL measures, like the EQ-5D, have seen a dramatic increase in use over the last ten years. Despite this, general information on HRQoL pathways to recovery are missing from the literature, as many injury studies focus on specific injury types within exclusive populations. This study: (1) identified studies using the EQ-5D in injury populations, (2) collected individual level patient data, and (3) produced population level predictions of HRQoL, as defined by the EQ-5D, across injury sub-types.

Methods

A systematic search of literature concerning injury outcome, published between January 1990 and November 2008 (inclusive), was completed. Studies were excluded if the EQ-5D was not used, a degenerative disease was required for study inclusion or injury was a secondary outcome not required for the study. Researchers were invited to contribute Individual Patient Data (IPD) to the meta-analysis. Injuries collected were grouped into 39 categories based on the Eurocost injury classifications. Multilevel mixed effects models were used to produce predictions across both the dimensions and the Visual Analogue Score (VAS) of the EQ-5D measure.

Results

From a potential pool of 13,785 persons across 39 study datasets, IPD from 10,496 injured persons was sourced from 18 discrete datasets. Predictions were fitted to 25 of the 39 injury categories, covering a wide spectrum of injury types. Point predictions were produced for the dimensions and VAS at 3, 30, 120 and 360 days after injury. Figures were also produced of recovery pathways within the EQ-5D dimensions, where relationships with the facet of the EQ-5D and time were statistically significant.

Across the majority of injuries *pain and discomfort (PD)* was the most severely impaired dimension at both 30 and 360 days post injury. Recovery for *PD* was gradual, with fractures of the femur, lower leg and pelvis showing marked improvements in *mobility* and *usual activities* at 360 days but not *PD*. Regardless of anatomical location of injury a similar pattern was seen between fractures, with high initial impairment and rapid recoveries, and strains, where impairment at 30 days was significantly less but recovery was gradual. VAS scores showed a great variation in subjective assessments of general health states after an injury. The dimensions of *cognitive function* and *anxiety and depression* showed a limited relationship with most injury categories.

Discussion

The HRQoL predictions produced here will aid clinical researchers in comparing their populations to norm values, as well as aiding policy makers in obtaining a greater understanding of the burden of injury types. This will aid in both justifying prevention measures, as well as identifying areas for prioritisation of resources.

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Table of contents

Quality of life after injury: an IPD meta-analysis	II
Abstract.....	III
<i>Purpose</i>	<i>III</i>
<i>Methods.....</i>	<i>III</i>
<i>Results</i>	<i>III</i>
<i>Discussion</i>	<i>III</i>
Acknowledgements.....	IV
The Collaborators Group	V
Table of contents	VII
List of tables	XIII
List of figures	XVI
List of abbreviations.....	XVIII
Background	1
Injury	1
What is injury?	2
The burden of injury	3
Assessing injury	3
Eurocost.....	4
Health related quality of life (HRQoL).....	4
A plethora of HRQoL measures.....	4
The EQ-5D	5
Development and purpose	5
Facets of the measure.....	5
<i>The 5 dimensions</i>	<i>6</i>
<i>Visual Analogue Score (VAS).....</i>	<i>6</i>
<i>The index score</i>	<i>6</i>
Current usage.....	7
Validity and reliability	7
Literature review: EQ-5D outcomes in injury populations	8
Methods.....	8
Results	10
Conclusions from current literature	12
Aims	13
Methods	14
Design.....	15
<i>Ethical approval and consultation</i>	<i>15</i>

<i>Intellectual property provisions</i>	15
Collecting data	15
Bridging search.....	15
Inclusion and exclusion criteria.....	15
Data collection	16
Contacting authors.....	16
Information sought	16
Recoding.....	17
Data analysis	20
Dataset hierarchy.....	20
Multilevel mixed effects linear modelling	21
Multilevel mixed effects logit modelling.....	22
Stata	22
<i>Interpreting the predictions for the dimensions</i>	23
Collected datasets.....	24
Datasets not retrieved	27
Study population profile	28
Variables retrieved.....	28
Injury type representation.....	29
Injury outcomes.....	30
Head injuries	31
1. Concussion	31
<i>Profile</i>	31
<i>The group norm values</i>	31
2. Other skull-brain injury	33
<i>Profile</i>	33
<i>The group norm values</i>	33
3. Open wound head.....	35
<i>Profile</i>	35
<i>Injury group norm values</i>	35
Face	37
4. Eye injury.....	37
<i>Profile</i>	37
<i>Injury group norm values</i>	37
5. Fracture facial bone	39
<i>Profile</i>	39
<i>Injury group norm values</i>	39
6. Open wound face	41
<i>Profile</i>	41

<i>Injury group norm values</i>	41
Vertebrae / Spine	42
7. Vertebral column fracture / dislocation / sprain / strain.....	42
<i>Profile</i>	42
<i>Injury group norm values</i>	42
8. Whiplash, neck sprain, distortion of cervical spine	44
<i>Profile</i>	44
<i>Injury group norm values</i>	44
9. Spinal cord injury (SCI)	46
<i>Profile</i>	46
<i>Injury group norm values</i>	46
Abdomen / Thorax	47
10. Internal organ injury	47
<i>Profile</i>	47
<i>Injury group norm values</i>	47
11. Fracture of rib / sternum	49
<i>Profile</i>	49
<i>Injury group norm values</i>	49
Upper extremity.....	51
12. Fracture of clavicle / scapula	51
<i>Profile</i>	51
<i>Injury group norm values</i>	51
13. Fracture of upper arm.....	53
<i>Profile</i>	53
<i>Injury group norm values</i>	53
14. Fracture of elbow / forearm	55
<i>Profile</i>	55
<i>Injury group norm values</i>	55
15. Fracture of wrist (incl. carpal bones)	57
<i>Profile</i>	57
<i>Injury group norm values</i>	57
16. Fracture of hand / fingers	58
<i>Profile</i>	58
<i>Injury group norm values</i>	58
17. Dislocation / sprain / strain shoulder / elbow	60
<i>Profile</i>	60
<i>Injury group norm values</i>	60
18. Dislocation / sprain / strain wrist / hand / fingers.....	62
<i>Profile</i>	62

<i>Injury group norm values</i>	62
19. Injury of nerves	63
<i>Profile</i>	63
<i>Injury group norm values</i>	63
20. Complex soft tissue injury of the upper limb.....	64
<i>Profile</i>	64
<i>Injury group norm values</i>	64
Lower extremity	65
21. Fracture of pelvis.....	65
<i>Profile</i>	65
<i>Injury group norm values</i>	65
22. Fracture of the hip	67
<i>Profile</i>	67
<i>Injury group profile</i>	67
23. Fracture of femur shaft	69
<i>Profile</i>	69
<i>Injury group norm values</i>	69
24. Fracture of knee / lower leg.....	71
<i>Profile</i>	71
<i>Injury group norm values</i>	71
25. Fracture of ankle	73
<i>Profile</i>	73
<i>Injury group norm values</i>	73
26. Fracture of foot	75
<i>Profile</i>	75
<i>Injury group norm values</i>	75
27. Dislocation / sprain / strain of knee.....	77
<i>Profile</i>	77
<i>Injury group norm values</i>	77
28. Dislocation / sprain / strain of ankle / foot.....	79
<i>Profile</i>	79
<i>Injury group norm values</i>	79
29. Dislocation / sprain / strain of hip	81
<i>Profile</i>	81
<i>Injury group norm values</i>	81
30. Injury of nerves	83
<i>Profile</i>	83
<i>Injury group norm values</i>	83
31. Complex soft tissue injury of the lower limb	84

<i>Profile</i>	84
<i>Injury group norm values</i>	84
External injuries	86
32. Superficial injury (inc. contusions)	86
<i>Profile</i>	86
<i>Injury group norm values</i>	86
33. Open wounds	88
<i>Profile</i>	88
<i>Injury group norm values</i>	88
34. Burns	89
<i>Profile</i>	89
<i>Injury group norm values</i>	89
35. Poisoning.....	90
<i>Profile</i>	90
<i>Injury group norm values</i>	90
36. Multitrauma	91
<i>Profile</i>	91
<i>Injury group norm values</i>	91
Other injuries	92
37. Foreign body	92
<i>Profile</i>	92
<i>Injury group norm values</i>	92
38. No injury after examination	93
<i>Profile</i>	93
<i>Injury group norm values</i>	93
39. Other / unspecified injury	94
<i>Profile</i>	94
<i>Injury group norm values</i>	94
40. Amputations.....	95
<i>Profile</i>	95
<i>Injury group norm values</i>	95
General results and trends.....	96
Discussion.....	99
Principal findings.....	100
General trends	100
<i>The impact of pain and discomfort, usual activities and mobility</i>	100
<i>Injury and anxiety and depression, cognitive function and self-care</i>	101
<i>The recovery profile dichotomy: strains and fractures</i>	102
Findings specific to injury regions.....	103

<i>Injuries of the head, face, skull and brain</i>	103
<i>Injuries of the back, neck and abdomen</i>	103
<i>Upper limb fractures</i>	104
<i>Upper limb strains</i>	104
<i>Lower limb fractures</i>	105
<i>Lower limb strains</i>	105
Strengths and weaknesses of the study	106
The EQ-5D	106
<i>The questionnaire</i>	106
<i>The EQ-5D construct of quality of life</i>	106
Precision of predictions	107
Validity of the statistical model	108
Using the Eurocost injury classifications	109
Strengths and weaknesses in the context of current literature	111
Meaning of the study: implications and unanswered questions	112
References	114
Appendix	121
I. Sample EQ-5D	121
II. Data use agreement	122
III. Letter to researchers	123

List of tables

Table 1 Eurocost coding.....	18
Table 2 Location of injury.....	19
Table 3 Injury types coded for in the dataset	19
Table 4 Datasets included in the analysis	26
Table 5 Individual patient data not retrieved	27
Table 6 Study population profile.....	28
Table 7 Eurocost categories used in this study.....	29
Table 8 Age and sex profile of concussion injury group	31
Table 9 EQ-5D predicted norms for concussion	32
Table 10 Age and sex of skull-brain injury group.....	33
Table 11 EQ-5D predicted norms for skull-brain injury	34
Table 12 Age and sex of open head wound group	35
Table 13 EQ-5D predicted norms for open face wound injuries	36
Table 14 Age and sex of eye injury group.....	37
Table 15 Predicted EQ-5D norms for eye injury	38
Table 16 Age and sex of facial fracture group	39
Table 17 EQ-5D norms facial fracture.....	40
Table 18 Age and sex of open face wound group.....	41
Table 19 Age and sex of vertebral column injury group.....	42
Table 20 EQ-5D norms for vertebrae fracture/ sprain/ dislocation or strain	43
Table 21 Age and sex profile of whiplash group.....	44
Table 22 EQ-5D norms for neck injury	45
Table 23 Age and sex of SCI group.....	46
Table 24 EQ-5D predicted norms for SCI	46
Table 25 Age and sex of internal organ injury group.....	47
Table 26 EQ-5D predicted norms for internal organ injury	48

Table 27 Age and sex of rib/ sternum fracture injury group	49
Table 28 EQ-5D norms for rib/ sternum fracture	50
Table 29 Age and sex of upper extremity injury group	51
Table 30 Predicted EQ-5D values after fracture of the shoulder or scapula	52
Table 31 Age and sex of upper arm fracture group.....	53
Table 32 EQ-5D norms for upper arm fracture.....	54
Table 33 Age and sex of elbow/forearm fracture group	55
Table 34 EQ-5D predicted norms for elbow/ forearm fracture.....	56
Table 35 Age and sex of wrist fracture group.....	57
Table 36 EQ-5D predicted norms for wrist fractures.....	57
Table 37 Age and sex of hand/ finger fracture group.....	58
Table 38 EQ-5D norms for hand/ finger fracture.....	58
Table 39 Age and sex of shoulder and elbow joint injury groups.....	60
Table 40 EQ-5D norms for shoulder and elbow joint injuries	61
Table 41 Age and sex of wrist/ hand joint injury group.....	62
Table 42 Predicted VAS for wrist/ hand joint injury	62
Table 43 Age and sex of upper extremity nerve injury group	63
Table 44 Age and sex of upper limb complex soft tissue injury	64
Table 45 Age and sex of pelvis fracture group.....	65
Table 46 EQ-5D norms for pelvis fracture injuries.....	66
Table 47 Age and sex of hip fracture group.....	67
Table 48 EQ-5D norms for hip fracture injuries.....	68
Table 49 Age and sex of femur fracture group	69
Table 50 EQ-5D norms for femur fracture injuries	70
Table 51 Age and sex of knee / lower leg fracture group.....	71
Table 52 EQ-5D norms for lower leg fracture injuries	72
Table 53 Age and sex of ankle fracture group	73

Table 54 EQ-5D norms for ankle fracture group.....	74
Table 55 Age and sex of foot fracture group	75
Table 56 EQ-5D norms for foot fracture injuries	76
Table 57 Age and sex of knee joint sprain/ strain/ dislocation injuries.....	77
Table 58 EQ-5D norms for knee dislocation/ sprain/ strain injuries	78
Table 59 Age and sex of ankle/ foot sprain/ strain/ dislocation injuries	79
Table 60 EQ-5D norms for ankle/foot dislocations/ sprains/ strains in a group	80
Table 61 Age and sex of hip dislocation/ sprain/ strain group	81
Table 62 EQ-5D norms for hip dislocation/ sprain/ strain	82
Table 63 Age and sex profile, percentages omitted due to low number or persons	83
Table 64 EQ-5D norms for lower limb complex soft tissue injuries.....	85
Table 65 Age and sex of superficial injuries.....	86
Table 66 EQ-5D norms for superficial injuries	87
Table 67 Age and sex of open wound injury group	88
Table 68 Age and sex of burn injury group	89
Table 69 Age and sex of poisoning injury group	90
Table 70 Age and sex of multitrauma injury group	91
Table 71 Age of profile of foreign body injury group.....	92
Table 72 Age and sex of group with no known injury after examination.....	93
Table 73 Age and sex of unclassifiable injuries.....	94
Table 74 Age and sex of amputation injury group.....	95
Table 75 Predictions for injury groups at 360 days.	98

List of figures

Figure 1 Retrieved studies.	10
Figure 2 Flowchart of datasets using the EQ-5D in injury.....	11
Figure 3 Stages of this thesis.....	14
Figure 4 Subset hierarchy	20
Figure 5 EQ-5D concussion dimension scores	32
Figure 6 EQ-5D skull-brain injury VAS predictions.....	33
Figure 7 Dimension score predictions after skull-brain injury.....	34
Figure 8 Usual activity dimension predictions after facial fracture	40
Figure 9 EQ-5D VAS score predictions for vertebral fractures	42
Figure 10 Dimension score predictions for vertebrae injury group.....	43
Figure 11 Predicted neck injury VAS scores.....	44
Figure 12 Dimension score predictions for neck injury	45
Figure 13 VAS score predictions for internal organ injury	47
Figure 14 Usual activity dimension score predictions for internal organ injury.....	48
Figure 15 Predicted VAS norms for rib sternum fracture	49
Figure 16 Dimension score predictions for rib/ sternum fracture	50
Figure 17 Predicted EQ-5D VAS values after fracture of the shoulder or scapula	51
Figure 18 Predicted EQ-5D dimension values after a fracture of the shoulder or scapula.	52
Figure 19 Dimension score predictions for upper arm fracture	54
Figure 20 Predicted VAS for elbow/ forearm fracture	55
Figure 21 Dimension score predictions for forearm/ elbow fractures	56
Figure 22 Dimension score predictions for hand/ finger fracture	59
Figure 23 Dimension score predictions for shoulder and elbow joint injuries	61
Figure 24 EQ-5D VAS scores for pelvis fractures	65
Figure 25 EQ-5D dimension score predictions for pelvis fracture injuries	66
Figure 26 Dimension score predictions for hip fracture group.....	68

Figure 27 VAS score predicted values for femur fracture.....	69
Figure 28 Dimension score predictions for femur fracture injuries	70
Figure 29 EQ-5D VAS score predictions for knee/ lower leg fracture injuries	71
Figure 30 Dimension predictions for lower leg fracture injuries	72
Figure 31 VAS score predictions for ankle fracture injuries	73
Figure 32 Dimension score predictions for ankle fracture injuries	74
Figure 33 VAS score predictions for foot fracture	75
Figure 34 Dimension score predictions for foot fracture injuries	76
Figure 35 Dimension score predictions for knee dislocations/ sprains/ strains.....	78
Figure 36 VAS score predictions for ankle/ foot dislocations/ strains/ sprains	79
Figure 37 Dimension score predictions for ankle/ foot dislocations/ strains/ sprains	80
Figure 38 VAS score predictions for dislocation/ sprain/ strain of hip	81
Figure 39 Dimension score predictions for hip dislocation/ sprain/ strain	82
Figure 40 VAS score predictions for lower limb complex soft tissue injuries	84
Figure 41 Dimension score predictions for lower limb complex soft tissue injuries	85
Figure 42 VAS score predictions for superficial injuries	86
Figure 43 Dimension score predictions for superficial injuries.....	87

List of abbreviations

95%CI 95% Confidence Interval

EQ-5D The measure of general health status used in this study

GCS Glasgow Coma Score

HRQoL Health Related Quality of Life

ILO International Labour Organisation

IPD Individual Patient Data

ISS Injury Severity Score

MM Multilevel Model

SCI Spinal Cord Injury

VAS Visual Analogue Score

WHO World Health Organisation

Background

Injury

Injury has always had an unwanted presence within society. In 1998, approximately 5.8 million people died from an injury (Krug, Sharma et al. 2000). Globally, injury is a leading cause of both mortality and morbidity. The World Health Organisation (WHO) attributes 12-16% of the 'burden of disease' and 9% of all deaths to injury (Krug, Sharma et al. 2000; World Health Organization 2008); with unintentional injury implicated in 13-18% of disabilities (World Health Organisation 2005). While 51% of deaths in males aged 10-24 are attributed to injury, the deaths occur predominately in the developing world (Patton, Coffey et al. 2009). Mortality projections from 2002 to 2030 show an increase in deaths from injury of 40% (Mathers and Loncar 2005), predominately due to both the increase in population densities and greater access to motor vehicles.

Injury continues to have a strong impact on the New Zealand population, with the reduction of injury seen as an important focus for health policy and research (Dyson 2003). In 2008, there were 1,116 hospital discharges for non-fatal injury per 100,000 persons in New Zealand (IPRU 2009). Injuries covering a great range of morbidity, from superficial lacerations and minor fractures with a temporally defined healing profile, to paraplegia, burns and head injuries where recovery, or adaption, may span a lifetime.

Historically a passive acceptance of injury as an 'accident' limited prevention being an important goal in the public, academic, and political arena (Krug, Sharma et al. 2000). In fact during World War II, the incidence of permanent disability from injury within America (1,250,000 from 1941-5) exceeded the total number of casualties sustained by the American military in the same period (1,070,000) (Armstrong and Cole 1946). This began to change in 1966, when the American National Academy of Sciences labelled disability as the "neglected disease of modern society" (National Academy of Sciences 1966), and the development and uptake of a systematic approach to injury research started (Haddon, Suchman et al. 1964; Haddon 1968; Haddon 1970).

What is injury?

Injury is a broad term that encompasses the superficial scratch, to the conclusive decapitation. Therefore, it is essential that the boundaries of an injury be defined for this thesis. The majority of published research defines injury by convenience, or explicitly, according to where the population was sourced (e.g emergency department admission or inclusion within a trauma register) (Cryer and Langley 2008). From a search of the literature, via OVID and EBSCO, it would appear that the threshold of injury is an event that results in a clinically perceptible change, or an interaction with a healthcare resource such as an emergency department.

Harder to define than the threshold of injury, is the importance of the aetiology and clinical manifestation of an injury. An injury can occur after an acute trauma, which is an injury resulting from one traumatic event. Injury can also be caused by repetitive micro-trauma, where one injury event is not sufficient but the cumulative effect is a definite pathological injury (Nainzadeh, Malantic-Lin et al. 1999). Despite cumulative trauma injuries having little-to-no threat to life, these injuries represent an important facet of injury research. Prior to 1970 the prevalence of these injuries was relatively static, and they were not seen as a priority in research (Spillane 2008). These cumulative injuries, often associated with repetitive tasks in a setting that lacks ergonomic considerations (Mathews and Calabrese 1982), are now an important burden on the population. In fact in 1994 cumulative trauma constituted more than 50% of workers' compensation costs in America (Bureau of Labour Statistics 1995).

The boundaries of injury are further blurred when there is no physical manifestation. Instead only a psychological injury is present. While a valid case could be put forward for including injuries of a psychological nature, it is more widely accepted to define injury as a consequence of an energy exchange. The WHO in collaboration with the United Nations group, the International Labour Organisation (ILO), provides an internationally recognised and commonly replicated definition of what constitutes injury:

Unintentional and/or intentional damage to the body resulting from: acute and/or cumulative exposure to mechanical, thermal, electrical or chemical energy and/or the application of a force or resistance (including gravity) on the human body, and/or acute or cumulative exposure to psychologically damaging events, and/or the absence of essentials such as heat or oxygen (ILO 2002).

This is distinct from the standard WHO definition of injury which does not include cumulative injuries (Baker, O'Neill et al. 1992; Holder, Peden et al. 2001). The ILO definition acknowledges the impact of injuries that may not pose immediate threat to life, but may still infer disability.

The burden of injury

The burden of injury is often examined using Disability-Adjusted Life Years (DALY), a measure developed by the WHO in the seminal Global Burden of Disease Study (GBD) (World Health Organization 2008). As a summary measure the DALY represents an estimation of the gap between a population's health, and an ideal population that continues to live into old age free of disease and disability (Mathers, Vos et al. 2001). It does this by combining an estimate of the relative Years of Life Lost (YLL) and Years of Life Lost to Disability (YLD). This allows the relative number of DALY lost to represent the relative health deficit, and allows political and health system agendas to respond appropriately. Regardless of age, sex or locality injury represents a substantial burden on populations (Krug, Sharma et al. 2000). While the global burden of injury is derived using the DALY, the measure is usually associated with assessments of the impact of disease, and exploration of injury sub-types with the DALY is missing from literature (Krug, Sharma et al. 2000; Mathers, Vos et al. 2001).

Burden can also be examined according to the fiscal burden of an injury on a person, health provider, or nation. In 2000 Finkelstein estimated that non-fatal and fatal injury within America resulted in an expenditure of USD\$80.1 billion dollars on medical care. In addition an estimated USD\$184 billion was lost to the general economy through time off work (Finkelstein, Corso et al. 2006).

Assessing injury

The grouping of injury sub-types is an important factor in injury meta-analysis. A classification system must enable the separation of injuries into relatively equivalent groups, where accurate and relevant conclusions can be drawn, without introducing too many groups and reducing the statistical power of the analysis. There are different schemes to classify injury, and it can be assumed that across the selected studies the many possible choices to classify injury would be represented. By choosing a relatively simple scheme for this study it would be possible to map collected injury details from any scheme encountered.

The International Classification of Diseases (ICD-10) provides a comprehensive breakdown of injury aetiology (chapter XIX, S00-T98). This measure would have allowed the collapsing of comprehensive injury groups into injury sub-sets. Yet despite it being the most prevalent classification system many of the studies, especially those not involving hospitalised patients, were expected to use different schemes or lack formal injury diagnoses entirely. Because of this a more general scheme was needed.

Eurocost

The Eurocost injury classification scheme is a relatively simple approach that divides injury into 39 groups (Polinder, Meerdering et al. 2007; Polinder, Meerdering et al. 2008a). This measure allowed other injury categories present in studies to be mapped to a common set of injury sub-types in the meta-analysis.

Health related quality of life (HRQoL)

Health Related Quality of Life (HRQoL) is a patient reported summary measure of a person's health state and is often self-reported by patients. It is often referred to as *health state*, *functional status* or *quality of life*, despite these concepts differing in underlying constructs across literature (Guyatt, Feeny et al. 1993). In general, a HRQoL measure aims to represent a person's health state, but with an emphasis on the direct impact of their current 'health', rather than external environmental factors. Within this definition many different measures, and the constructs of HRQoL they represent, can exist. Within HRQoL measures there are two distinct approaches. One type is disease specific measures. These measures are often more sensitive to the effects of a disease. This can be seen in the Knee Quality of Life (KQoL-26) questionnaire, which is weighted towards the effects of mobility (Garratt, Brealey et al. 2008). The second type is general HRQoL measures, which are designed to be applied to any population – ill, injured or healthy.

A plethora of HRQoL measures

A variety of generic measures of HRQoL have been used in injury outcome research. The most common being: the EQ-5D, Functional Independence Measure (FIM), Health Utilities Index (HUI3), Nottingham Health Profile (NHP), Quality of Well-Being scale (QWB), Sickness Impact Profile (SIP) and the QualityMetric Short Form SF-12 and SF-36.

The European Consumer Safety Association (ECOSA) recruited a working party in 2003 to develop a consensus on guidelines for injury-related follow-up studies (Van Beeck, Larsen et al. 2007). This group aimed to prevent the loss of collective inference from injury studies due to the use of conflicting outcome measures, study designs and injury populations. The group met at the 7th World Conference on Injury Prevention and Control, and the output from these workshops was subsequently published (Van Beeck, Larsen et al. 2007). The group concluded that the EQ-5D and HUI were best suited to studies across the spectrum of injury, largely due to: brevity, sensitivity, validity and ability to aid in deriving cost-effectiveness measures.

The EQ-5D

The EQ-5D is a general HRQoL measure developed by the EuroQol Group, an international consortium of multidisciplinary researchers. It takes less than five minutes to complete and provides a descriptive profile of health status, a subjective assessment of overall health state, and the ability to produce a descriptive index score of the person's current health state.

Development and purpose

The EuroQol Group aimed to develop a standardised non-disease-specific measure for describing and valuing HRQoL, to complement other (more specific) measures (Rabin and Charro 2001). Rabin and Charro go on to list that the measure must:

(1) Be an easy 'add on' to studies' existing instruments; (2) capable of being disseminated as a postal questionnaire for self-completion; (3) relatively undemanding – taking only a few minutes to complete; (4) relevant to all correspondents: healthy or severely ill; at home or in hospital; of all ages; (5) capable of producing a single index value; (6) consistent with health states 'worse than dead'.

In developing the EQ-5D it was apparent that a health state could be simplified as a composite measure of dimensions within the broad concept of 'health'. Within these dimensions a number of levels of 'severity' needed to be represented. Having enough levels was required to ensure the measure was sensitive to health state changes (van Agt and Bonsel 2005). As the EQ-5D was a general measure, and designed to be bolstered by disease-specific measures in injury specific studies, or more involved instruments in general injury studies, just three gradations of 'severity' were included in the measure (Williams 2005).

To complement the domains of health, that were to represent a composite breakdown of HRQoL, an assessment of purely subjective health states was included. This was done with the Visual Analogue Score (VAS); a scale from 0-100 representing a subjective snapshot of current health state.

The Group also aimed to develop a single index score of health state. Initially a lack of funds to conduct a large-scale study resulted in the index score tariffs being derived from a survey of the general populations' valuations of specified health states on the VAS. As the impetus behind both the measure and HRQoL grew this was expanded to the use of Time Trade Off (TTO) questionnaires, where participants from the general population traded off a preference for time spent in a given state for a set time (Williams 2005). To date value sets, for deriving the index score, have been defined for 15 countries (EuroQol Group 2009b).

Facets of the measure

The 5 dimensions

The first of three parts in the EQ-5D is the five dimensions: *mobility, self-care, usual activities, pain and discomfort, and anxiety and depression*. Within each dimension are three levels of severity. The severity is based on a personal interpretation of no problems, some problems, or extreme problems within a dimension. Limited guidance is given within the question. For example, the responses for *usual activities* are framed as (Gudex 2005):

1. No problems with performing usual activities (e.g. work, study, housework, family or leisure activities)
2. Some problems with performing usual activities
3. Unable to perform usual activities

By providing a limited framework within the available responses the collected health profile bears a functional relevance while still representing a subjective self-assessment of HRQoL.

Officially the EQ-5D contains five dimensions. There is though a sixth unofficial dimension of cognitive function (Krabbe, Stouthard et al. 1999). This dimension appends a question for *cognitive function* to the measure. When used it is occasionally referred to as the EQ-5D+C, although often the EQ-5D title is used regardless of whether six dimensions are utilised or not (Krabbe, Stouthard et al. 1999; Wolfs, Dirkson et al. 2007).

Visual Analogue Score (VAS)

The VAS represents a snapshot of subjective self-assessed health state, at the time of completion. It comprises a vertical scale of 20cm in length, with increments, anchored at zero for worst imaginable health state and 100 for best. The person completing the EQ-5D is asked to draw a line on the scale that represents their current health (Appendix I).

The index score

The final component of the EQ-5D is not asked in the questionnaire, instead being derived from the responses. It is an index score where the person's health state is scored from zero to one, with negative values possible for states valued as 'worse than death'. The official EQ-5D measure contains 3 levels of severity within 5 dimensions; this enables the EQ-5D to represent 243 distinct health states. Additionally the state of unconsciousness and death bring the total number of health states the EQ-5D can describe to 245 (Selai and Rosser 2005). The relative values of these health states are assessed using predominately TTO techniques, and collated in country specific value sets (Kind,

Dolan et al. 1998; Selai and Rosser 2005). The addition of new value sets for deriving the index score is on going, and the most up-to-date information is available at *EuroQol.org*.

Current usage

To date comprehensive general population norms for the EQ-5D have been produced in 15 countries from a total of 29,839 persons (Szende and Williams 2004). The EuroQol Group reports that the measure has been applied in over 100 specific clinical areas (EuroQol Group 2009a). As of November 2009, literature searched via OVID for instances of the EQ-5D reported in the title or abstract returned 1,738 published articles.

Validity and reliability

Paramount to an injury study using an outcome measure is the validity and reliability of the measure in an injury population. The EQ-5D has shown good test-retest reliability (van Agt, Essink-Bot et al. 1994), as well as a high level of construct validity and responsiveness to HRQoL changes in studies evaluating the EQ-5D in a wide variety of populations (Glick, Polsky et al. 1999; Bushnell, Martin et al. 2006; Sakamaki, Ikeda et al. 2006; van der Zanden, Dijkgraaf et al. 2006; Janssen, Birnie et al. 2007). A comprehensive assessment of the performance of the EQ-5D in a general injury population had not been completed at the time of writing, further warranting an in-depth systematic literature search of studies utilising the EQ-5D in injury populations.

Literature review: EQ-5D outcomes in injury populations

In 2008 a literature review was undertaken to retrieve and describe papers using the EQ-5D within injury populations. This literature review was subsequently published (Derrett, Black et al. 2008). Following this review, the research questions for this MPH thesis were refined. The aims of the literature review relevant to this thesis were:

1. Systematically search for published studies of outcome following injury where the EQ-5D had been used.
2. Describe the administration of the EQ-5D.
3. Summarise the use of the measure across injury and injury sub-types.

Methods

A systematic literature search was conducted in May 2008 of research published between January 1990 and May 2008. This time period covered the introduction of the EQ-5D (Dolan, Gudex et al. 1995), through to the date the literature review was undertaken. Online databases CINAHL and MEDLINE were searched via the portals EBSCO and OVID respectively. The terms (EQ-5D OR EQ5D OR Euroqol OR EuroQol OR EuroQol-5D) were searched against the mapped and exploded headings of: ("wounds and injuries+" OR "wounds, penetrating+" OR "wounds, non penetrating+" OR "surgical wounds+") AND ("outcome assessment" OR "outcomes (Health Care)" OR "Quality of Life+"). Exploding terms within the inbuilt Medical Subject Headings (MeSH) insured that the sensitivity of the search within EBSCO and OVID was higher than would be available via other search platforms (Jeroan, Catarina et al. 1999; Darmoni, Thirion et al. 2001). The Web of Science was searched via the Web of Knowledge platform. (Topic= (EQ-5D OR EuroQol)) was searched against (Topic= ("Quality of Life")) and (Topic= (injury)). The Australia New Zealand Clinical Trials Registry, the U.S. National Institute of Health's clinicaltrials.gov and the ISRCTN Register were searched for "EQ-5D". Results were further screened manually. While the results of this search were not utilised in the literature review, the authors were contacted for the subsequent individual patient data meta-analysis. SCOPUS and GOOGLE Scholar were searched using the condition: ((EQ-5D OR EQ5D OR Euroqol OR EuroQol OR EuroQol-5D) AND (Injury OR Wound)). Completed thesis and dissertations were searched via the web portals of the Australasian Digital Thesis Program, the Interdisciplinary Dissertations and Thesis Register (ProQuest) and the Index to Thesis Register (Which holds only theses from the United Kingdom). The Journal of Injury and the Journal of Trauma were searched via Science Direct and Ovid respectively for an instance of EQ-5D, EuroQol or EQ5D. The EuroQol group database was manually searched for any injury studies.

References of found studies and direct contact with authors known to be using the EQ-5D was used to identify additional papers. The inclusion and exclusion criteria used in this literature review were replicated in the main study, and is presented within the main study methodology (pg 15).

Results

The literature search retrieved 79 potentially eligible articles (Figure 1). Study protocols retrieved from clinical registries were set aside if the protocol indicated the study would complete follow up by 2009, and were not included in this literature review. A total of 44 studies met the inclusion criteria for the literature review. Of these 31 were independent studies of injury, 10 were highly associated with injury (e.g. knee cartilage surgeries), and three were publications of the same dataset with an adjusted inclusion criteria for the analysis or examining differing variables. Of the excluded studies: three only collected injury as an outcome at follow-up, 11 exclusively recruited people with a degenerative condition, three were theoretical exercises, four were duplicated datasets, eight did not report EQ-5D results, four were literature reviews, one utilised a discontinued EQ-6D (which is distinct from the EQ-5D+C), and one study appeared to be incorrectly indexed with the EQ-5D label.

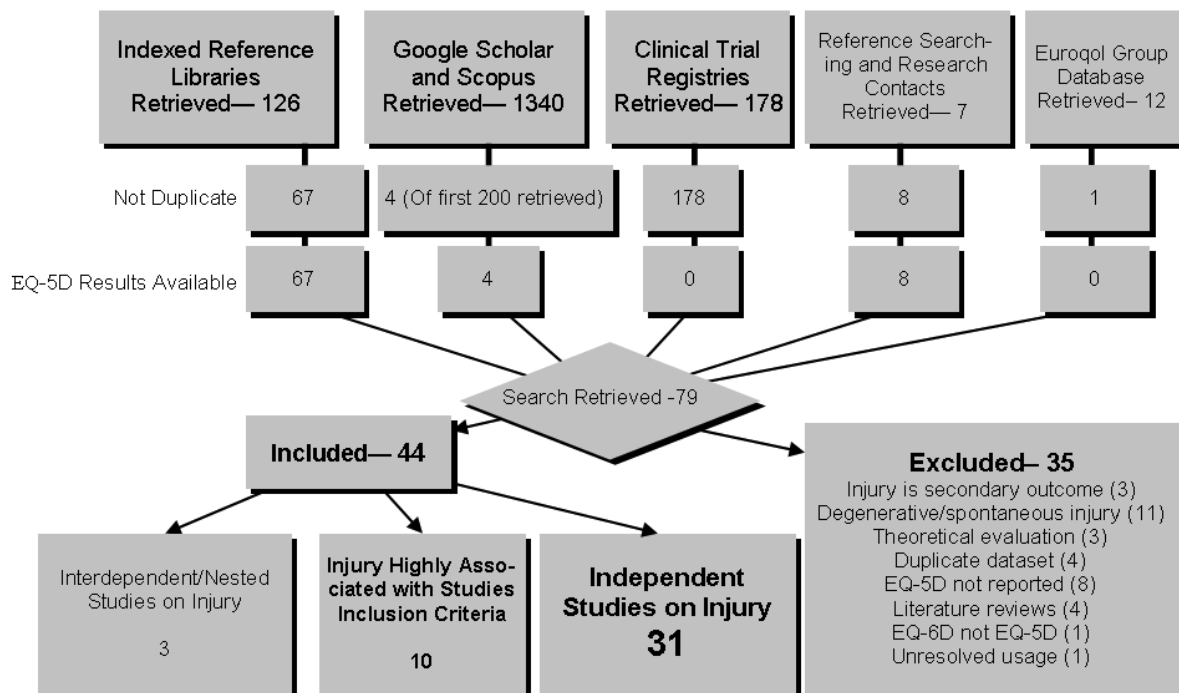


Figure 1 Retrieved studies. *Reproduced from (Derrett, Black et al 2009)*

To illustrate the uptake of the EQ-5D across injury the 41 distinct datasets are broken down by injury region in Figure 2. Uptake of the EQ-5D has been in highest in studies of the lower limb (n=18) and all injury populations (n=8), with these two populations representing 63% of studies to date. While the EQ-5D has been applied in other injury region sub-types, there are fewer datasets.

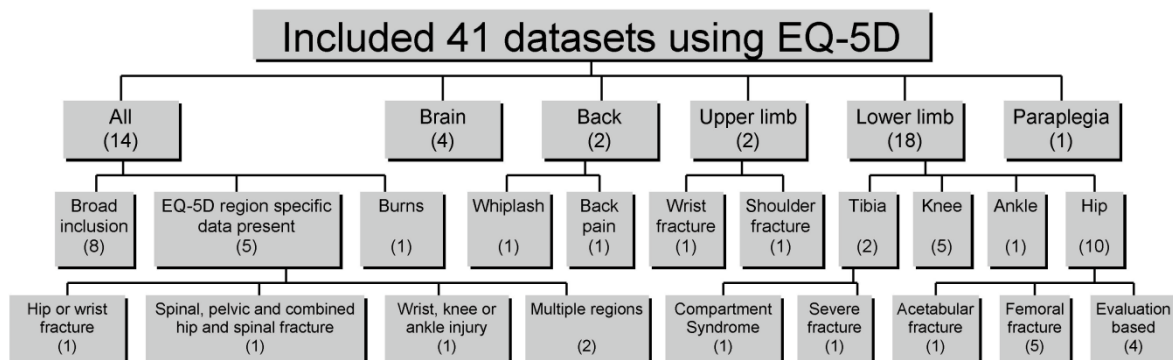


Figure 2 Flowchart of datasets using the EQ-5D in injury. *Reproduced from (Derrett, Black et al 2009)*

The included studies showed a great deal of variation in the application and presentation of the EQ-5D. Only nine studies (23%) reported the dimension scores, VAS and mean index scores. The time from injury to EQ-5D measurement varied from 6 days to 7 years. The majority of the studies were completed in developed countries.

While a comprehensive assessment of the performance of the EQ-5D in injury populations was not present, researchers have noted facets of the measure's importance within studies. A study of femoral neck fractures highlighted a possible lack of sensitivity to substantial changes in clinical health (Tidermark, Zethraeus et al. 2002). The EQ-5D was found to correlate with the SF-36 and Coping Strategies Questionnaire in neck fractures (Peolsson and Gerdle 2004). It was also found to correlate with the Katz index, a measure of functional ability and independence (Tidermark, Zethraeus et al. 2002).

Conclusions from current literature

The EQ-5D proved to be used across the spectrum of injury research, and with 16 of the datasets retrieved being from 2005 and later, it appeared to be continuing to build a stable presence in injury research. The validity of the EQ-5D in injury appeared to be assumed, or inferred from general population studies, in the majority of injury studies included (Derrett, Black et al. 2009b). Although, Derrett, Black et al note a possible lack of face validity being inferred by the inclusion of the *cognitive function* dimension within seven of the included studies. The literature search highlighted that a large amount of data on EQ-5D injury outcomes was present in the 41 datasets retrieved. These datasets covered many injury regions of particular interest to injury researchers (like hip fractures), and provided eight “all injury” datasets to provide injury details on a comprehensive range of injury subtypes.

This literature review aimed to establish the use of the EQ-5D in injury research, in order to enable an analysis of EQ-5D assessed HRQoL after injury. As the largest study retrieved from the search contained only 3,231 participants, a single study would not have the statistical power to conduct an analysis of all injury and still investigate less common injuries. This made the use of a meta-analysis a more practical choice as resources were not limitless. A high degree of heterogeneity was also present in the populations studied, making a traditional pooled meta-analysis of the dataset problematic. Furthermore only nine studies presented all the EQ-5D facets, making an analysis of published data impractical. This led to the conclusion that an individual patient data meta-analysis would enable a better understanding of EQ-5D outcome after injury.

Aims

Following the literature review, which included a systematic literature search of all studies involving the EQ-5D and injury outcome, the following aims were defined.

1. To identify and source primary individual patient data (IPD) of EQ-5D outcome following injury.
2. Produce descriptive norms of EQ-5D outcome according to: anatomical region of injury and injury type subsets (e.g. burns).
3. Examine the suitability of the EQ-5D within different injury type subsets.
4. Compare the burden of different types of injury.

Many injury studies identified in the literature study investigated only specific types of injury. Also, the study populations had diverse profiles. This prevents a wider descriptive portrait of EQ-5D outcome across injury type being deduced. By identifying and sourcing IPD data a descriptive norm can be produced via a mixed model, which will provide a population-level benchmark of outcomes after injury. The produced norms will enable an appreciation of relative quality of life estimates for different injuries, and help better understand the recovery profile of injury populations. By exploring injury through injury sub-groups used in cost-utility analysis (the Eurocost injury classification scheme), the HRQoL recovery profiles will be of immediate aid to policy makers.

Methods

This thesis comprised three stages, as represented in Figure 3. The first stage of the study was to identify and quantify the use of the EQ-5D in injury studies. This is presented in the previous chapter of the thesis. Following the identification of heterogeneous studies, the process of establishing contact with researchers and collecting individual patient data began. Near the end of collection a bridging search was run to ensure all available studies were collected that had recently been published. Finally, the collected datasets were analysed using multilevel mixed effects models, and the results presented.

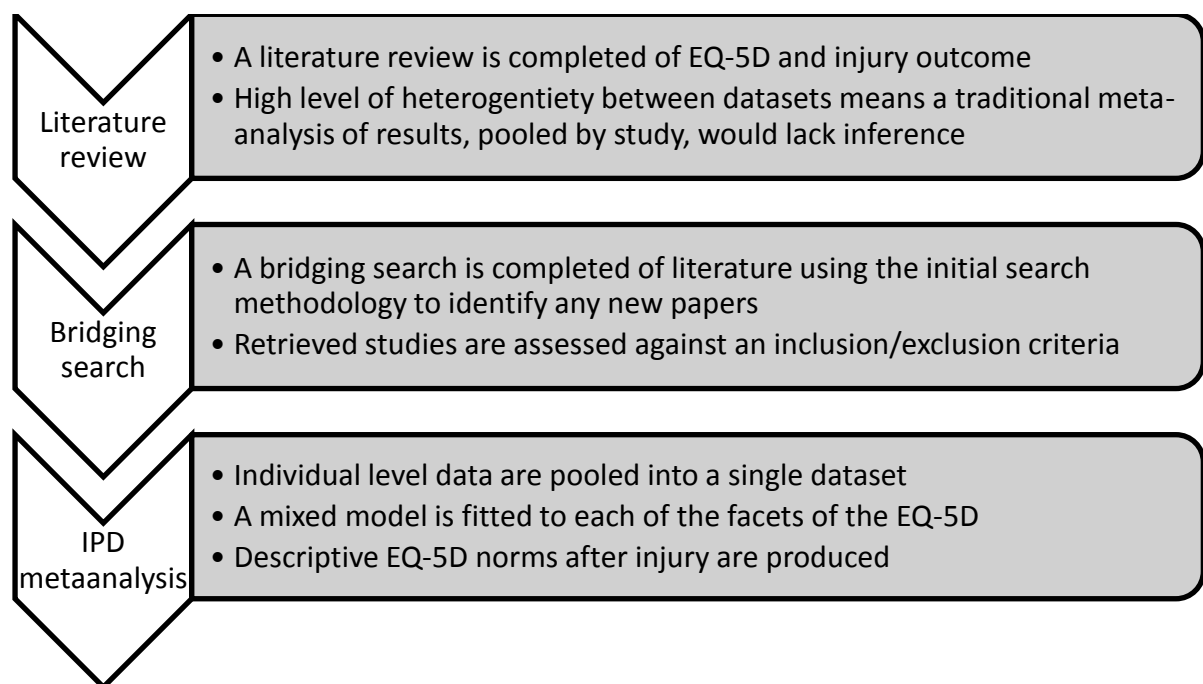


Figure 3 Stages of this thesis

Design

An individual patient data meta-analysis design was most appropriate. All persons from an injury study using the EQ-5D before December 2008 were eligible. Study datasets were collated into a hierarchal meta-dataset. A multilevel mixed effects model was applied to analyse subsets.

Ethical approval and consultation

Departmental ethical approval was gained for a Category B study, using de-identified human participants data. A proposal of this study was also submitted to the Ngāi Tahu Research Consultation Committee in November 2008. No concerns were noted.

Intellectual property provisions

Contact with an author also led to the creation of a Data Use Agreement (Appendix II). This was made available, at request, to reassure any concerns about security or dissemination of a studies data. The contract ensured that no individual or study level data could be released. Doing so complied with the Ethics approval obtained for the original studies, as well as protecting the information for future publications by the original researchers.

Collecting data

Bridging search

The majority of studies eligible for inclusion were identified in the preceding literature review. A bridging search through to December 2008 was run with the same protocol as the original literature search.¹ Additionally, ongoing studies identified from Clinical Trial Registries were now eligible for inclusion due to the use of individual level data not requiring previous publication.

Inclusion and exclusion criteria

For inclusion, the research was verified as a primary analysis involving the evaluation of outcomes after injury using the EQ-5D.

Injury definitions can vary greatly, and in accordance with literature recommendations (Cryer and Langley 2008), an exact definition of injury for this study was chosen. The energy definition requires the exchange of energy producing discernable effects (Robertson 1998). As detailed in a narrative literature review by Langley, this provides an inclusive injury definition that extends to the absence of energy as in asphyxiation and frostbite (Langley and Brenner 2004). This definition is refined to include injuries that involved the exchange of small amounts of energy; or cumulative events leading

¹ The search methodology is already presented on page 9.

to injury. An example being tennis elbow², which is the result of many macro and microscopic tears within the forearm (Nirschl and Pettrone 1979).

Studies were excluded if: sustaining an injury was not a baseline variable (e.g. a study of quality of life in heart patients, with possible injuries assessed at follow up), the presence of a degenerative condition was required for inclusion³ (e.g. Quality of life outcomes in patients with osteoporosis), or the EQ-5D was not actually applied.

Data collection

Study profiles were constructed via two tables to ensure systematic retrieval of relevant information. Researchers of included studies were contacted requesting inclusion of their datasets into the meta-analysis via email. An electronic data file preferably in Stata format was requested (Appendix III). If not available any digital format was readily accepted. The researchers were requested to provide the datasets in a de-identified state with accompanying data dictionary if relevant.

Contacting authors

With inclusion, authors were invited to become part of an “EQ-5D Injury Outcome Collaborators Group”, allowing their contribution to be noted in this thesis as well as any reports or publications arising from this research. An attempt at contact was made with the corresponding author of all included studies. If the initial contact did not return a response within one-month several reminders were sent. Where the respective email server returned email contact or there was no response within two months, current author details were retrieved though tracing the researchers via the internet and research affiliations. As a last resort co-authors and the last known employer were contacted.

Information sought

In addition to individual level EQ-5D data at each collected time point, variables were requested to contextualise the EQ-5D results. General baseline data of: age, birth date, employment, socio-economic status (SES), ethnicity and sex were sought. As the study involved foreign datasets SES and ethnicity were collected, but did not feature in the analysis due to the meaning, method of collection and impact of this data differing by nation. To describe the injury sustained the: Eurocost coding, anatomical region of injury (Table 2), type of injury (Table 3), injury description (free text),

² Referring specifically to lateral epicondylitis

³ A degenerative condition could still exist within the study population, as long as the condition was not exclusively selected for in the inclusion criteria.

date of injury, ISS and ICD 10 scores, if work-related, if they were an inpatient and any data on reported co-morbidities were collected. The five dimensions of the EQ-5D, as well as the VAS and the additional cognitive dimension were collected if it was applied (Hoeymans, van Lindert et al. 2005). Time from injury was collected for each application of the EQ-5D.

Recoding

Recoding of the dataset was completed via Microsoft Excel in a tab-delimited file. As studies could be expected to collect variables that could be mapped to requested variables, recoding was done where it would not affect data integrity. If possible the inclusion criteria (e.g. an exclusively inpatient population inferring all could be coded as hospitalised) was used to code a variable. Higher-level variables were also used to recode into the variables we sought. This was only where a detailed variable was collapsed to a less detailed variable (i.e. the full Abbreviated Injury Score (AIS) into Eurocost) or the variables were essentially analogous (e.g. type of employment recoded into a dichotomous employed or not employed).

The majority of this coding was completed by hand, and with formulae in Microsoft Excel. If free text injury descriptions were recoded into Eurocost, injury type and/or anatomical location, coding was repeated to ensure accuracy.

Injury details were translated into the variables of anatomical location and injury type following the definitions shown in Tables 2 and 3 respectively. Strains, sprains and dislocations were not differentiated due to the crossover in what type of injury the terms quantify.

The coded dataset was read into Stata v10.0 using the *insheet* function.

Eurocost group	Variable scope
1) Concussion	Concussion only
2) Skull-brain injury	Injury to the skull or brain, including traumatic brain injury
3) Open head wound	Open laceration/cut to the face or head
4) Eye injury	Injury to the eye
5) Fracture of facial bones	Fracture of facial bone
7) Vertebral column	Fractures, dislocations, sprains and strains
8) Whiplash	Sprain, strain, distortion of the cervical spine
9) Spinal cord injury	Incomplete and complete lesions of the spinal cord
10) Internal organ injury	Injuries to organs of the abdominal cavity
11) Fracture rib/sternum	Fracture of ribs or sternum
12) Fracture of clavicle/scapula	Fracture of the clavicle or scapula
13) Fracture of upper arm	Long bone fracture of the upper arm
14) Fracture of elbow/forearm	Fracture of the elbow or forearm joint
15) Fracture of wrist	Fracture of the wrist (inc. carpal bones)
16) Fracture of hand/fingers	Fracture of the hand or fingers
17) Shoulder injury	Sprain, strain or dislocation of the shoulder
18) Wrist/hand injury	Sprain, strain or dislocation of the wrist or hand
20) Upper extremity complex	Sub dermal laceration involving tendons
21) Pelvis fracture	Fracture of the pelvis
22) Hip fracture	Fracture of the hip
23) Femur shaft fracture	Fracture of the femur
24) Knee/lower leg fracture	Fracture of the knee or lower leg
25) Ankle fracture	Fracture of the ankle
26) Foot fracture	Fracture of the foot
27) Knee injury	Sprain, strain, distortion of the knee
28) Ankle/foot injury	Sprain, strain, distortion of the ankle/ foot
29) Hip injury	Sprain, strain or dislocation of the hip
31) Lower extremity complex	Sub dermal laceration involving tendons
32) Superficial injury	Including minor lacerations (superficial), contusions and abrasions
33) Open wounds	Open lacerations (excluding involvement of specific tendons)
34) Burns	Burns from chemicals, lack of heat and excess heat
35) Poisoning	Poisonings
36) Multi-trauma	Eligible for multiple Eurocost groups (excluding superficial injury)
37) Foreign body	
Codes 6, 19, 30, 38 dropped	

Table 1 Eurocost coding, nerve injuries & no-discernable injury groups were dropped, adapted from (Polinder & Meerdering, 2008)

Anatomical location of injury	Variable definition
Brain	Brain injury, concussion
Hip	Injury to hip region
Lower limb	Injury to lower limb
Upper limb	Injury to upper limb
Back	Injury to the back and/or vertebral column
Torso	Injury to the chest and/or abdomen
Neck	Injury to the neck and/or the cervical spine
Face	Injury to the face and/or superficial injuries of the scalp
Multiple major trauma	Injuries were present in multiple anatomical regions

Table 2 Location of injury

Type of injury	Variable definition
Burn	Injury was reported as a temperature, chemical or radiological burn
Fracture	Fracture of a skeletal bone was reported as the principle injury
Open wound	Underlying flesh was exposed
Joint cartilage tear	Joint injury was confirmed as being an articulating cartilage tear or deformation
Poisoning	Poisoning was reported as the mechanism of injury
Internal organ injury	Injury of an internal organ was the sole injury (including brain, concussion)
Foreign body	Injury was caused by the introduction of a foreign body
Superficial tissue	Superficial injury that did not qualify as an open wound (e.g. hematomas)
Sprain, strain or dislocation	Injury was reported as a sprain, strain, dislocation, stretched muscle, tendon or ligament
Amputation	Loss of limb (including phalanges)
Pinched nerve	Only injury reported was a “pinched nerve”
Multiple major trauma	Multiple types of injury

Table 3 Injury types coded for in the dataset

Data analysis

Dataset hierarchy

The final dataset contained baseline variables, EQ-5D responses and information on the type of injury sustained. Specific injuries were regressed separately by using subsets from the dataset. Observations were tagged with a variable to identify which study they came from. Sub-groups were created from three variables; Eurocost codes (Table 1), recorded injury type and anatomical location. Eurocost codes produce 38 discrete injury subgroups⁴, although more specific subgroups were available from injury type and anatomical location where it was of interest.

Within each subgroup a hierarchy exists. At the atomistic level is the measurement occasion, or rather each time a person was interviewed using the EQ-5D. At the next level are the particular participants, who are then clustered within the 3rd level, the different studies. Figure 4 shows the example of the injury subset for a fractured hip. In Study 1 only a baseline measurement of EQ-5D was completed (1 month after injury). Study 2 did not feature hip fractures and is not part of this subset. Study 3 had three follow up points (1,2 and 3 months after injury), although person one was lost to the final follow up. All injury subtypes were analysed within this hierarchy.

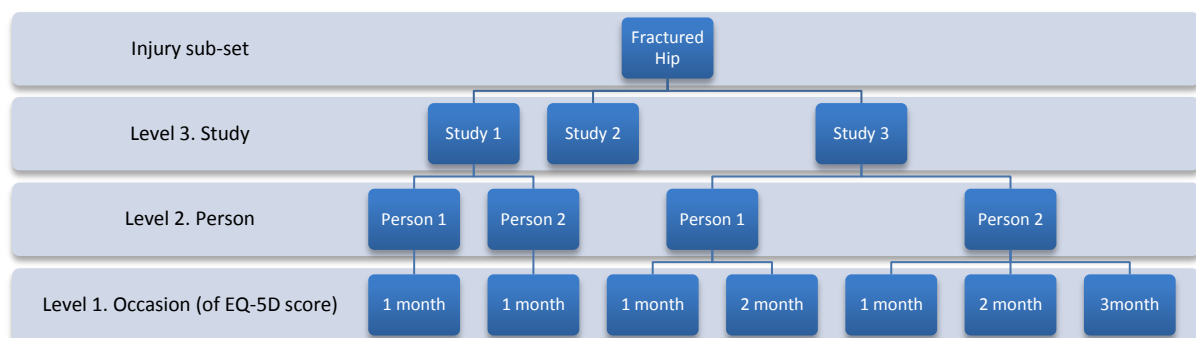


Figure 4 Subset hierarchy

⁴ An additional group, amputations, was appended to the defined Eurocost codes.

Multilevel mixed effects linear modelling

As the EQ-5D features both an ordinal (dimensions) and continuous (VAS) scale, two types of model were used. For the VAS, which is a subjective assessment between 0 and a 100, a linear model was used.

While as many potential covariates as possible were collected; it became apparent early in the collection of IPD data that only a few common covariates were available across the studies. These were age, sex and time from injury to the application of the EQ-5D.

In ordinary least-squares regression a common assumption is covariates have an equal effect on each observation. So, using age as an example, basic linear regression assumes that the relationship between EQ-5D scores and age does not differ between studies, people, or EQ-5D measurement occasion. Instead variation in the relationship between studies only occurs where the participant's EQ-5D responses theoretically start (the intercept).

This assumption cannot be made for this dataset. The design brings together many different datasets, with different external influences and differing inclusion criteria. As such it is not feasible that we could assess every possible variable that dictates this heterogeneity (Sheiner 1991). To address the heterogeneity a multilevel mixed effects linear model was applied to each injury subset. Here the basic regression effects are still used (fixed effects) but the idea is expanded to factor in effects (called random effects) that could exist between different studies. The random effect allows more realistic errors to be produced, by assuming that a collected variable could have a different relationship with the EQ-5D score depending on which study it came from. For instance lack of employment at the time of injury may lead to very different recovery pathways within different health systems (i.e. studies). By fitting employment status as a random effect at the level of study we acknowledge that the different study samples may have substantial differences in healthcare access to unemployed, and thus we can control for this heterogeneity between studies.

Further, the mixed effects model, via random effects, assumes that the study population is a random sample of individuals from a random sample of groups. This allows the model to be used to make inference of where the population values lie, rather than just estimates of the sample means (Hox and Kreft 1994).

Multilevel mixed effects logit modelling

The dimension scores for the EQ-5D are ordinal responses from one to three. The linear model assumes that the difference between a score of no problems (1) and some problems (2) is the same as some problems and extreme problems (3). The interval between increments in the dimension scale is not fixed though, which means that an analysis using a standard linear model would not be valid. Multilevel modelling of non-continuous responses is relatively undeveloped, leading to strong methodology only existing for dichotomous responses (Rodriguez and Goldman 2001). The EQ-5D scores were thus dichotomised into problem or no problem across the dimensions. Within the logit model the methodology for assessing fixed effect coefficients was analogous to standard regression. The random effects were estimated from their variances and covariance's, rather than directly (Breslow and Clayton 1993).

Stata

Normative data for VAS was modelled via the *xtmixed* function of Stata. The regression coefficients and variance components of the model were estimated using the Restricted Maximum Likelihood (REML) method. This method is seen as robust in the literature (Eliason 1993). The REML method estimates variance components, after first removing the effect of fixed effects. The *xtmixed* function produces general estimates of the various parameters. Stata then uses an algorithm to produce new, more precise, iterations until the difference between the estimations becomes trivial. At this point it is assumed that the estimations for the model have converged, and a mixed effect model has been fitted. Where too many variance components were fitted, and they were very close to zero, Stata was unable to reach a point of "convergence". As such, the exact model and random variance components used differed for each analysis. As a general rule a simple multilevel model with age and sex as fixed effects was created. Variations were then made with the addition of random effects based on the estimations produced. The effect of variations on the Wald statistic, as well as changes in the strength of the predicted coefficients, was used to decide if additional random effects at any level of the model allowed a better model to be fitted. Additionally, the variable of time since injury was transformed by a square function. This function best represented the trends that appeared in scatter plots of the raw data. By transforming the variable of time, curvature of the EQ-5D predictions was possible within the models.

The EQ-5D dimensions were modelled using the Stata function *xtmelogit*. This command was developed to fit multilevel models to binary responses. This is because the same method used for the VAS cannot be applied to the ordinal scale, which has been dichotomised, of the EQ-5D dimension scores. Binomial regressions produce relative coefficients rather than absolute

coefficients. The method used by Stata to integrate out the random effects is adaptive Gaussian quadrature (Pinheiro and Chao 2006; Gutierrez 2007). This integration method produced results with less bias than both the penalised quasi-likelihood and marginal quasi-likelihood equations (Green 1987; Breslow and Clayton 1993; Pinheiro and Chao 2006; Gutierrez 2007).

For presentation, results were adjusted to 35 years of age or 75 years of age depending on the mean age of the population when they sustained an injury. This was to allow comparisons between injury sub-types.

Model fit was examined by plotting the residuals. Raw data scatter graphs were also used to visualise the data before fitting a model. Significance for the estimated parameters were estimated from the Wald test (Wald 1943). 95% Confidence Intervals (95% CI) were defined as an indication that significant inference was possible from the results.

Interpreting the predictions for the dimensions

Each dimension prediction produced a linear predictor (z_{ij}) of the odds of having a problem in a particular dimension within a single injury group. These linear predictors were then expressed as predicted probabilities (π_{ij}). The formula used is as follows:

$$\pi_{ij} = \frac{\exp(z_{ij})}{1 + \exp(z_{ij})}$$

Results

The identification, collection and processing of individual patient data spanned from December 2008 to July 2009. The profile of the populations present in the collected studies, as well as those not presented, are integral to statistical validity of any inference to the true injury population norms. Because of this a profile of the dataset is presented first. The predicted injury population means are then presented by the Eurocost injury classifications (Polinder, Meerdering et al. 2008b).

Collected datasets

In total 21 datasets were collected from 18 discrete studies providing individual data for 10,496 people. Three studies divided their participants into two datasets; subject to age (Polinder, van Beeck et al. 2007), hospitalisation (Barnes 2006) and the presence of a nested cohort (Klose, Watt et al. 2007). The median number of participants in each study was 172.5; with a range from 37 to 3758 (Table 4). Table 4 shows that 8188 participants were from studies of 'all injury'.

In total 110 participants were from a study primarily looking at the long term (6 months to 27 years) effects of brain trauma (Klose, Watt et al. 2007), with an additional 306 participants from an all injury study who had sustained skull-brain injuries. Hip fractures were represented in four studies with a total of 743 persons (Keating, Grant et al. 2005; Lindahl, Garellick et al. 2006; Ryan, Enderby et al. 2006; Frihagen, Grotle et al. 2008), with an additional 284 hip fractures being present in the all injury studies. Knee joint injuries were also well represented with 1049 diagnosed specifically with suspected chondral or osteochondral lesions (Hollingworth, Mackenzie et al. 1995; Derrett, Stokes et al. 2005; Marcacci, Berruto et al. 2005; Bridgman, Richards et al. 2007; Garratt, Brealey et al. 2008), and an additional 421 persons identified within the all injury studies sustaining a sprain, strain or dislocation of the knee. Notably amongst the dislocation, sprains and strains injury populations, knee was the only region where a subset of possible chondral or osteochondral lesions exists in this study. Within this lesion subset the identification of the injury resulting from trauma was not stressed by the studies, and an unknown proportion are possibly degenerative in nature.

Datasets included in the analysis				
Study title	Principal author/ investigator	Location of study population	Study population	n
All injury (n=8188)				
Using the EQ-5D to measure changes in quality of life 12 months after discharge from an intensive care unit	Badia, X	Spain	Trauma victims that are discharged from an Intensive Care Unit (ICU). Injury types not collected.	81
An exploratory study of road crash survivors: injury outcomes and quality of life	Barnes, J	United Kingdom	Two arms were evaluated. One being a self selected cohort of people involved in a road crash. The second arm were hospitalised road crash survivors.	120
Prospective outcomes of injury study (pilot study)	Derrett, S	New Zealand	Pilot study population analogous in inclusion criteria to that of the full study.	107
Prospective outcomes of injury study	Derrett, S	New Zealand	Injured persons from the Accident Compensation Corporation (ACC) entitlement claims register. Participants were likely to of spent the equivalent of one or more weeks away from work.	2604
Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands <i>and</i> Prevalence and prognostic factors of disability after childhood injury	Polinder, S	Netherlands	Been admitted to an emergency department.	3758
The UK burden of injury study	Lyons, R	United Kingdom	Attended an emergency department or admitted to hospital with an injury.	1518
Traumatic brain injury (n=110)				
Posttraumatic hypopituitarism is associated with an unfavourable body composition and lipid profile, and decreased quality of life 12 months after injury	Klose, M	Denmark	Traumatic brain injury with a Glasgow Coma Score of less than 15.	110
Hip injuries (n=733)				
Hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: Randomised controlled trial	Frihagen, F	Norway	Previously ambulant patients with displaced intracapsular femoral neck fractures who received surgical interventions.	222

Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty	Keating, J	United Kingdom	Previously independent persons who received surgical interventions for displaced intracapsular hip fractures.	233
Three hundred and twenty-one periprosthetic femoral fractures	Lindahl, H	Sweden	Received treatment for a periprosthetic hip fracture.	217
A randomized controlled trial to evaluate intensity of community based rehabilitation provision following stroke or hip fracture in old age	Ryan, T	United Kingdom	Diagnosed with a hip fracture over the age of 65. Stroke participants were excluded from this meta-analysis.	71
Lower limb injuries (1049)				
The effect of magnetic resonance imaging scans on knee arthroscopy: randomized controlled trial	Bridgman, S	United Kingdom	Patient's eligible to receive arthroscopy for knee injury, although receiving surgery was not required for inclusion.	252
Cost and health status analysis following autologous chondrocyte implantation and mosaicplasty: a retrospective comparison	Derrett, S	United Kingdom	Participants were awaiting or had recently received surgery for chondral or osteochondral lesions of the knee.	79
Development of the knee quality of life (KQoL-26) 26-item questionnaire: data quality, reliability, validity and responsiveness	Garratt, A	United Kingdom	All patients referred for an MRI or orthopaedic consultation, and all patients listed for arthroscopic surgery of the knee within the catchment of two major hospitals.	553
Measuring Changes in Quality of Life following Magnetic Resonance Imaging of the Knee: SF-36, EuroQol or Rosser Index?	Hollingworth, W	United Kingdom	Participants with knee injuries that warranted use of MRI as a diagnostic technique.	37
Articular cartilage engineering with Hyalograft C: 3-year clinical results	Marcacci, M	Italy	Patients receiving autologous chondrocyte implantation for chondral or osteochondral lesions of the knee.	128
Other specific injuries (n=406)				
A longitudinal study of the life histories of people with Spinal Cord Injury (SCI)	Sullivan, M	New Zealand	Experiencing a SCI	40
The transition from acute to subacute and chronic low back pain	Kovacs, F	Spain	Presenting with acute lower back pain at a general practice.	366
Total number of participants				10496

Table 4 Datasets included in the analysis

Datasets not retrieved

In total 21 datasets identified in the literature search were not retrieved (Table 5). Individual patient data was not retrieved for more than 3289 people, across 21 studies. In total 24% of the individual patient data sought was not retrieved (Alderman, Dawson et al. 2001; Bryan, Weatherburn et al. 2001; Oppe and De Charro 2001; Giannoudis, Nicolopoulos et al. 2002; Lash, Horne et al. 2002; Goodwin, Morrissey et al. 2003; Tidermark, Bergstrom et al. 2003; Gopal, Giannoudis et al. 2004; Peolsson and Gerdle 2004). Collection rates were poorest in TBI specific studies, were only 32% of the 347 participant's patient data was collected.

One author declined due to ethical concerns over any information being used outside the context of the initial ethics approval. The remaining researchers: had either not retained the original data (n=3), initially experienced willingness but did not supply a dataset by cut-off (n=2), were under resourced to participate (n=2) or were unable to be contacted (n=13).

Patient data not retrieved	n
All injury	
All injury with an ISS $\geq$ 16 at admission	521
ICU trauma admission	239
Injury incidents requiring deployment of a mobile trauma team	517
Total all injury	1277
Traumatic brain injuries (TBI)	
TBI	52
TBI population eligible for in home rehabilitation	157
Registered a GCS of 13-15, 5-7 years after TBI	28
Total TBI	237
Hip fractures	
Subtrochanteric or trochanteric fractures	142
Hip fracture injuries	409
Total hip fractures	551
Lower limb injuries	
Knee joint injuries being considered for surgery	118
Tibial compartment syndrome and tibial fractures (as a control).	59
Diagnosis of a patellofemoral full-thickness chondral defect	32
Post knee surgery (arthroscopic partial menisectomy)	84
Severe tibial fractures	29
Ankle fractures	74
Traumatic injury of the wrist, knee or ankle	500
Total lower limb injuries	896
Other injuries	
Traumatic paraplegia patients.	23
Whiplash associated injuries.	275
Combined pelvic and spinal fractures.	30
Total other injuries	328
Total number of participants	3289

Table 5 Individual patient data not retrieved

Study population profile

Individual level patient data were collected for 10,496 persons, aged between 5 and 100 years old.

Within the collected dataset injuries were present to a greater degree in males aged less than 40 years (Table 6) and to a greater degree in females beyond 60 years of age; with females representing 47% of all injuries. The participants were sourced from eight countries, but predominately The Netherlands (36%), United Kingdom (33%) and New Zealand (26%). The EQ-5D was collected 88 days post injury on average

(median 72). A total of 216 EQ-5D questionnaires were administered on the day of the injury, and the longest follow-up was 816 days following injury.

Study Profile	Male	Total
	n (%)	n (%)
Age group:		
5-40 years	3016 (63%)	4790
41-60 years	1818 (55%)	3331
61-100 years	879 (34%)	2588
All ages	5605 (53%)	10496
Regions:		
Denmark, Sweden, Norway		549 (5.2%)
Spain, Italy		575 (5.5%)
New Zealand		2751 (26%)
United Kingdom		3506 (33%)
Netherlands		3758 (36%)

Table 6 Study population profile

Variables retrieved

Amongst the collected participants, with at least one EQ-5D measurement, many variables sought for the meta-analysis were not collected by the researchers. The proportion of data missing for age (0.5%) and sex (1.1%) allowed age and sex to be used in the regression analysis. Other variables were missing in significant proportions to render them unavailable for analysis; hospitalisation (31%), employment (42%), method of EQ-5D data collection (51%), and comorbidities (65%).

Injury type representation

All 40 Eurocost injury categories were represented in the final dataset. Lower limb nerve injuries was the least represented Eurocost injury code (n=3), with knee joint injuries being the most prevalent (n=1464). In addition the categories of amputation and ICU admission were added to reflect the injuries collected.

Due to low numbers and an inability to control for severity some injury categories classifications were not used in the analysis: nerve injuries (n=25 from any anatomical site), open facial wounds (n=48), upper limb complex soft tissue injuries (n=92), open wounds (n=352), burns (n=104), poisoning (n=40), multi-trauma (n=94), foreign body related (n=42), and no injury after an examination (n=39) and other unspecified injuries (n=135). Amputations (n=24), a category added to Eurocost for this analysis, was also not modelled. A further sub group of unknown injury, but confirmed ICU admission (n=263), was present in the received data and was not suitable for modelling due to the varying severity, and presumed type, of injuries contained.

Eurocost category	n	(%)
Concussion	409	3.9%
Other skull-brain injury	306	2.9%
Open head wound	96	0.9%
Eye injury	105	1.0%
Fracture facial bones	142	1.4%
Open facial wound	48	0.5%
Vertebral column fractures/ dislocations/ sprain strain	862	8.2%
Whiplash, neck sprain, distortion of cervical spine	100	0.95%
Spinal cord injury	57	0.54%
Internal organ injury	123	1.2%
Fracture rib / sternum	187	1.8%
Fracture clavicle / scapula	189	1.8%
Fracture of upper arm	244	2.3%
Fracture of elbow / forearm	395	3.8%
Fracture of wrist (incl. carpal bones)	179	1.7%
Fracture of hand / fingers	313	3.0%
Dislocation/ sprain/ strain of shoulder	350	3.3%
Dislocation/ sprain/ strain wrist/ hand/ fingers	187	1.8%
Complex soft tissue injury (upper limb)	84	0.80%
Fracture of pelvis	114	1.1%
Fracture of hip	1027	9.8%
Fracture of femur shaft	103	0.98%
Fracture of knee/ lower leg	478	4.6%
Fracture of ankle	395	3.8%
Fracture of foot	296	2.8%
Dislocation/ sprain/ strain knee	1470	14%
Dislocation/ sprain/ strain of ankle/ foot	418	4.0%
Dislocation/ sprain/ strain of hip	75	0.71%
Nerve injury (upper or lower limb)	26	0.25%
Complex tissue injury (lower limb)	92	0.88%
Superficial injury	533	5.1%
Open wounds	352	3.3%
Burns	104	0.99%
Poisoning	40	0.38%
Multi-trauma	94	0.90%
Foreign body related	42	0.40%
No injury on examination	39	0.37%
Other injury	135	1.3%
Amputation*	24	0.23%
Unknown injury (ICU Admission)*	263	2.5%
<i>* Not a Eurocost category. Some Eurocost categories have been condensed due to very low numbers.</i>		
Total	10496	

Injury outcomes

Where models could be fitted, predictions for VAS and dimension scores of the EQ-5D have been presented for the Eurocost injury categories. Predictions were produced for the time periods that frequently were used in literature (1, 30, 120 and 360 days post injury). In addition to tables, general trends over the course of one-year post injury have been presented graphically. Where the relationship with time was weak, and presenting a trend may be misleading, the particular dimension or VAS predictions were omitted from the figures.

For 14 injury categories no predictions were produced. The exact reasons for failing to fit a model was most likely due to low sample size, combined with a broad level of severity being defined by the injury category itself. In some injury categories a model could not be fitted to only one or two measured EQ-5D outcomes (e.g. the cognitive dimension, where a measurable relationship to the injury may not exist). As the reasons for not making predictions in this instance are less universal they are justified within each injury category.

Results are adjusted to a 35 year old population in all injury predictions except hip fractures, where results are adjusted to a 75 year old population.

Head injuries

1. Concussion

Profile

The participants included all cases that would be diagnosed as a concussion (*commotio cerebri*). This diagnosis involves a trauma-induced change in mental status, which may manifest as confusion, amnesia and/or a brief loss of consciousness.

Age and sex profile		
Age	Male	n
5-39	61%	219
40-59	58%	114
60-94	53%	73
All	59%	406

Table 8 Age and sex profile of concussion injury group

A total of 406 persons, from 8 studies, who experienced a concussion were included in the analysis. The average age at time of injury was 39 years (SD=19.9, range 5-94). The injury group was predominately male (59%). Injuries between the ages of 5 and 39 contributed 54% of the total count of injuries.

The average number of times the EQ-5D was applied to each person was 2.1 times (range 1-4). On average, the EQ-5D was first administered 129 days following injury: the mean for subsequent observations was 227 days. The first measurement of the EQ-5D was 43 days after the injury. The last follow-up EQ-5D assessment was made 837 days after the date of injury.

The group norm values

Within the VAS a multilevel regression model was easily fit. This was despite initial application of the EQ-5D occurring 45 days post concussion. At 360 days the VAS score did not differ significantly from the initial scores predicted 45 days post injury.

Sustaining a concussion appeared to have minimal effects on EQ-5D dimension scores, with little effect being found in all dimensions except *pain and discomfort*. *Pain and discomfort* predictions showed a gradual rate of recovery. *Usual activities* experienced a greater level of impairment than *cognitive function*, but unlike *cognitive function* did not decrease at a steady rate over time. The presence of impairment did not appear to have a strong association with time in the remaining dimensions.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of any problem (95% CI)					
3	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*
120	73 (67,80)	0.049 (0.020,0.122)	0.030 (<0.001,0.019)	0.333 (0.123,0.630)	0.492 (0.231,0.762)	0.099 (0.041,0.219)	0.099 (0.017,0.422)
360	75 (69,82)	0.047 (0.018,0.115)	0.030 (<0.001,0.018)	0.265 (0.091,0.565)	0.281 (0.107,0.565)	0.115 (0.051,0.237)	0.025 (0.003,0.187)

Table 9 EQ-5D predicted norms for concussion adjusted to a 35 year old group *predictions were not made outside of the collected data

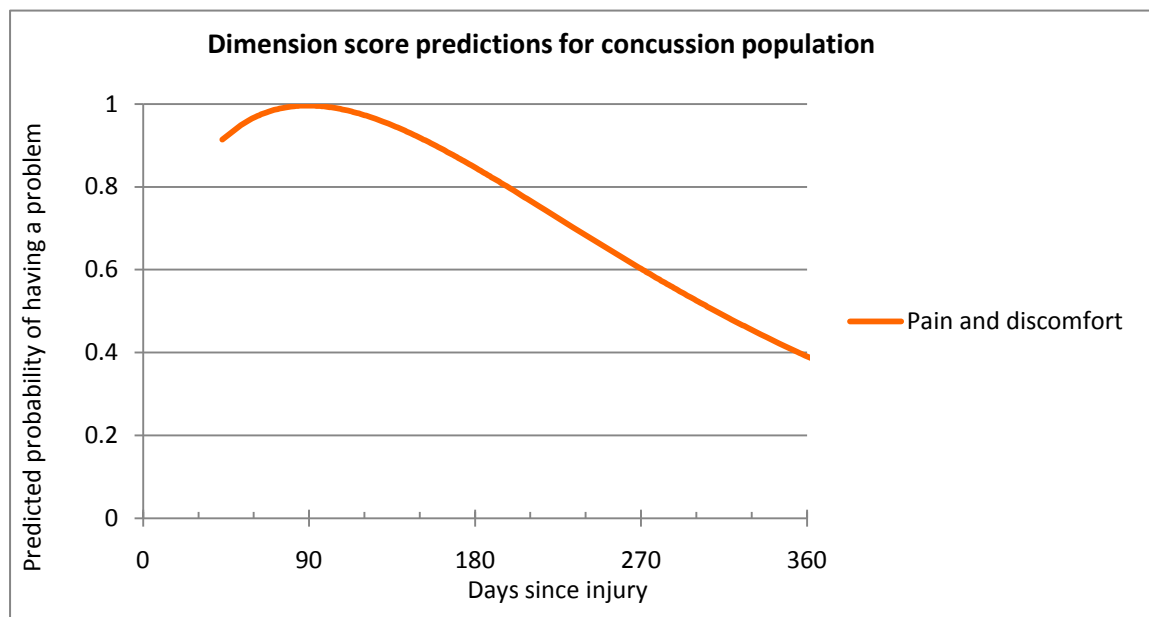


Figure 5 EQ-5D concussion dimension scores adjusted to a 35 year old population

2. Other skull-brain injury

Profile

The injury group included skull fractures (with or without facial fractures) and all intracranial injuries except concussions. Of the 306 participants, 110 had a confirmed TBI. A comparison of all skull-brain injury against TBI was not possible. This was due to all 110 cases being from a single study, with the publication of data from a single study contravening data use agreements (Appendix I). Confirmation of a TBI was unknown in the remaining participants.

Age and sex profile		
Age	Male	n
5-39	58%	154
40-59	54%	76
60-94	57%	76
All	57%	306

Table 10 Age and sex of skull-brain injury group

A total of 306 persons, from 4 studies, who fractured their skull, or received a brain injury were included in the analysis. The average age at time of injury was 41 years (SD=24, range 5-94). The injury group was predominately male (57%). Injuries between the ages of 5 and 39 contributed 50% of the total count of injuries.

The average number of times the EQ-5D was applied to each person was 2.4 times (range 1-3). On average, the EQ-5D was first administered 70 days following injury: the mean for subsequent observations was 222 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 601 days after the date of injury.

The group norm values

The VAS for the skull and/or brain injury group increased from VAS=73 at 30 days, to VAS=80 at 360 days post injury.

The model, while fitting the data, showed a great deal of variability was present across the EQ-5D dimensions. This variability in patient scores led to large confidence intervals being present around the predictions, meaning that statistically sound conclusions comparing the effect of the injury on each dimension is not possible.

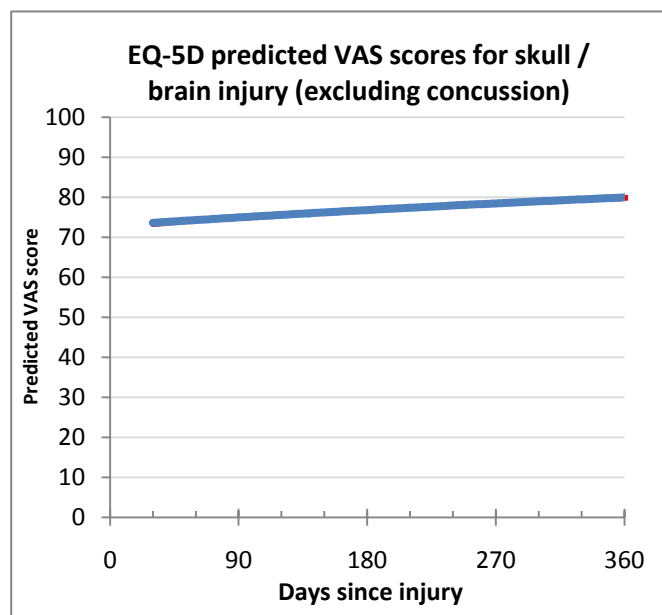


Figure 6 EQ-5D skull-brain injury VAS predictions adjusted to a 35 year old population

Across the broad group of skull-brain injuries the one-month and one-year predictions were found to differ in the predicted probability of having problems in *usual activities*. The association between time and problems in a dimension score was relatively weak across the remaining dimensions. Without a similar measure of severity being present across the studies it was not possible to control for severity across this discordant injury group. This discordance is particularly relevant in other skull-brain injuries as it includes minor skull fractures through to severe traumatic brain injuries.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having a problem (95% CI)					
3	*	*	*	*	*	*	*
30	73 (68,79)	0.063 (0.012,0.270)	0.0018 (<0.001,0.046)	0.477 (0.211,0.756)	0.320 (0.044,0.823)	0.339 (0.139,0.619)	0.487 (0.002,0.998)
120	76 (71,80)	0.023 (0.006,0.084)	0.001 (<0.001,0.018)	0.182 (0.101,0.306)	0.224 (0.031,0.720)	0.078 (0.037,0.156)	0.660 (0.004,0.999)
360	80 (75,85)	0.004 (0.001,0.030)	<0.001 (<0.001,0.010)	0.019 (0.005,0.070)	0.028 (0.003,0.236)	0.103 (0.037,0.257)	0.363 (0.001,0.996)

Table 11 EQ-5D predicted norms for skull-brain injury adjusted to a 35 year old group *predictions were not made outside of the collected data

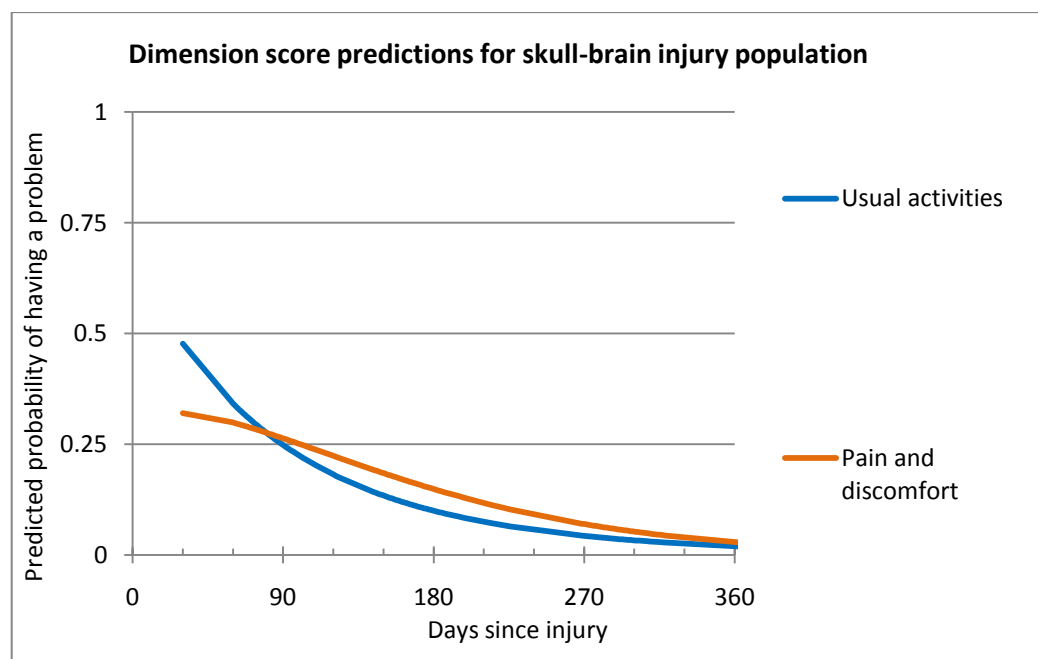


Figure 7 Dimension score predictions after skull-brain injury adjusted to a 35 year old population

3. Open wound head

Profile

The open head wound injury group only included open wounds to the scalp (including avulsions).

A total of 96 persons, from 3 studies, who experienced an open wound of the head were included in the analysis. The average age at time of injury was 42 years (SD=24, range 5-92). The injury group was predominately male (60%). Injuries between the ages of 5 and 39 contributed 54% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	67%	52
40-59	60%	15
60-92	48%	29
All	60%	96

Table 12 Age and sex of open head wound group

The average number of times the EQ-5D was applied to each person was 2.2 times (range 1-3). On average, the EQ-5D was first administered 57 days following injury: the mean for subsequent observations was 225 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

No measurements were collected in the first 30 days of injury, preventing predictions of the immediate impact on all aspects of HRQoL. Predicted norms for the VAS and dimensions did not show a significant variation from 30 days to one year after injury (Table 13). While a low increase in the predicted probability of problems in *pain and discomfort* was reported at 30 days (0.575 (95%CI 0.163,0.904) the predicted probability returned to that could be assumed to be basal levels of impairment in the group within two months. For the remaining dimensions the lack of marked change over time, coupled with large variability, meant an association of the injury with impairment could not be found.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having a problem (95% CI)					
3	*	*	*	*	*	*	*
30	79 (73,85)	0.009 (<0.001,0.309)	†	0.150 (0.034,0.475)	0.575 (0.163,0.904)	0.163 (0.035,0.508)	0.037 (<0.001,0.680)
120	80 (75,85)	0.006 (<0.001,0.109)	0.004 (<0.001,0.478)	0.098 (0.034,0.253)	0.073 (0.015,0.300)	0.045 (0.009,0.196)	0.011 (<0.001,0.153)
360	80 (75-85)	<0.001 (<0.001,0.096)	<0.001 (<0.001,0.294)	0.021 (0.002,0.197)	0.056 (0.004,0.464)	0.012 (<0.001,0.196)	0.003 (<0.001,0.255)

Table 13 EQ-5D predicted norms for open face wound injuries adjusted to a 35 year old population. † Observation at 30 days missing *Predictions were not made outside of the collected data

Face

4. Eye injury

Profile

The eye injury group included open wounds of the eyelid and any injury to the eye and orbit excluding the optic nerve and orbital bone fractures.

A total of 105 persons, from 5 studies, who experienced injury of the eye (including via a foreign object) were included in the analysis. The average age at time of injury was 41 years (SD=18, range 6-86). The injury group was predominately male (81%). Injuries between the ages of 6 and 39 contributed 53% of the total count of injuries.

Age and sex profile		
Age	Male	n
6-39	86%	56
40-59	72%	29
60-86	80%	20
All	81%	105

Table 14 Age and sex of eye injury group

The average number of times the EQ-5D was applied to each person was 1.9 times (range 1-3). On average, the EQ-5D was first administered 58 days following injury: the mean for subsequent observations was 229 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

A strong correlation between time and EQ-5D scores was not found in this analysis. Variability in initial and follow up scores differed greatly within this eye injury group. The predictions also produced a great deal of uncertainty around the estimates. Predicted levels of impairment in EQ-5D assessed HRQoL were relatively low, taking into account the wide error margins.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having a problem (95% CI)					
3	*	*	*	*	*	*	*
30	77 (69,84)	<0.001 (<0.001,0.495)	0.005 (<0.001,0.215)	0.005 (<0.001,0.265)	0.203 (0.036,0.637)	†	0.034 (<0.001,0.603)
120	81 (74,87)	<0.001 (<0.001,0.366)	0.071 (0.022,0.202)	0.022 (<0.001,0.512)	0.098 (0.021,0.355)	†	0.016 (0.003,0.081)
360	83 (75,91)	<0.001 (<0.001,0.461)	<0.001 (<0.001,0.294)	<0.001 (<0.001,0.136)	0.028 (0.001,0.378)	†	0.022 (<0.001,0.502)

Table 15 Predicted EQ-5D norms for eye injury adjusted to a 35 year old group *Predictions were not made outside of the collected data † Non convergent model

5. Fracture facial bone

Profile

The facial fracture group included fractures of the orbital bones, jaw, teeth, nose and palate.

A total of 141 persons, from 4 studies, who fractured a facial bone were included in the analysis. The average age at time of injury was 34 years (SD=19, range 8-86). The injury group was predominately male (66%).

Injuries between the ages of 8 and 39 years contributed 68% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	72%	96
40-59	70%	30
60-86	20%	15
All	66%	141

Table 16 Age and sex of facial fracture group

The average number of times the EQ-5D was applied to each person was 2.2 times (range 1-3). On average, the EQ-5D was first administered 65 days following injury: the mean for subsequent observations was 224 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

A strong correlation with the injury and recovery was found in *usual activity* (Table 17). Predictions of *pain and discomfort* were relatively high, but variation in the group (and most likely injuries sustained) limited the strength of the predictions. The predictions suggest there is little impact of facial bone fractures in *mobility, cognitive function* and *self-care*, with a relatively small impairment in *anxiety and depression* and *usual activities*, but the low sample size limits the strength of these findings.

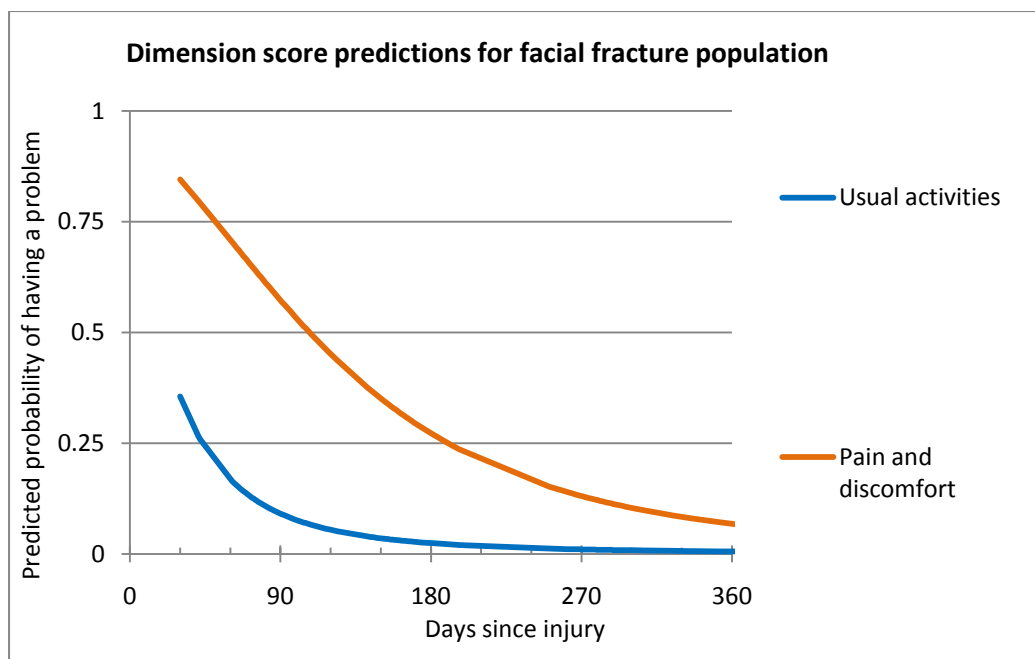


Figure 8 Usual activity dimension predictions after facial fracture adjusted to 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having a problem (95% CI)					
3	*	*	*	*	*	*	*
30	77 (69,84)	<0.001 (<0.001,0.202)	<0.001 (<0.001,0.521)	0.356 (0.111,0.709)	0.846 (0.384,0.980)	0.181 (0.049,0.488)	0.002 (<0.001,0.077)
120	81 (74,87)	0.005 (<0.001,0.187)	<0.001 (<0.001,0.365)	0.055 (0.015,0.184)	0.452 (0.126,0.825)	0.083 (0.003,0.212)	0.033 (0.005,0.179)
360	83 (75,91)	<0.001 (<0.001,0.068)	<0.001 (<0.001,0.357)	0.060 (<0.001,0.088)	0.066 (0.006,0.464)	0.012 (0.001,0.114)	<0.001 (<0.001,0.031)

Table 17 EQ-5D norms facial fracture adjusted to a 35 year old group *Predictions were not made outside of the collected data

6. Open wound face

Profile

The injury group included open wounds of the face, amputation of the ear or rupture of the eardrum excluding wounds to the eye and decapitation.

A total of 48 persons, from 4 studies, who experienced an open wound of the face were included in the analysis. The average age at time of injury was 35 years (SD=30, range 5-90). The injury group was predominately male (69%). Injuries between the ages of 5 and 39 contributed 63% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	70%	30
40-59	80%	5
60-90	62%	13
All	69%	48

Table 18 Age and sex of open face wound group

The average number of times the EQ-5D was applied to each person on 1.9 occasions (range 1-4). On average, the EQ-5D was first administered 55 days following injury: the mean for subsequent observations was 229 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 394 days after the date of injury.

Injury group norm values

No models were fit to this data due to the low number of participants in this injury category.

Vertebrae / Spine

7. Vertebral column fracture / dislocation / sprain / strain

Profile

The injury group included fractures, dislocations, sprains and strains of vertebrae as well as general lower back pain.

Age and sex profile		
Age	Male	n
8-39	53%	314
40-59	54%	371
60-95	45%	176
All	52%	861

Table 19 Age and sex of vertebral column injury group

A total of 861 persons, from 7 studies, who fractured, dislocated, sprained or strained vertebrae were included in the analysis. The average age at time of injury was 46 years (SD=15, range 8-95). The injury group was almost evenly split by sex (52% male). Injuries between the ages of 8 and 39 contributed 36% of the total count of injuries.

The average number of times the EQ-5D was applied to each person was 2.3 (range 1-4). On average, the EQ-5D was first administered 51 days following injury: the mean for subsequent observations was 104 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 483 days after the date of injury.

Injury group norm values

Across all facets of the EQ-5D, excluding cognitive function, a correlation was found with time. This correlation was moderate in *anxiety and depression*, but very strong for the remaining four dimensions and VAS.

Initial VAS predictions immediately after injury were severe, with a prediction of 39 (95%CI 27,40) one day after injury. There was a relatively

quick rate of recovery levelling at around 180 days. The plateau in recovery was also seen in the

dimension scores, however only *self-care* returned to what could be assumed a general group rate of impairment. A slight decrease in quality of life is seen from 270 days to 360 days (Figure 10 and 11). This is most likely influenced by the inclusion of IPD from a study of chronic back pain, which had a longer follow up period (Kovacs, Abraira et al. 2005).

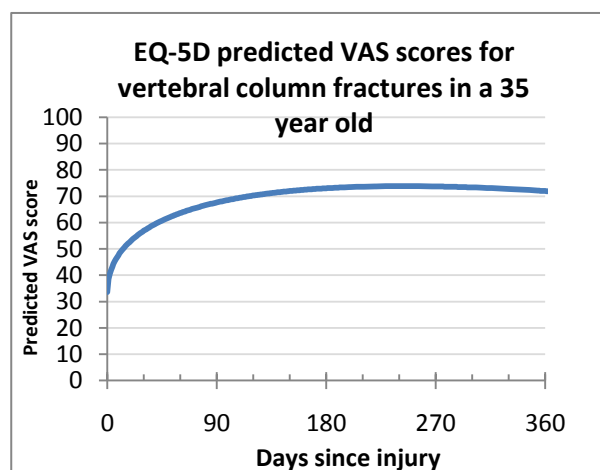


Figure 9 EQ-5D VAS score predictions for vertebral fractures adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having a problem (95% CI)					
3	42 (36,49)	0.944 (0.825,0.984)	0.753 (0.475,0.911)	0.989 (0.961,0.997)	0.998 (0.992,1.00)	0.412 (0.275,0.566)	0.015 (<0.001,0.196)
30	57 (51,63)	0.652 (0.367,6.1)	0.911 (0.115,0.565)	0.908 (0.765,0.968)	0.974 (0.916,0.992)	0.195 (0.134,0.278)	0.026 (0.007,0.097)
120	70 (64,76)	0.220 (0.069,0.720)	0.044 (0.014, 0.132)	0.531 (0.283,0.765)	0.779 (0.537,0.915)	0.097 (0.065,0.144)	0.040 (0.016,0.095)
360	72 (65,79)	0.100 (0.025,0.400)	0.009 (0.002,0.041)	0.301 (0.110,0.600)	0.767 (0.469,0.924)	0.142 (0.068,0.274)	0.037 (0.009,0.133)

Table 20 EQ-5D norms for vertebrae fracture/ sprain/ dislocation or strain adjusted to a 35 year old group *Predictions were not made outside of the collected data

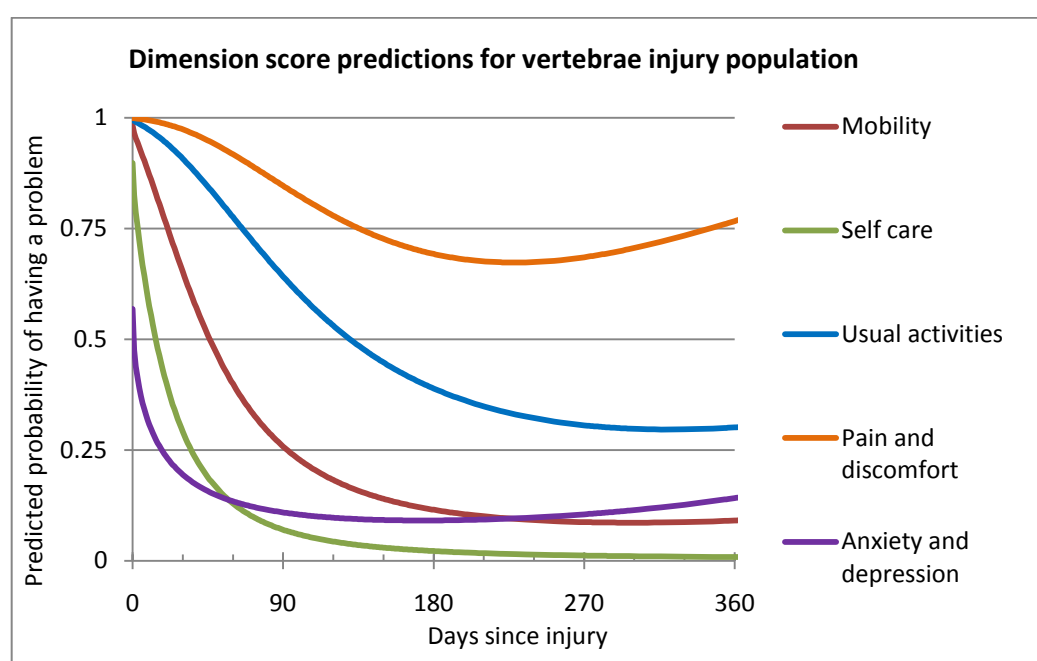


Figure 10 Dimension score predictions for vertebrae injury group adjusted to 35 years old

8. Whiplash, neck sprain, distortion of cervical spine

Profile

A total of 99 persons, from 5 studies, who experienced whiplash, a neck sprain or distortion of the cervical spine were included in the analysis. The average age at time of injury was 40 years (SD=13, range 18-81). Injuries between the ages of 18 and 39 contributed 47% of the total count of injuries. The injury group was almost evenly split by sex (48% male).

Age and sex profile		
Age	Male	n
18-39	43%	47
40 - 59	56%	45
60-81	43%	7
All	48%	99

Table 21 Age and sex profile of whiplash group

The average number of times the EQ-5D was applied to each person was 2.1 times (1-4 range). On average, the EQ-5D was first administered 73 days following injury: the mean for subsequent observations was 227 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 502 days after the date of injury.

Injury group norm values

Predictions for the VAS showed a gradual recovery was experienced over the course of 360 days (Figure 13).

Within the dimension scores a high probability of having problems was found in *pain and discomfort*, which despite a strong recovery remained moderate 0.349 (95%CI 0.108,0.702) at one year.

Usual activities predictions were less severe, with a nearly linear decrease in the probability of having a problem over one-year (Figure 14).

Anxiety and depression predicted values showed a slight association with time, and it was the least severe of the dimensions where the injury could be associated with an EQ-5D dimension.

For the remaining dimensions a relationship could not be drawn with time due to low rates of impairment (Table 21).

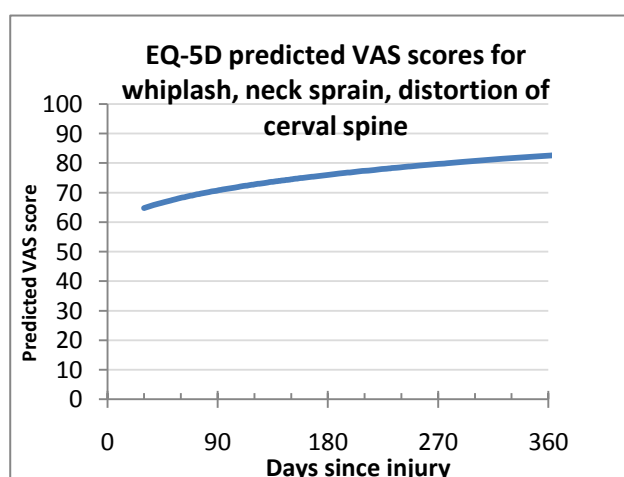


Figure 11 Predicted neck injury VAS scores adjusted to 35 a year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	65 (57,72)	0.122 (0.024,0.443)	0.029 (0.0032,0.216)	0.857 (0.593,0.961)	0.963 (0.778,0.995)	0.497 (0.256,0.738)	0.669 (<0.001,0.984)
120	73 (66,79)	0.029 (0.005,0.164)	0.027 (0.004,0.171)	0.657 (0.411,0.840)	0.818 (0.559,0.941)	0.258 (0.123,0.462)	0.615 (<0.001,0.981)
360	83 (75,90)	0.003 (<0.001,0.062)	<0.001 (<0.001,0.063)	0.099 (0.021,0.358)	0.349 (0.108,0.702)	0.076 (0.019,0.260)	0.584 (<0.001,0.584)

Table 22 EQ-5D norms for neck injury adjusted to a 35 year old group *predictions were not made outside of the collected data

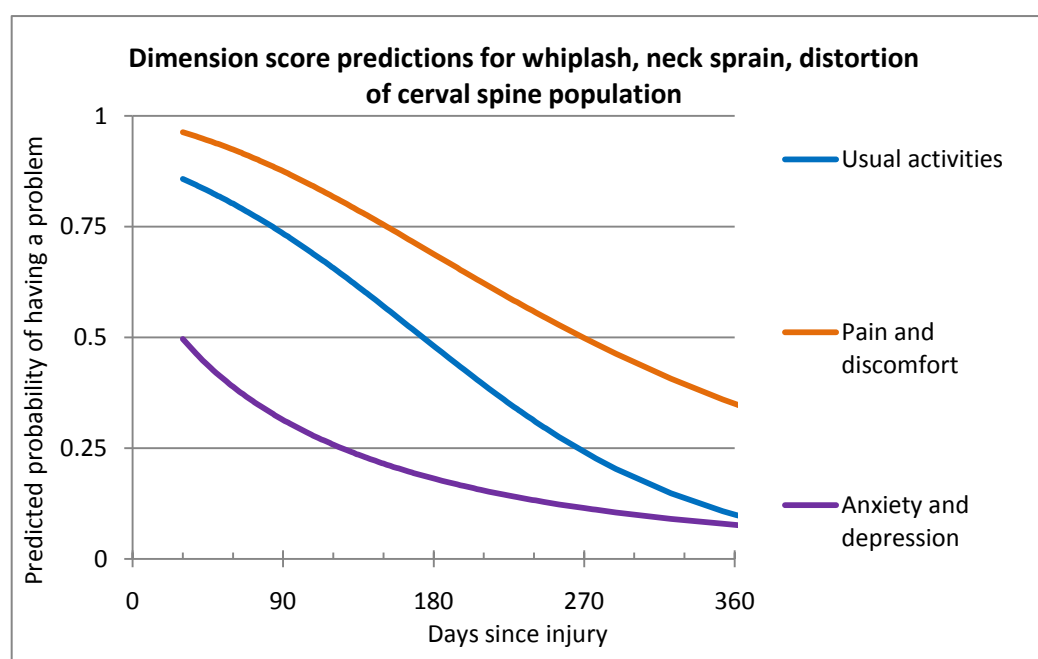


Figure 12 Dimension score predictions for neck injury adjusted to a 35 year old population

9. Spinal cord injury (SCI)

Profile

The Spinal Cord Injury (SCI) group included participants with compression or oedema of the spinal cord, through to injuries of the spinal cord that involved multiple body regions.

A total of 55 persons, from 4 studies, who experienced a SCI were included in the analysis. The average age at time of injury was 43 years

(SD=18, range 5-86). The injury group was predominately male (71%). Injuries between the ages of 8 and 39 contributed 38% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	76%	21
40-59	78%	23
60-96	45%	11
All	71%	55

Table 23 Age and sex of SCI group

The average number of times the EQ-5D was applied to each person was 1.5 (range 1-3). On average, the EQ-5D was first administered 151 days following injury: the mean for subsequent observations was 238 days. The first measurement of the EQ-5D was 62 days after the injury. The last follow-up EQ-5D assessment was made 521 days after the date of injury.

Injury group norm values

The defined injury group included a wide spectrum of severity, from bruising induced temporary paraparesis through to severing of the cord and paralysis, and this was seen in the large error margins that accompany the predicted values. While the fitted model showed a correlation may exist between the facets of the EQ-5D at the coefficients level, the scope of injuries included prevented accurate predictions being made for this injury group.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*
120	60 (38,82)	0.864 (0.399,0.984)	0.847 (0.349,0.983)	0.939 (0.082,1.00)	0.991 (0.506,1.00)	0.322 (0.069,0.754)	0.248 (0.054,0.655)
360	*	†	†	†	†	†	†

Table 24 EQ-5D predicted norms for SCI adjusted to a 35 year old group. *Predictions were not made outside of the collected data. † Data was heavily grouped and estimates only produced within the groups.

Abdomen / Thorax

10. Internal organ injury

Profile

The internal organ injury group contained all injuries to the intra-thoracic organs, thorax, intra-abdominal organs and urinary and pelvic organs.

A total of 122 persons, from 5 studies, who experienced an injury to the abdomen or thorax were included in the analysis. The average age at time of injury was 40 years (SD=20, range 5-90). The injury group was predominately male (66%). Injuries between the ages of 5 and 39 contributed 50% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	64%	61
40-59	70%	40
60-90	62%	21
All	66%	122

Table 25 Age and sex of internal organ injury group

The average number of times the EQ-5D was applied to each person was 2.1 times (range 1-4). On average, the EQ-5D was first administered 79 days following injury: the mean for subsequent observations was 221 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 387 days after the date of injury.

Injury group norm values

Across the facets of the EQ-5D a difference from 30-day score to one year score was shown in only the VAS and *usual activities* (Figure 15 and 16).

Predicted norms across the remaining facets come with the caveat of high levels of uncertainty, and may not differ significantly from the basal rate of impairment in the group.

A possible exception to this being *pain and discomfort*, which contains a relatively high

probability of problems at one month of 0.905 (95%CI 0.450, 0.991), but is limited by wide error estimates in the prediction (Table 25).

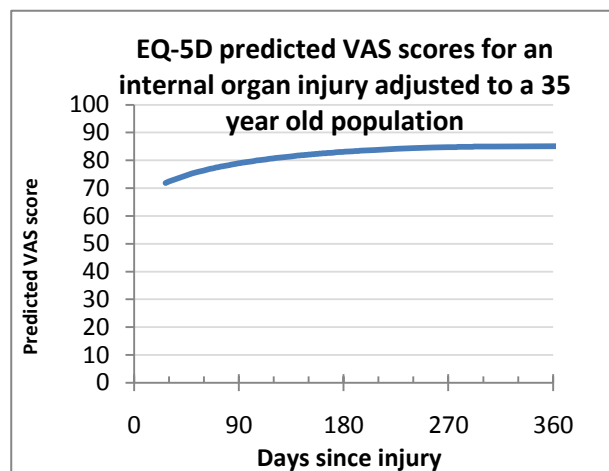


Figure 13 VAS score predictions for internal organ injury adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	72 (63,81)	0.255 (0.048,0.698)	0.067 (0.002,0.682)	0.923 (0.562,0.991)	0.905 (0.450,0.991)	0.336 (0.077,0.755)	0.005 (<0.001,0.268)
120	81 (74,88)	0.043 (0.011,0.155)	0.001 (<0.001,0.059)	0.260 (0.100,0.528)	0.567 (0.164,0.89.9)	0.055 (0.017,0.167)	0.005 (<0.001,0.263)
360	85 (76,94)	0.023 (0.002,0.196)	<0.001 (<0.001,0.114)	0.022 (0.002,0.224)	0.101 (0.001,0.565)	0.114 (0.020,0.454)	0.006 (<0.001,0.320)

Table 26 EQ-5D predicted norms for internal organ injury adjusted to a 35 year old group *Predictions were not made outside of the collected data

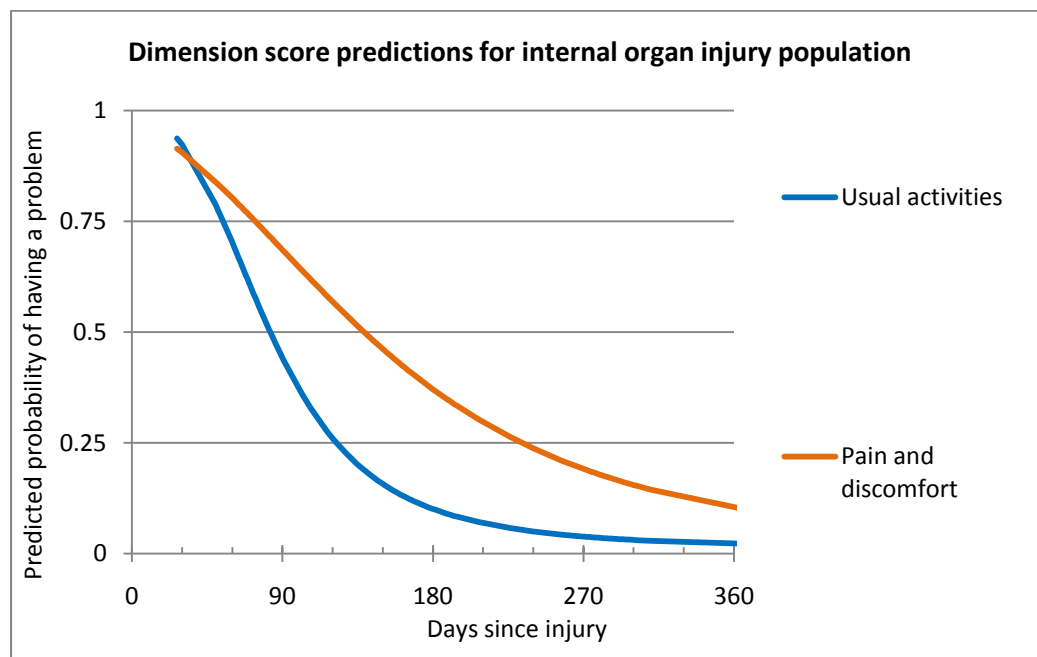


Figure 14 Usual activity dimension score predictions for internal organ injury adjusted to a 35 year old group

11. Fracture of rib / sternum

Profile

The rib or sternum fracture group included fractures of the bony thorax.

A total of 186 persons, from 5 studies, who experienced a fractured rib or sternum were included in the analysis. The average age at time of injury was 54 years (SD=17, range 12-93). The injury group was predominately male (60%). Injuries between the ages of 12 and 39 contributed 20% of the total count of injuries, with injury counts spread relatively evenly in those aged 40 to 59 (42%), and those aged over 60 (37%).

Age and sex profile		
Age	Male	n
12-39	68%	38
40-59	67%	79
60-93	48%	69
All	60%	186

Table 27 Age and sex of rib/ sternum fracture injury group

The average number of times the EQ-5D was applied to each person was 2.2 times (range 1-4). On average, the EQ-5D was first administered 71 days following injury: the mean for subsequent observations was 215 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 416 days after the date of injury.

Injury group norm values

Predictions for the VAS score saw an increase of 10 units to 80 (95%CI 75,86) in the first 132 days post injury. The increase in VAS assessed health status eased from 132 to 360 days (VAS figure).

Usual activities and *pain and discomfort* showed a significant decrease in the probability of problems from 30 to 360 days. *Usual activities* showed a relatively rapid decrease in the probability of problems occurring from 30 to 180 days. Unlike the VAS and *usual activity* predictions, the predicted norm for *pain and discomfort* did not approach a plateau in the first 6 months (Figure 18). Rather it appears that it may maintain a steady rate of improvement beyond one-year.

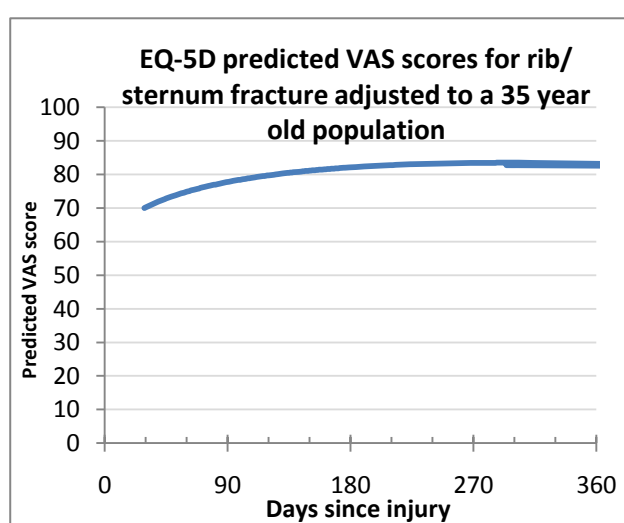


Figure 15 Predicted VAS norms for rib sternum fracture adjusted to a 35 year old population

Accurate conclusions of the remaining dimensions and effect over time could not be

reached, but the upper bounds of predictions included a low level of impairment compared to the VAS, usual activity and pain and discomfort (Table 27).

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	70 (63,77)	0.143 (0.032,0.462)	0.075 (0.012,0.361)	0.892 (0.590,0.979)	0.937 (0.748,0.987)	0.197 (0.034,0.632)	0.005 (<0.001,0.268)
120	80 (74,85)	0.037 (0.009,0.132)	0.013 (0.002,0.079)	0.213 (0.082,0.452)	0.768 (0.549,0.900)	0.014 (0.002,0.079)	0.005 (<0.001,0.263)
360	83 (78,88)	0.016 (0.002,0.105)	0.004 (<0.001,0.056)	0.025 (0.003,0.163)	0.169 (0.004,0.089)	0.040 (0.004,0.089)	0.006 (<0.001,0.320)

Table 28 EQ-5D norms for rib/ sternum fracture adjusted to a 35 year old group *Predictions were not made outside of the collected data

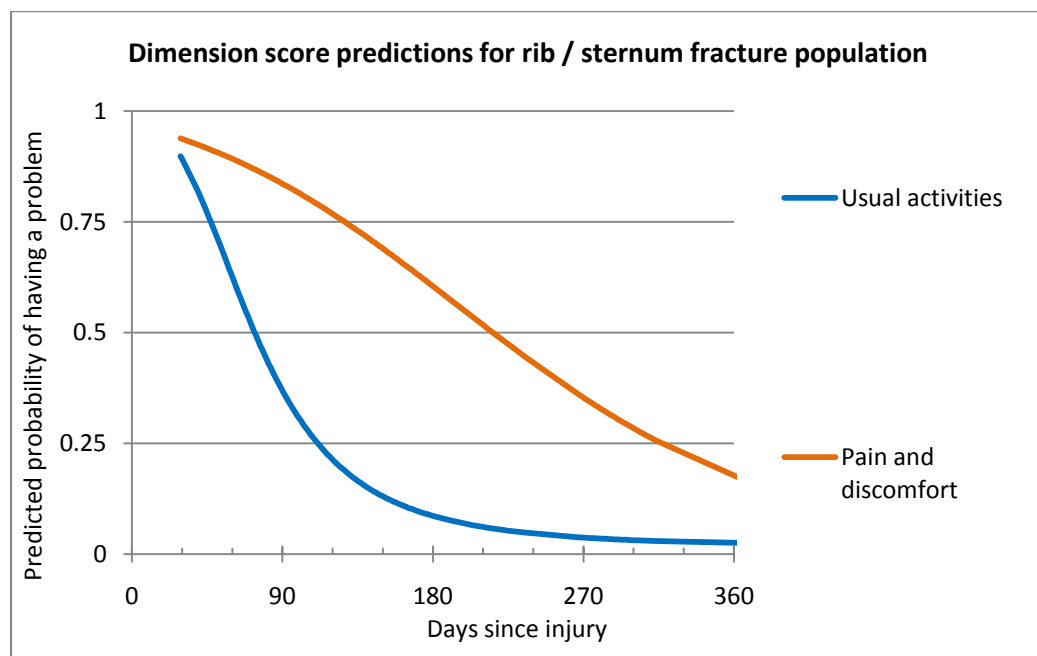


Figure 16 Dimension score predictions for rib/ sternum fracture adjusted to a 35 year old group

Upper extremity

12. Fracture of clavicle / scapula

Profile

A total of 189 persons, from 5 studies, who fractured their clavicle or scapula were included in the analysis. The average age at time of injury was 44 years (SD=22, range 5-94). The injury group was predominately male (58%). Injuries between the ages of 5 and 39 contributed 43% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	75%	81
40-59	58%	66
60-94	26%	42
All	58%	189

Table 29 Age and sex of upper extremity injury group

The average number of times the EQ-5D was applied to each person was twice (2.0, range 1-4). On average, the EQ-5D was first administered 20 days following injury: the mean for subsequent observations was 444 days. The first measurement of the EQ-5D was 15 days after the injury. The last follow-up EQ-5D assessment was made 406 days after the date of injury.

Injury group norm values

At 15 days post scapula or clavicle fracture the predicted group level VAS was 67 (95% CI 59-77). VAS scores improved steadily over the following 180 days before the rate of recovery began to plateau. Beyond 180 days the spread of VAS scores increased, possibly due to the influence of other factors, possibly not related to the initial injury.

Exploratory scatter graphs of raw dimension data against time indicated less favourable mobility scores immediately post injury. A significant correlation could not be found between mobility and time over the course of the EQ-5D measurements. A significant correlation was found between mobility and time through to 190 days post injury. The predictions for mobility through to 190 days are presented here as an indication of impairment in the mobility dimension (Table 29).

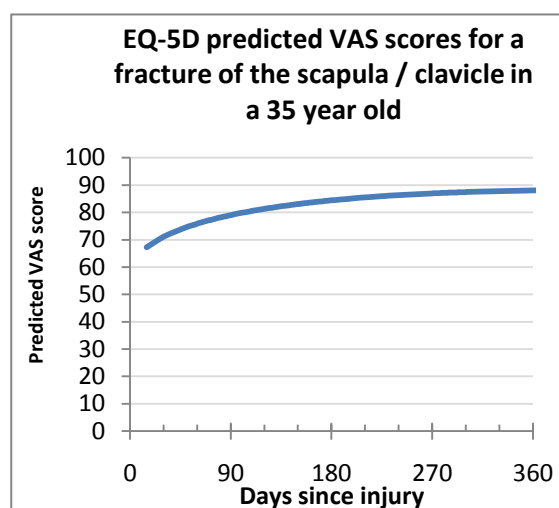


Figure 17 Predicted EQ-5D VAS values after fracture of the shoulder or scapula

The most severe impairment was seen in usual activities and pain and discomfort (Figure 20). While usual activities appeared to have a faster rate of recovery, the two were unable to be separated with statistical certainty before one year. While still presenting a correlation with time, the group appeared to have returned to what can be assumed to be full recovery levels of impairment within 180 days.

The analysis did not find a correlation between the cognitive dimension and time after injury. In total 87% of the 431 participants recorded 'no problem' in the cognitive dimension.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	71 (64,77)	0.076 (0.011,0.379)	0.134 (0.023,0.500)	0.892 (0.590,0.979)	0.847 (0.507,0.968)	0.037 (0.003,0.309)	0.002 (<0.001,0.054)
120	81 (77,86)	0.002 (<0.001,0.021)	0.009 (0.001,0.072)	0.213 (0.082,0.452)	0.454 (0.207,0.726)	0.004 (<0.001,0.069)	0.002 (<0.001,0.024)
360	88 (81,95)	†	<0.001 (<0.001,0.053)	0.025 (0.003,0.163)	0.052 (0.008,0.276)	<0.001 (<0.001,0.016)	<0.001 (<0.001,0.016)

Table 30 Predicted EQ-5D values after fracture of the shoulder or scapula. *No data present for predictions. †A relationship between mobility and this injury could only be modelled on the first 190 days.

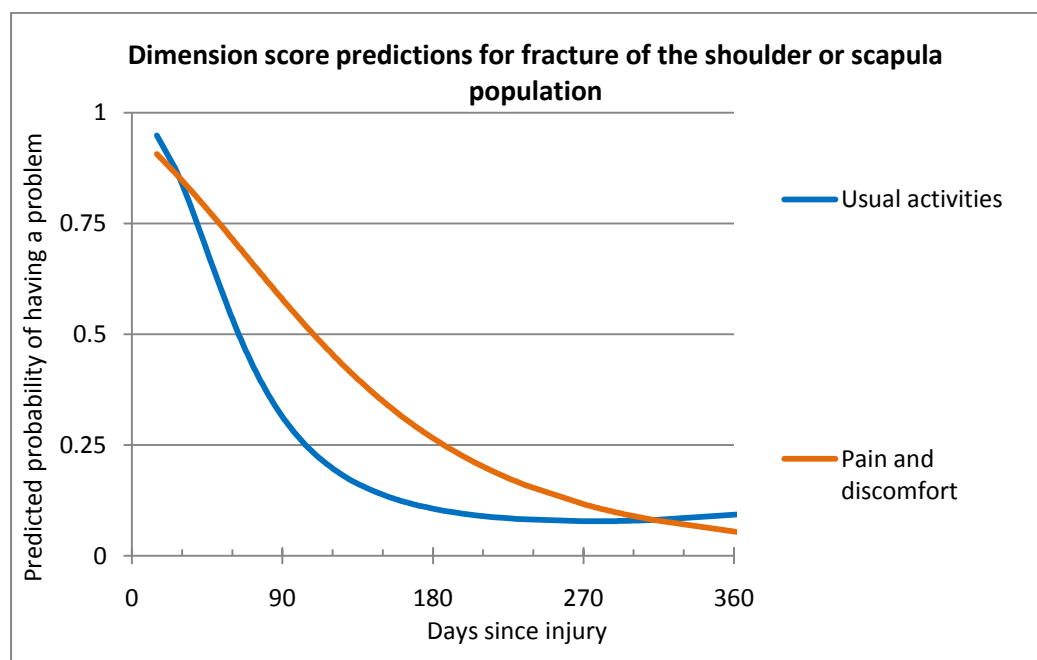


Figure 18 Predicted EQ-5D dimension values after a fracture of the shoulder or scapula.

13. Fracture of upper arm

Profile

Within the fracture of the upper arm injury group were fractures of the upper end and shaft of the humerus. Fractures could be open or closed.

A total of 243 persons, from 6 studies, who experienced a fracture of the upper arm were included in the analysis. The average age at time of injury was 43 years (SD=28, range 5-93). The injury group was predominately female (65%). Injuries between the ages of 5 and 39 contributed 44% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	54%	108
40-59	33%	51
60-93	11%	84
All	35%	243

Table 31 Age and sex of upper arm fracture group

The average number of times the EQ-5D was applied to each person was 2.3 (range 1-4). On average, the EQ-5D was first administered 64 days following injury: the mean for subsequent observations was 221 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 466 days after the date of injury.

Injury group norm values

Within the VAS there was a small increase in self-assessed health status from 64 days 75 (95%CI 69-80) to one year 82 (95%CI 75-88). Estimates for 0-64 days could not be produced due to a lack of collected data.

Predictions for the dimensions showed the probability of having problems was high, in relation to the other dimensions, in *pain and discomfort* and *usual activities* (Table 31). Both dimensions showed a decrease in impairment through to 270 days before tapering at levels that, while exceeding the other dimensions predicted scores, still had relatively large confidence intervals.

The remaining dimensions of *mobility, anxiety and depression* and *cognitive function* did not show a substantial change over the predicted period, and remained relatively low (Table 31).

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*
120	77 (72,83)	0.018 (0.005,0.060)	0.059 (0.021,0.153)	0.679 (0.255,0.929)	0.722 (0.324,0.933)	0.068 (0.032,0.139)	0.017 (0.004,0.072)
360	82 (75,88)	0.021 (0.006,0.080)	0.007 (0.001,0.040)	0.202 (0.032,0.662)	0.260 (0.049,0.705)	0.022 (0.006,0.079)	0.002 (<0.001,0.025)

Table 32 EQ-5D norms for upper arm fracture adjusted to a 35 year old group. *No data present for predictions.

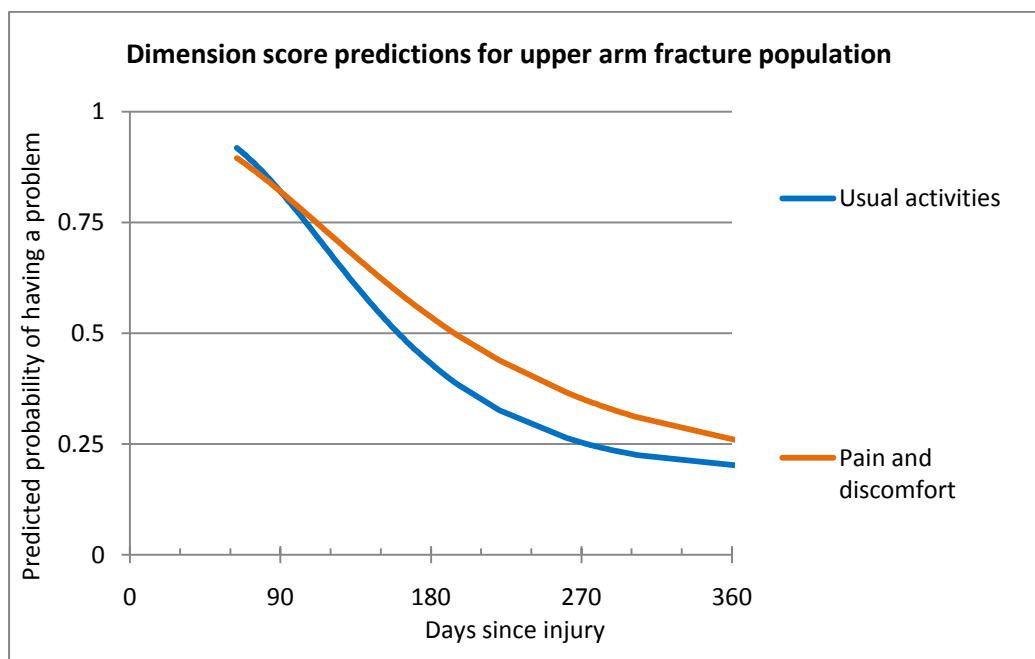


Figure 19 Dimension score predictions for upper arm fracture adjusted to a 35 year old population

14. Fracture of elbow / forearm

Profile

The elbow and forearm injury group included fractures of the lower end of the humerus as well as the upper end and shaft of the radius and ulna.

A total of 393 persons, from 6 studies, who experienced a fracture of the elbow or forearm were included in the analysis. The average age at time of injury was 35 years (SD=26, range 5-97). The injury group was 54% female. Injuries between the ages of 5 and 39 contributed 59% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	60%	231
40-59	44%	68
60-97	12%	94
All	46%	393

Table 33 Age and sex of elbow/forearm fracture group

The average number of times the EQ-5D was applied to each person was 2.1 (range 1-4). On average, the EQ-5D was first administered 54 days following injury: the mean for subsequent observations was 230 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

A small gradual increase in the VAS was seen from three days 74 (95%CI 68,80) to one year 84 (95%CI 79,81).

Significant impairment was present in the *self-care*, *usual activities* and *pain and discomfort* dimensions during the first 90 days (Table 33). At one year levels of impairment in *pain and discomfort* and *usual activities* remained slightly elevated, while *self-care* had decreased dramatically.

Mobility, *anxiety and depression* and *cognitive function* did not appear to be elevated, or show substantial change over time (Table 33).

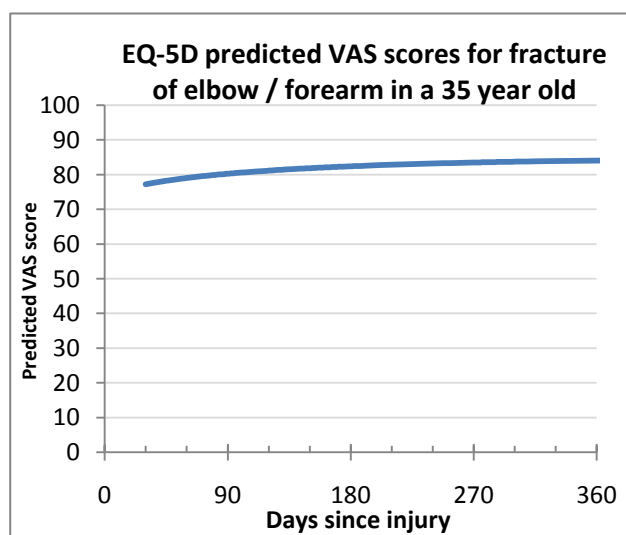


Figure 20 Predicted VAS for elbow/ forearm fracture adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	74 (68,80)	0.004 (<0.001,0.093)	0.998 (0.973,1.00)	0.999 (0.985,1.00)	0.986 (0.889,0.998)	0.177 (0.046,0.489)	0.050 (<0.001,0.783)
30	77 (73,82)	0.001 (<0.001,0.020)	0.607 (0.413,0.773)	0.904 (0.772,0.963)	0.906 (0.706,0.975)	0.090 (0.042,0.185)	0.006 (<0.001,0.094)
120	81 (77,85)	<0.001 (<0.001,0.007)	0.019 (0.006,0.064)	0.280 (0.149,0.463)	0.497 (0.232,0.763)	0.040 (0.018,0.088)	<0.001 (<0.001,0.015)
360	84 (79,89)	<0.001 (<0.001,0.009)	0.010 (0.002,0.047)	0.182 (0.073,0.385)	0.286 (0.093,0.611)	0.030 (0.010,0.089)	<0.001 (<0.001,0.027)

Table 34 EQ-5D predicted norms for elbow/ forearm fracture adjusted to a 35 year old group *Predictions were not made outside of the collected data

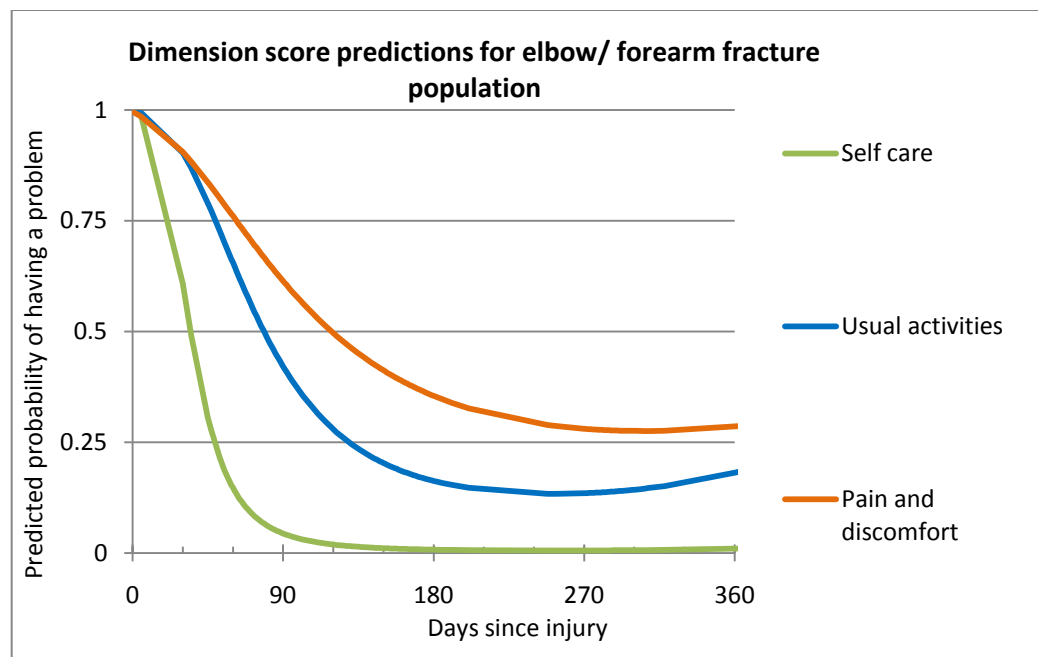


Figure 21 Dimension score predictions for forearm/ elbow fractures adjusted to a 35 year old population

15. Fracture of wrist (incl. carpal bones)

Profile

The wrist fracture group included fractures of the lower end of the ulna and radius, including Colles' and Smith's fractures, and fractures of the navicular (scaphoid) and carpal bones.

A total of 179 persons, from 3 studies, who fractured their wrist were included. The average age at time of injury was 40 years (SD=19, range 5-86). The injury group was predominately female (56%).

Injuries between the ages of 5 and 39 contributed 50% of the total count of injuries.

The average number of times the EQ-5D was applied to each person twice (range 1-3). On average, the EQ-5D was first administered 82 days following injury: the mean for subsequent observations was 194 days. The first measurement of the EQ-5D was 37 days after the injury. The last follow-up EQ-5D assessment was made 335 days after the date of injury.

Age and sex profile		
Age	Male	n
5-39	61%	89
40-59	31%	58
60-86	19%	32
All	44%	179

Table 35 Age and sex of wrist fracture group

Injury group norm values

The wrist fracture group was relatively small n=179, and responses were heavily clustered at a mean of 139 days (SD 79). This prevented a good fit for the model, most noticeably in estimating the tail end of the function, and led to large uncertainty being present around the predictions. While it appears *pain and discomfort*, then *usual activities*, are the most adversely affected dimensions; strong conclusions are not possible from this data (Table 35).

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
30	*	*	*	*	*	*	*
120	82 (72-93)	0.002 (<0.001,0.026)	0.048 (0.014,0.156)	0.182 (0.030,0.614)	0.361 (0.079,0.788)	0.014 (0.002,0.109)	0.002 (<0.001,0.046)
360	*	*	*	*	*	*	*

Table 36 EQ-5D predicted norms for wrist fractures adjusted to a 35 year old group. *No data present for predictions.

16. Fracture of hand / fingers

Profile

The hand and finger fracture group included: fractures of the metacarpal bones, thumb and unspecified fractures of the hand.

A total of 202 persons, from 5 studies, who experienced a fracture of the hand or fingers were included in the analysis. The average age at time of injury was 35 years (SD=18, range 5-86). The injury group was predominately male (64%). Injuries between the ages of 5 and 39 contributed 65% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	70%	202
40 - 59	69%	72
60-86	34%	38
All	64%	312

Table 37 Age and sex of hand/ finger fracture group

The average number of times the EQ-5D was applied to each person was 1.8 times (range 1-4). On average, the EQ-5D was first administered 67 days following injury: the mean for subsequent observations was 219 days. The first measurement of the EQ-5D was 20 days after the injury. The last follow-up EQ-5D assessment was made 426 days after the date of injury.

Injury group norm values

Impairment after injury was present in *usual activities* and *pain and discomfort* (Table 37). Predictions for *self-care*, *cognitive function*, *anxiety and depression* as well as the VAS decreased slightly over one year, but the predictions contained large uncertainties.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	80 (75,84)	0.005 (<0.001,0.047)	0.101 (0.031,0.281)	0.663 (0.415,0.845)	0.689 (0.529,0.814)	0.030 (0.007,0.123)	0.037 (0.004,0.259)
120	81 (77,85)	0.003 (<0.001,0.027)	0.015 (0.002,0.104)	0.181 (0.078,0.365)	0.500 (0.388,0.612)	0.007 (0.001,0.038)	0.011 (0.001,0.103)
360	83 (78,88)	0.002 (<0.001,0.041)	<0.001 (<0.001,0.018)	0.022 (0.004,0.116)	0.133 (0.045,0.335)	0.002 (<0.001,0.034)	0.001 (<0.001,0.071)

Table 38 EQ-5D norms for hand/ finger fracture adjusted to a 35 year old group *Predictions were not made outside of the collected data

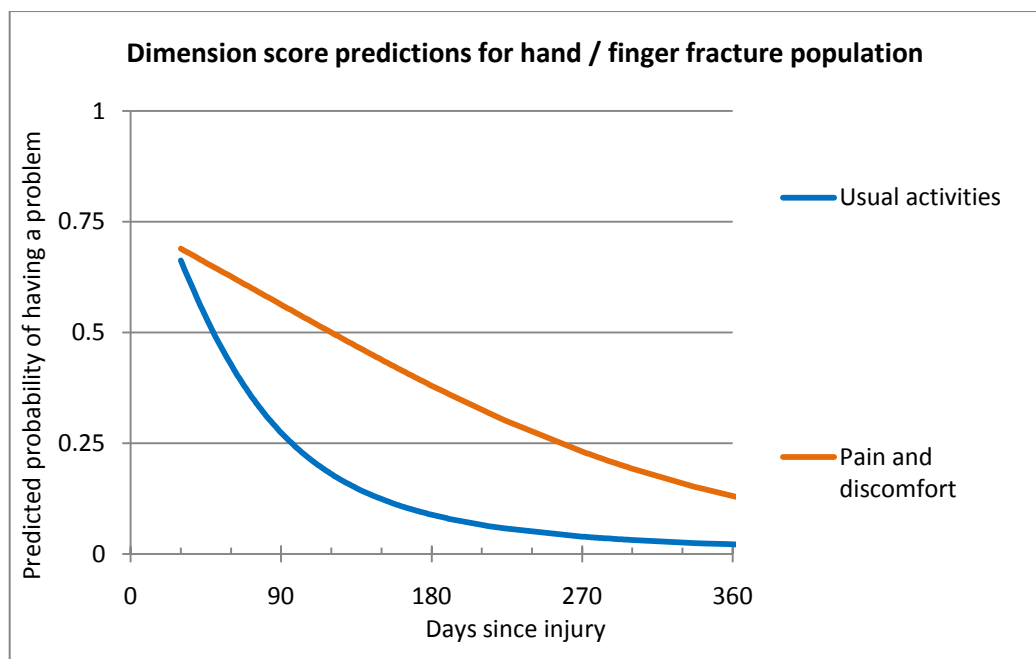


Figure 22 Dimension score predictions for hand/ finger fracture adjusted to 35 year old population

17. Dislocation / sprain / strain shoulder / elbow

Profile

A total of 350 persons, from 5 studies, who dislocated, sprained or strained their shoulder or elbow were included in the analysis. The average age at time of injury was 41 years (SD=17, range 5-91). The injury group was predominately male (56%). Injuries between the ages of 8 and 39 contributed 47% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	63%	165
40-59	52%	134
60-96	41%	51
All	56%	350

Table 39 Age and sex of shoulder and elbow joint injury groups

The average number of times the EQ-5D was applied to each person was 1.8 times (range 1-4). On average, the EQ-5D was first administered 84 days following injury: the mean for subsequent observations was 204 days. The first measurement of the EQ-5D was 12 days after the injury. The last follow-up EQ-5D assessment was made 463 days after the date of injury.

Injury group norm values

The VAS predictions at one month 75 (95%CI 70,93) and at one year 82 (95%CI 77,88) did not indicate a consistent impact of this injury on self-assessed health status. From the predictions, and the raw values attained, it appears the impact of this injury maybe minor at one month, and severe for others, but by one year the divergent subgroups within this injury group are relatively similar. Likewise for *mobility, self-care, anxiety and depression* and *cognitive function* the predicted probability of having problems were low (Table 39).

The dimensions of *usual activities* and *pain and discomfort* were at 0.631 (95%CI 0.355,0.841) and 0.655 (95%CI 0.399,0.856) at 30 days, respectively.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	75 (70,83)	0.020 (0.003,0.112)	0.225 (0.094,0.448)	0.631 (0.355,0.841)	0.665 (0.399,0.856)	0.186 (0.061,0.447)	0.009 (<0.001,0.088)
120	79 (75, 83)	0.015 (0.004,0.104)	0.084 (0.034,0.193)	0.382 (0.210,0.589)	0.623 (0.411,0.797)	0.068 (0.025,0.172)	0.012 (0.002,0.071)
360	82 (77, 88)	0.001 (0.001,0.069)	0.025 (0.005,0.107)	0.098 (0.027,0.297)	0.321 (0.128,0.605)	0.023 (0.004,0.112)	0.005 (<0.001,0.059)

Table 40 EQ-5D norms for shoulder and elbow joint injuries adjusted to a 35 year old group *Predictions were not made outside of the collected data

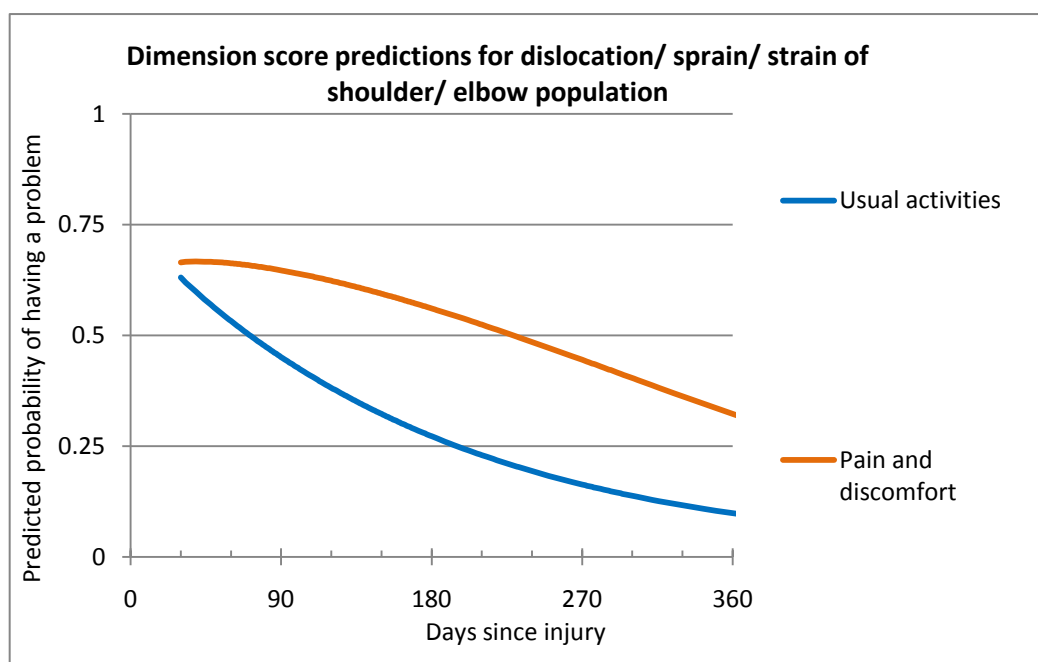


Figure 23 Dimension score predictions for shoulder and elbow joint injuries adjusted to a 35 year old population

18. Dislocation / sprain / strain wrist / hand / fingers

Profile

A total of 185 persons, from 5 studies, who experienced a dislocation, sprain or strain of the wrist, hand or fingers were included in the analysis. The average age at time of injury was 38 years (SD=18, range 6-92). Just over half of the injury group were male (55%). Injuries between the ages of 5 and 39 contributed 57% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	63%	106
40 - 59	47%	55
60-96	38%	24
All	55%	185

Table 41 Age and sex of wrist/ hand joint injury group

The average number of times the EQ-5D was applied to each person was 1.8 times (range 1-4). On average, the EQ-5D was first administered 75 days following injury: the mean for subsequent observations was 227 days. The first measurement of the EQ-5D was 11 days after the injury. The last follow-up EQ-5D assessment was made 458 days after the date of injury.

Injury group norm values

Estimates for the VAS were produced with wide confidence intervals that showed a very slight increase that lacked statistical strength.

A model could not be fitted to any of the dimension scores. This was due to the inability to produce a feasible estimate of where convergence for the model could be achieved. This is likely to be due to a combination of a low number of participants, or the impact of a dislocated finger (as an example), being too different to a dislocated wrist to produce a model from this group.

VAS	
Day	(95% CI)
3	*
30	80 (74-86)
120	84 (79-89)
360	87 (80-93)

Table 42 Predicted VAS for wrist/ hand joint injury adjusted to a 35 year old group

19. Injury of nerves

Profile

A total of 23 persons, from 3 studies, experienced an injury that was isolated to the nerves in an upper extremity. The average age at time of injury was 32 years (SD=19, range 9-70). The injury group was 48% male. Injuries between the ages of 5 and 39 contributed 61% of the total injury count.

Age and sex profile		
Age	Male	n
8-39	43%	14
40-59	50%	6
60-96	67%	3
All	48%	23

Table 43 Age and sex of upper extremity nerve injury group

The average number of times the EQ-5D was applied to each person was 2.4 (range 1-3). On average, the EQ-5D was first administered 61 days following injury: the mean for subsequent observations was 224 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

Due to the low number of injuries modelling predicted group level outcomes was not attempted.

20. Complex soft tissue injury of the upper limb

Profile

A total of 84 persons, from 3 studies, who experienced a fracture of the elbow or forearm were included in the analysis. The average age at time of injury was 40 years (SD=18, range 7-78). The injury group was predominately male (69%). Injuries between the ages of 5 and 39 contributed 43% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	72%	36
40 - 59	75%	36
60-96	42%	12
All	69%	84

Table 44 Age and sex of upper limb complex soft tissue injury

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-3). On average, the EQ-5D was first administered 72 days following injury: the mean for subsequent observations was 226 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 360 days after the date of injury.

Injury group norm values

A model could not be fitted to any aspect of the EQ-5D. There was a large variability in the severity of EQ-5D responses that could not be controlled without a measure of severity.

Lower extremity

21. Fracture of pelvis

Profile

A total of 114 persons, from 6 studies, who experienced a fracture of the pelvis were included in the analysis. The average age at time of injury was 60 years (SD=23, range 10-100). The injury group was 45% male. Injuries between the ages of 10 and 39 contributed 23% of the total count of injuries, with 59% occurring from the age of 60 and over.

Age and sex profile		
Age	Male	n
10-39	81%	26
40 - 59	62%	21
60-100	28%	67
All	45%	114

Table 45 Age and sex of pelvis fracture group

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-4). On average, the EQ-5D was first administered 64 days following injury: the mean for subsequent observations was 221 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 417 days after the date of injury.

Injury group norm values

The predicted values for the VAS showed a large impact on self-rated quality of life was experienced after a pelvis fracture. The group experienced a recovery in VAS state over the next 210 days.

The dimensions *mobility*, *usual activities* and *pain and discomfort* showed very high levels of impairment (Figure 27). Levels of impairment remained noticeably high at one year with 0.471 (95%CI 0.124,0.849) for *pain and discomfort*.

While experiencing problems in *self-care*, *anxiety and depression* and *cognitive function* did appear to increase immediately post injury, there was a large amount of variation in responses amongst

the individuals. The predictions reflect this variation with wide the confidence intervals (Table 45).

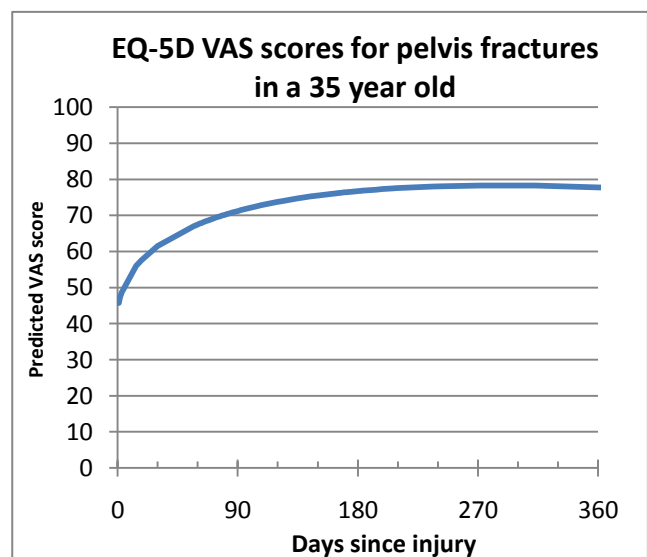


Figure 24 EQ-5D VAS scores for pelvis fractures adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	49 (32,61)	1.00 (0.979,1.00)	0.764 (0.049,0.995)	1.00 (0.901,1.00)	1.00 (0.901,1.00)	0.289 (0.037,0.813)	0.027 (<0.001,0.535)
30	61 (53,70)	0.985 (0.828,0.999)	0.237 (0.035,0.730)	0.986 (0.860,1.00)	0.973 (0.792,0.997)	0.200 (0.060,0.493)	0.015 (0.001,0.141)
120	74 (65,82)	0.310 (0.097,0.653)	0.025 (0.003,0.169)	0.564 (0.281,0.810)	0.665 (0.317,0.894)	0.115 (0.038,0.296)	0.008 (<0.001,0.069)
360	78 (69,87)	0.071 (0.009,0.383)	0.005 (<0.001,0.069)	0.148 (0.003,0.496)	0.471 (0.124,0.849)	0.053 (0.010,0.226)	0.005 (<0.001,0.063)

Table 46 EQ-5D norms for pelvis fracture injuries adjusted to a 35 year old group

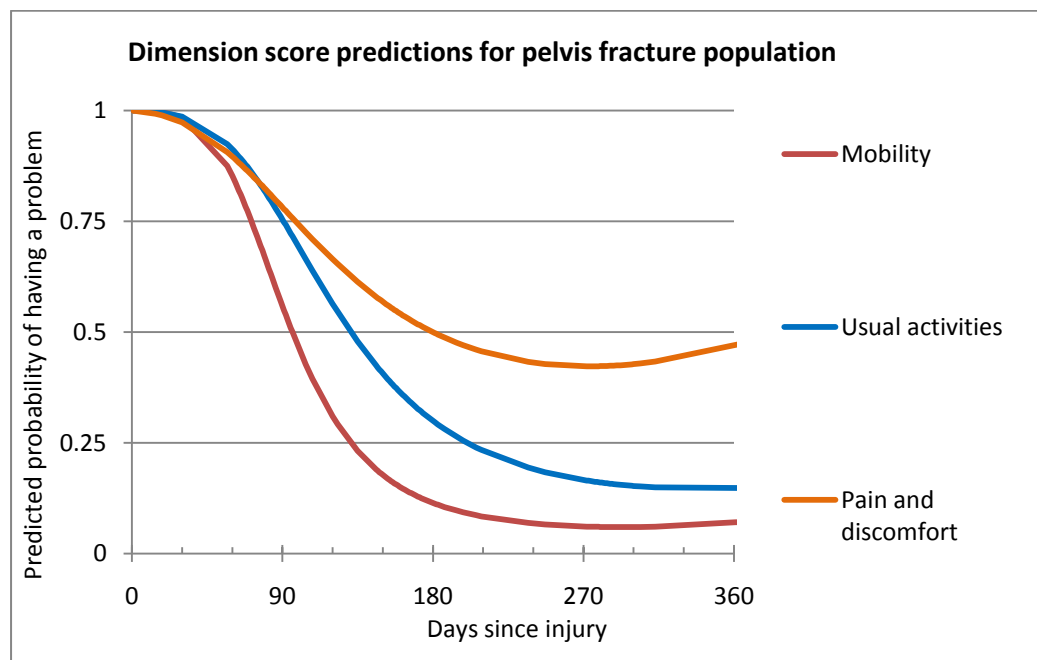


Figure 25 EQ-5D dimension score predictions for pelvis fracture injuries adjusted to a 35 year old group

22. Fracture of the hip

Profile

Group included all cases of hip fracture, including those that did not receive surgical intervention.

A total of 1026 persons, from 7 studies, who fractured their hip were included in the analysis. The average age at time of injury was 75.6 years (SD=12, range 12-100), and the group was predominately female (70%).

Age and sex profile		
Age	Male	n
12-39	65%	20
40 - 59	46%	54
60-100	28%	952
All	30%	1026

Table 47 Age and sex of hip fracture group

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-3). On average, the EQ-5D was first administered 221 days following injury: the mean for subsequent observations was 445 days. The first measurement of the EQ-5D was 11 days after the fracture, while for the majority of cases completion was later. The last follow-up EQ-5D assessment was made 730 days after the date of injury.

Injury group profile

VAS score predictions immediately post injury were low 11 days after injury VAS=61 (95%CI 57,66). Predictions of VAS at one year showed a marginal improvement in the group VAS=65 (95%CI 61,70).

The dimension of *mobility* was strongly impaired immediately after injury with a predicted probability of problems of 0.955 (95%CI 0.880,0.984). *Usual activities* and *pain and discomfort* were also strongly affected by a hip fracture (Figure 28). These dimensions all exhibited similar decreases in the probability of having problems, mostly within the first 180 days. At one year after injury *mobility*, *usual activities* and *pain and discomfort* all exhibited moderate levels of impairment.

Anxiety and depression exhibited a small decrease in the probability of having problems, and by one year the likelihood of having problems had decreased to a low level. While the dimension of *self-care* appeared to follow a similar path within the group, there was a high level of variance, which is shown in the 95%CI (Table 47).

Predictions were not modelled for the *cognitive function* dimension. This was due to the models experiencing 'numerical overflow', likely due to the gradient of the prediction being too small. This forced an error due to the limitations in the size of a number that could be regressed within the statistical program Stata. This is termed numeric overflow, and occurs when the number being processed by stata is too small for the way the program handles it data.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression
Day	(95% CI)	Predicted probability of having problems(95% CI)				
3	*	*	*	*	*	*
30	63 (58,67)	0.955 (0.880,0.984)	0.704 (0.532,0.832)	0.949 (0.896,0.976)	0.957 (0.909,0.981)	0.430 (0.250,0.631)
120	65 (61,69)	0.882 (0.746,0.950)	0.399 (0.264,0.551)	0.819 (0.713,0.892)	0.886 (0.801,0.938)	0.233 (0.129,0.385)
360	65 (61,70)	0.775 (0.575,0.897)	0.212 (0.124,0.340)	0.632 (0.484,0.759)	0.754 (0.614,0.855)	0.156 (0.080,0.282)

Table 48 EQ-5D norms for hip fracture injuries adjusted to a 75 year old group *Predictions were not made outside of the collected data.

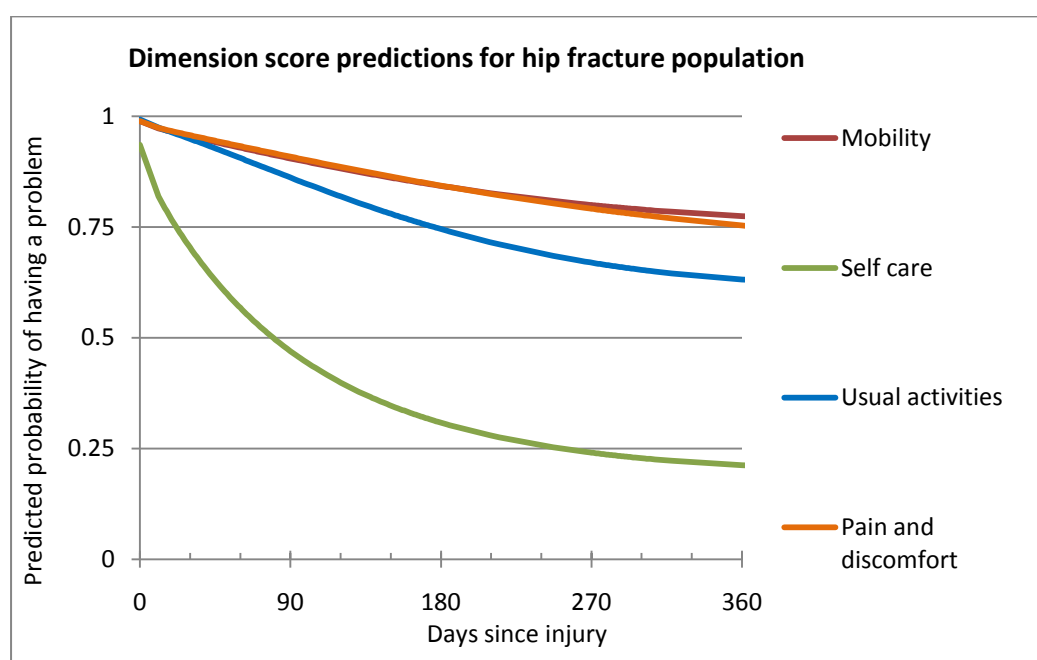


Figure 26 Dimension score predictions for hip fracture group adjusted to a 75 year old group

23. Fracture of femur shaft

Profile

A total of 105 persons, from 6 studies, who fractured their femur were included in the analysis. The average age at time of injury was 47 years (SD=26, range 6-97). A mean of 200 observations for each of the dimensions, as well as 244 separate VAS observations were collected. The injury group was predominately male (64%), with a high prevalence of injuries occurring in young males. The number of injured declined in those aged 40 years or more. In those aged 40 years or more a greater proportion of those injured were female.

Age and sex profile		
Age	Male	n
6-39	70%	53
40 - 59	68%	28
60-97	37%	20
All	64%	101

Table 49 Age and sex of femur fracture group

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-4). On average, the EQ-5D was first administered 68 days following injury: the mean for subsequent observations was 228 days. Two persons completed the EQ-5D on the day of their injury, while for the majority of cases completion was later. The last follow-up EQ-5D assessment was made 408 days after the date of injury.

Injury group norm values

The final model produced a relatively gradual rate of recovery occurred within the VAS measure (Figure 29). On the day of the injury the predicted group mean VAS is 47 (95%CI 30-65), and within 30 days this has increased to 60 (95% CI 53-66). At 80 days a score of 66 (95% CI 61-72) was predicted, at one year this had increased to 81 (95% CI 73-89).

The dimensions scores showed a strong level of divergence in the rate of attainment of the 'no problem' outcome (Figure 30). The cognitive dimension was not reported, as a model could not be fitted. This is likely to be due to the cognitive dimension not varying over time to a significant enough degree to allow the model to converge. Problems in mobility contrasted the relationship with time of the four other presented dimensions. The probability of having

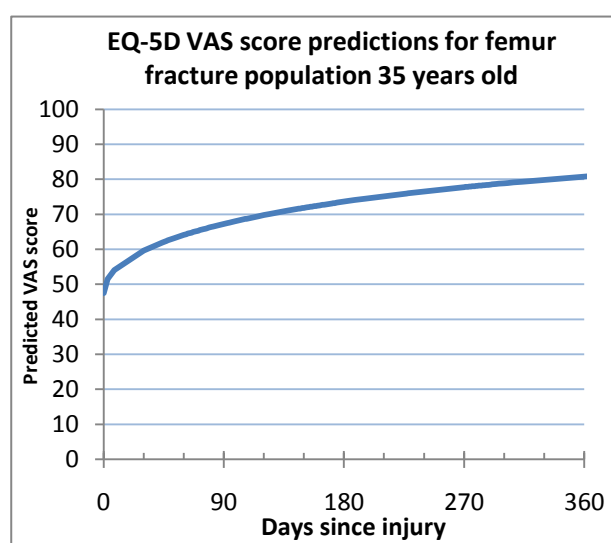


Figure 27 VAS score predicted values for femur fracture

problems with mobility was very high. The confidence levels achieved were refined greatly in an exploratory regression with people over the ages of 50 excluded; the results of this are not presented as they do not represent the femur fracture population as a whole. But it is likely that a smaller subset of older persons experience much more severe outcomes than younger persons with a femur fracture. The dimension of pain and discomfort, and usual activities appear to differ (Figure 30), but as their confidence intervals overlap they cannot be separated with statistical certainty. A similarly analogous relationship was seen between self care and anxiety and depression beyond 30 days; at 30 days the two are distinct with the probability of problems in self care being 0.940 (95% CI 0.51-6.7) and anxiety and depression being 0.636 (95% CI 0.153-0.944).

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression
Day	(95% CI)	Predicted probability of having problems(95% CI)				
3	52 (38, 65)	NA	0.940 (0.466,0.996)	1.00 (0.969,1.00)	0.998 (0.880,1.00)	0.636 (0.153,0.944)
30	60 (53, 66)	NA	0.649 (0.337,0.870)	0.994 (0.920,1.00)	0.982 (0.868,0.998)	0.323 (0.135,0.594)
120	70 (64, 75)	0.977 (0.817,0.998)	0.160 (0.061,0.356)	0.781 (0.553,0.912)	0.851 (0.627,0.951)	0.095 (0.031,0.259)
360	81 (73, 88)	0.156 (0.025,0.575)	0.039 (0.006,0.220)	0.488 (0.172,0.814)	0.095 (0.031,0.259)	0.025 (0.004,0.157)

Table 50 EQ-5D norms for femur fracture injuries adjusted to a 35 year old group

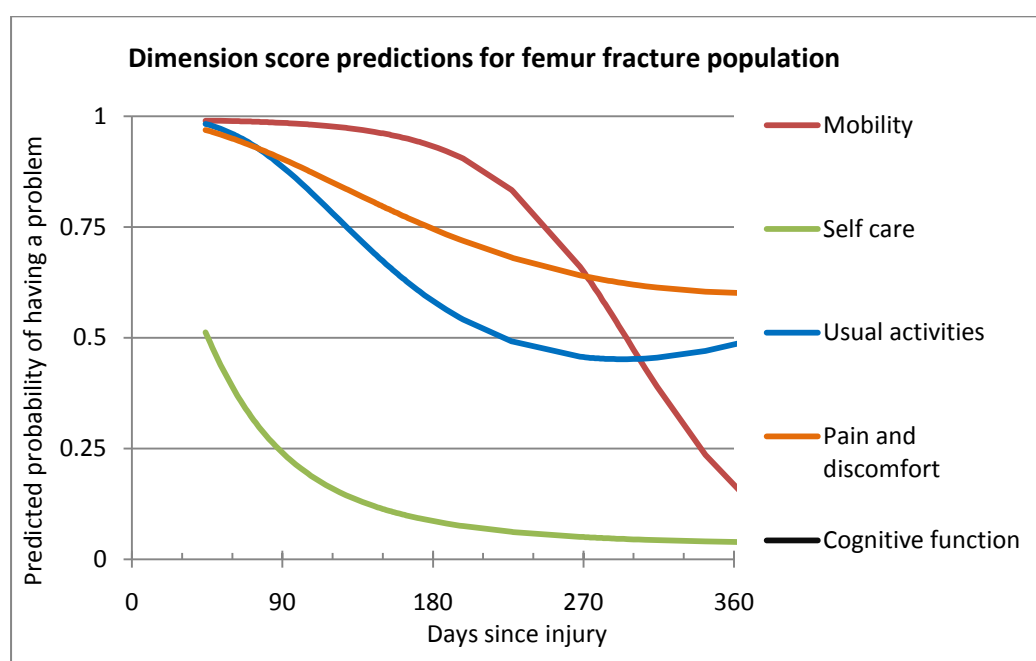


Figure 28 Dimension score predictions for femur fracture injuries adjusted to a 35 year old group

24. Fracture of knee / lower leg

Profile

A total of 475 persons, from 6 studies, who experienced a fracture of the knee or lower leg were included in the analysis. The average age at time of injury was 41 years (SD=20, range 5-89). The injury group was predominately male (57%). Injuries between the ages of 5 and 39 contributed 49% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	70%	231
40 - 59	54%	142
60-89	34%	102
All	57%	475

Table 51 Age and sex of knee / lower leg fracture group

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-4). On average, the EQ-5D was first administered 60 days following injury: the mean for subsequent observations was 226 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 413 days after the date of injury.

Injury group norm values

Overall self-rated health status, assessed by the VAS, was low three days after injury VAS=59 (95%CI 51,67). While initial VAS scores were less severe than femur fractures, by 120 days the VAS score predictions had marginal differences. Issues were still present at one year post injury.

At three days, through to one month, a high probability of having problems was predicted for *usual activities* and *mobility* (Table 51). *Pain and discomfort* estimates were comparatively lower initially, but at one year remained the only dimension where the probability prediction appeared to be elevated from levels of impairment that would be expected to exist in this group in the absence of injury, 0.441 (95%CI 0.207,0.704). Initial estimates of *self-care* problems decreased rapidly post injury (Figure 31). Problems in *cognitive function* did not appear to have a strong relationship with time post injury, and an absence of data at three days hindered analysis.

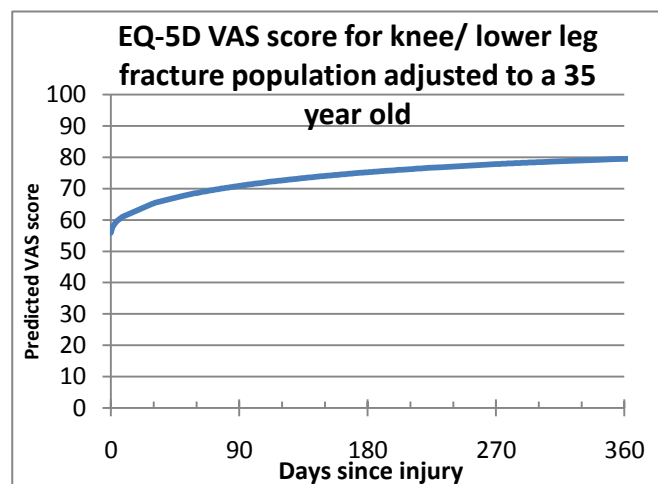


Figure 29 EQ-5D VAS score predictions for knee/ lower leg fracture injuries adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	59 (51,67)	0.996 (0.969,1.00)	0.904 (0.697,0.975)	1.00 (0.995,1.00)	0.954 (0.798,0.991)	0.327 (0.112,0.652)	†
30	65 (59,72)	0.979 (0.929,0.993)	0.471 (0.320,0.627)	0.990 (0.953,0.998)	0.917 (0.774,0.972)	0.229 (0.112,0.411)	0.020 (0.005,0.073)
120	73 (66,79)	0.813 (0.669,0.904)	0.064 (0.031,0.127)	0.751 (0.499,0.901)	0.801 (0.588,0.919)	0.129 (0.059,0.260)	0.030 (0.012,0.074)
360	80 (73,86)	0.226 (0.106,0.420)	0.010 (<0.001,0.034)	0.275 (0.101,0.561)	0.441 (0.207,0.704)	0.053 (0.020,0.136)	0.030 (0.008,0.102)

Table 52 EQ-5D norms for lower leg fracture injuries adjusted to a 35 year old group. † Data at 3 days was missing.

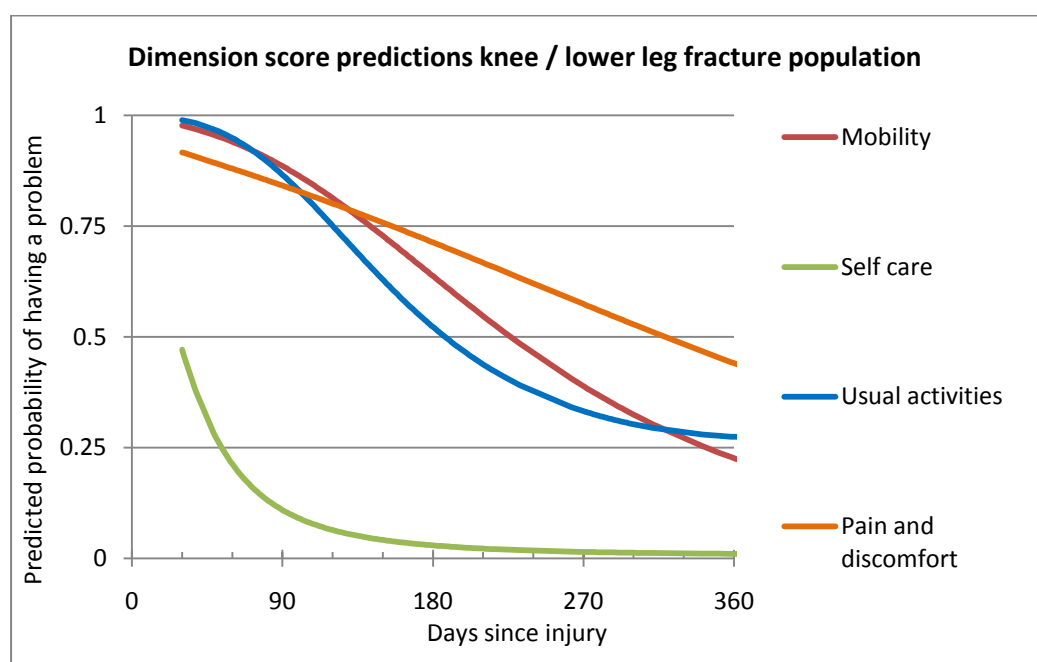


Figure 30 Dimension predictions for lower leg fracture injuries adjusted to a 35 year old group

25. Fracture of ankle

Profile

A total of 395 persons, from 5 studies, who experienced a fracture of the ankle were included in the analysis. The average age at time of injury was 42 years (SD=18, range 5-82). The injury group was 46% male. Injuries between the ages of 5 and 39 contributed 45% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	62%	178
40 - 59	39%	145
60-82	21%	72
All	46%	395

Table 53 Age and sex of ankle fracture group

The average number of times the EQ-5D was applied to each person was 2.1 (range 1-4). On average, the EQ-5D was first administered 77 days following injury: the mean for subsequent observations was 215 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 413 days after the date of injury.

Injury group norm values

VAS score predictions were relatively low three days post injury VAS=69 (95%CI 63,76). Over the following one year a very gradual increase in VAS was predicted (Figure 33).

Impairment in *mobility* and *usual activities* was very high in the first month after injury (Table 53). Recovery was rapid during the first 180 days for these dimensions.

Self-care was less affected initially than *mobility* and *usual activities*, and the predicted probability dropped markedly in the first 30 days after injury (Figure 32).

A marginal relationship with time was found with *pain and discomfort*, which had a low prediction at three days. *Cognitive function* did not appear to effect the injury, and did not show any conclusive relationship with time (Table 54).

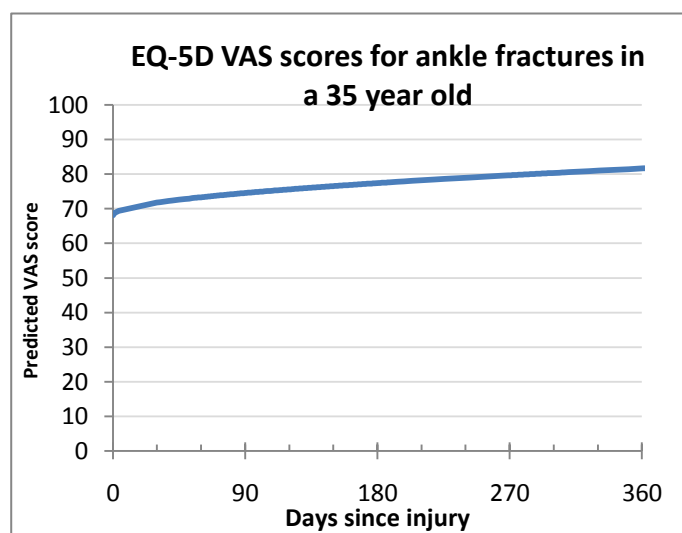


Figure 31 VAS score predictions for ankle fracture injuries adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	69 (63,76)	1.00 (0.996,1.00)	0.821 (0.243,0.985)	0.999 (0.989,1.00)	0.108 (0.008,0.635)	†	<0.001 (<0.001,0.019)
30	72 (68,76)	0.994 (0.959,0.999)	0.184 (0.062,0.435)	0.978 (0.912,0.995)	0.061 (0.016,0.206)	†	<0.001 (<0.001,0.007)
120	76 (72,79)	0.632 (0.328,0.858)	0.006 (0.001,0.038)	0.426 (0.240,0.634)	0.024 (0.008,0.069)	†	<0.001 (<0.001,0.007)
360	82 (77,86)	0.103 (0.023,0.358)	<0.001 (<0.001,0.008)	0.055 (0.015,0.179)	0.006 (0.001,0.033)	†	<0.001 (<0.001,0.004)

Table 54 EQ-5D norms for ankle fracture group adjusted to 35 years † A model could not be fitted due to discordant data

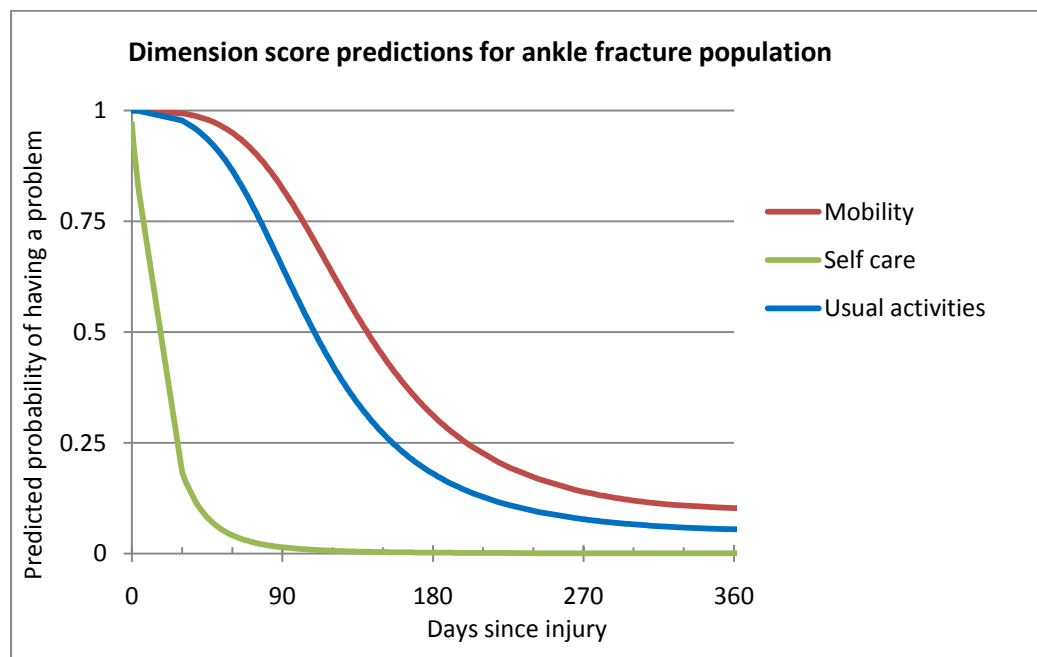


Figure 32 Dimension score predictions for ankle fracture injuries adjusted to a 35 year old group

26. Fracture of foot

Profile

A total of 292 persons, from 4 studies, who experienced a fracture of the foot were included in the analysis. The average age at time of injury was 41 years (SD=18, range 5-90). The injury group was split evenly by sex male (50% male). Injuries between the ages of 5 and 39 contributed 47% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	58%	137
40 - 59	47%	114
60-90	29%	41
All	50%	292

Table 55 Age and sex of foot fracture group

The average number of times the EQ-5D was applied to each person was 1.9 (1,3 range). On average, the EQ-5D was first administered 66 days following injury: the mean for subsequent observations was 225 days. The first measurement of the EQ-5D was 12 days after the injury. The last follow-up EQ-5D assessment was made 506 days after the date of injury.

Injury group norm values

The VAS score prediction for foot fractures was high at 30 days, and had a very gradual increase over one year to a VAS score of 85 (95%CI 80,89).

The probability of having problems across the dimensions was low in comparison to other lower extremity fractures. *Mobility, usual activities or pain and discomfort* were the highest predictions, but due to the width of the 95%CI, it was not possible to discern between them with certainty (Table 55). *Self-care* predicted impairment was marginal, and had a marked improvement over time. *Anxiety and depression* and *cognitive function* were both marginal in their association with both the injury and time from injury.

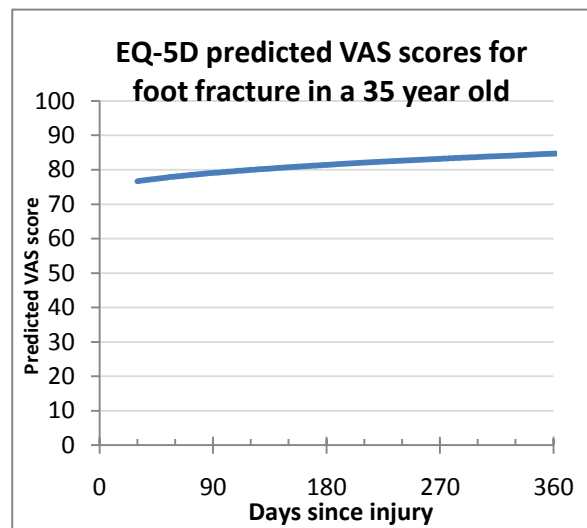


Figure 33 VAS score predictions for foot fracture adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	77 (73,81)	0.686 (0.248,0.936)	0.170 (0.069,0.362)	0.554 (0.079,0.948)	0.731 (0.368,0.927)	0.032 (0.005,0.172)	0.003 (<0.001,0.021)
120	80 (77,83)	0.253 (0.056,0.660)	0.035 (0.013,0.088)	0.133 (0.011,0.675)	0.589 (0.267,0.850)	0.011 (0.002,0.071)	0.003 (0.001, 0.010)
360	85 (80,89)	0.072 (0.009,0.390)	<0.001 (<0.001,0.003)	0.047 (0.003,0.454)	0.208 (0.048,0.576)	0.007 (<0.001,0.068)	0.001 (<0.001,0.013)

Table 56 EQ-5D norms for foot fracture injuries adjusted to a 35 year old group *Predictions were not made outside of the collected data

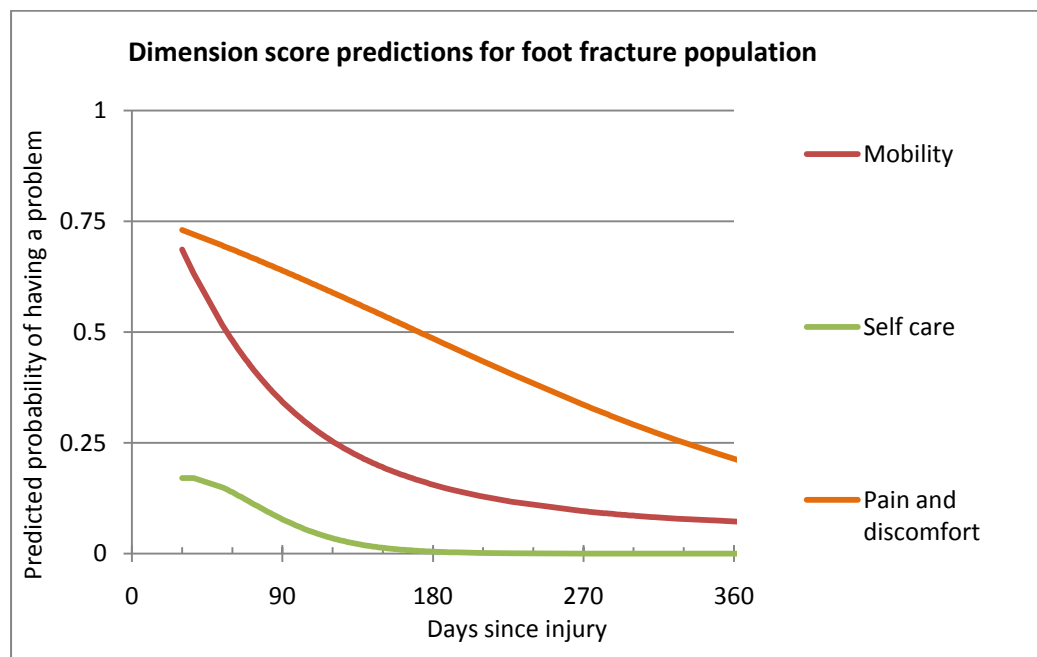


Figure 34 Dimension score predictions for foot fracture injuries adjusted to a 35 year old group

27. Dislocation / sprain / strain of knee

Profile

A total of 1432 persons, from 8 studies, who experienced a dislocation, sprain or strain of the knee were included in the analysis. The average age at time of injury was 40 years (SD=13, range 5-90). The injury group was predominately male (62%). Injuries between the ages of 5 and 39 contributed 50% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	67%	718
40 - 59	57%	627
60-90	55%	87
All	62%	1432

Table 57 Age and sex of knee joint sprain/ strain/ dislocation injuries

The average number of times the EQ-5D was applied to each person was 1.3 times (range 1-3). On average, the EQ-5D was first administered 95 days following injury: the mean for subsequent observations was 398 days (SD=326). The first measurement of the EQ-5D was 2 days after the injury. The last follow-up EQ-5D assessment was made 2403 days after the date of injury.

Injury group norm values

The predicted VAS scores post knee injury were relatively high and had a very gradual increase over the one year predicted (Table 57).

Pain and discomfort, usual activities and mobility appeared to be the most affected of the dimensions (Figure 35). The highest predicted probability of problems was in *pain and discomfort*. The probability of having problems in *anxiety and depression* and *cognitive function* was marginal, and showed a marginal decrease with time. A suitable model did not converge for *self-care*, and visual inspection of the data led a possible hypothesis that this was due to many receiving surgery at greatly differing times after injury, and receiving surgery for the knee injury having an effect on the EQ-5D that was not controlled for in this analysis. Thus the predictions here reflect the knee strain injury group as whole, including those who undergo (and required) restorative surgery in a timely manner, and those that require surgery but do not receive it. The group as a whole were still experiencing problems in HRQoL at one year.

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	73 (68,77)	0.774 (0.557,0.903)	†	0.834 (0.685,0.921)	0.946 (0.861,0.980)	0.118 (0.050,0.254)	0.042 (0.005,0.292)
30	74 (71,78)	0.617 (0.450,0.761)	†	0.756 (0.635,0.847)	0.901 (0.807,0.952)	0.107 (0.058,0.189)	0.039 (0.009,0.163)
120	76 (73,79)	0.396 (0.267,0.541)	†	0.599 (0.491,0.699)	0.784 (0.654,0.875)	0.088 (0.052,0.146)	0.037 (0.011,0.123)
360	79 (76,82)	0.180 (0.098,0.306)	†	0.354 (0.245,0.480)	0.537 (0.360,0.705)	0.063 (0.032,0.120)	0.038 (0.008,0.163)

Table 58 EQ-5D norms for knee dislocation/ sprain/ strain injuries adjusted to a 35 year old group † Predicted values not produced

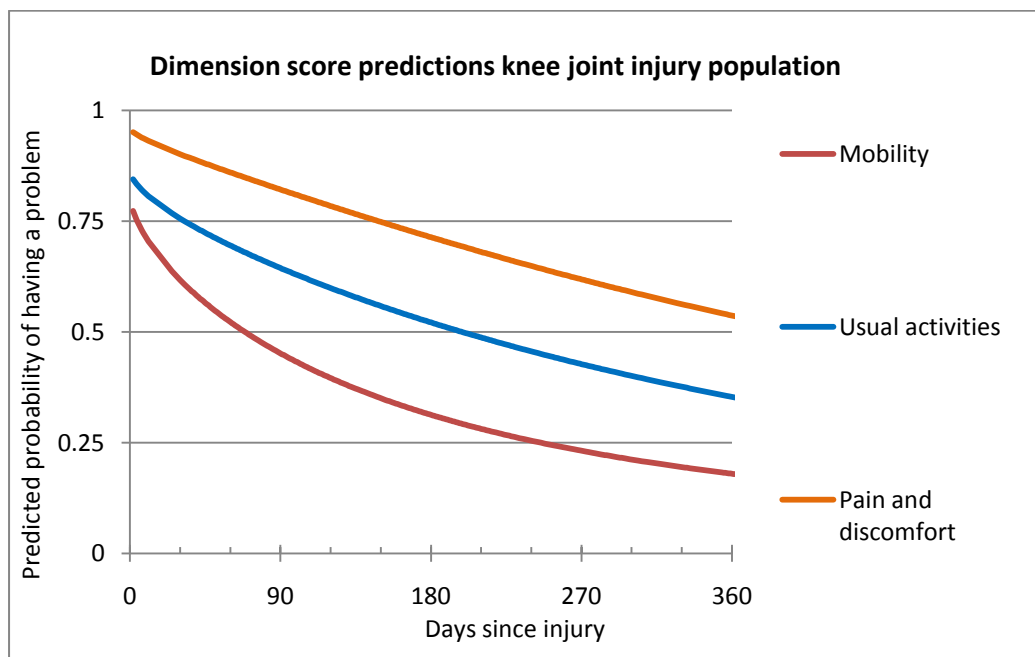


Figure 35 Dimension score predictions for knee dislocations/ sprains/ strains adjusted to a 35 year old population

28. Dislocation / sprain / strain of ankle / foot

Profile

A total of 416 persons, from 5 studies, who experienced a dislocation, sprain or strain of the ankle or foot were included in the analysis. The average age at time of injury was 39 years (SD=14, range 5-78). The injury group was 53% male. Injuries between the ages of 5 and 39 contributed 51% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	61%	212
40 - 59	45%	175
60-78	45%	29
All	53%	416

Table 59 Age and sex of ankle/ foot sprain/ strain/ dislocation injuries

The average number of times the EQ-5D was applied to each person was 1.7 times (range 1-4). On average, the EQ-5D was first administered 82 days following injury: the mean for subsequent observations was 216 days. The first measurement of the EQ-5D was 15 days after the injury. The last follow-up EQ-5D assessment was made 491 days after the date of injury.

Injury group norm values

Predicted VAS scores one month after injury were high (Figure 38), and by one year had reached a predicted score of 85 (95%CI 79,80). The dimensions of *mobility*, *usual activities* and *pain and discomfort* all experienced probabilities of having a problem that were elevated (Figure 39). Distinguishing between the three dimensions was difficult due width of the 95%CI. The remaining three dimensions of *self-care*, *anxiety and depression* and *cognitive function* had marginal, but not conclusive increases in the probability of having problems (Table 60). Most appeared to have recovered at one year.

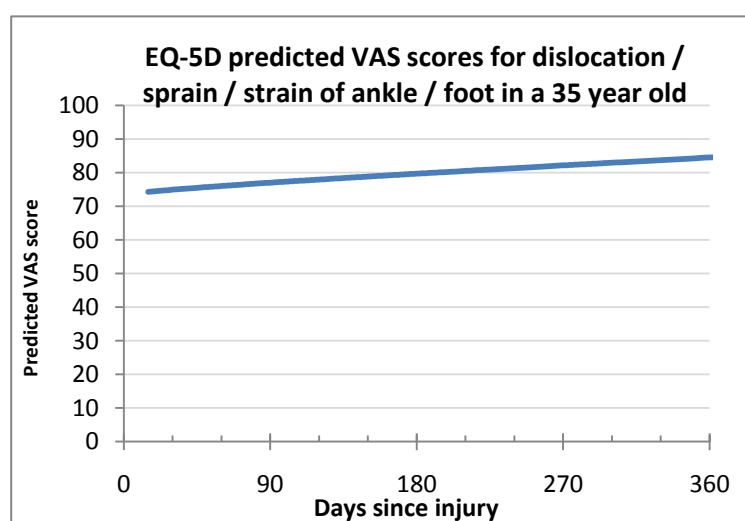


Figure 36 VAS score predictions for ankle/ foot dislocations/ strains/ sprains adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	75 (71,79)	0.716 (0.556,0.836)	0.083 (0.032,0.199)	0.681 (0.533,0.800)	0.807 (0.680,0.892)	0.056 (0.015,0.191)	0.002 (0.002,0.198)
120	78 (74,82)	0.505 (0.394,0.615)	0.030 (0.010,0.084)	0.430 (0.339,0.525)	0.710 (0.616,0.790)	0.028 (0.007,0.105)	0.006 (<0.001,0.090)
360	85 (79,90)	0.038 (0.011,0.124)	0.005 (<0.001,0.040)	0.046 (0.015,0.133)	0.118 (0.048,0.264)	0.009 (0.001,0.068)	0.002 (<0.001,0.073)

Table 60 EQ-5D norms for ankle/foot dislocations/ sprains/ strains in a group adjusted to 35 years old *Predictions were not made outside of the collected data

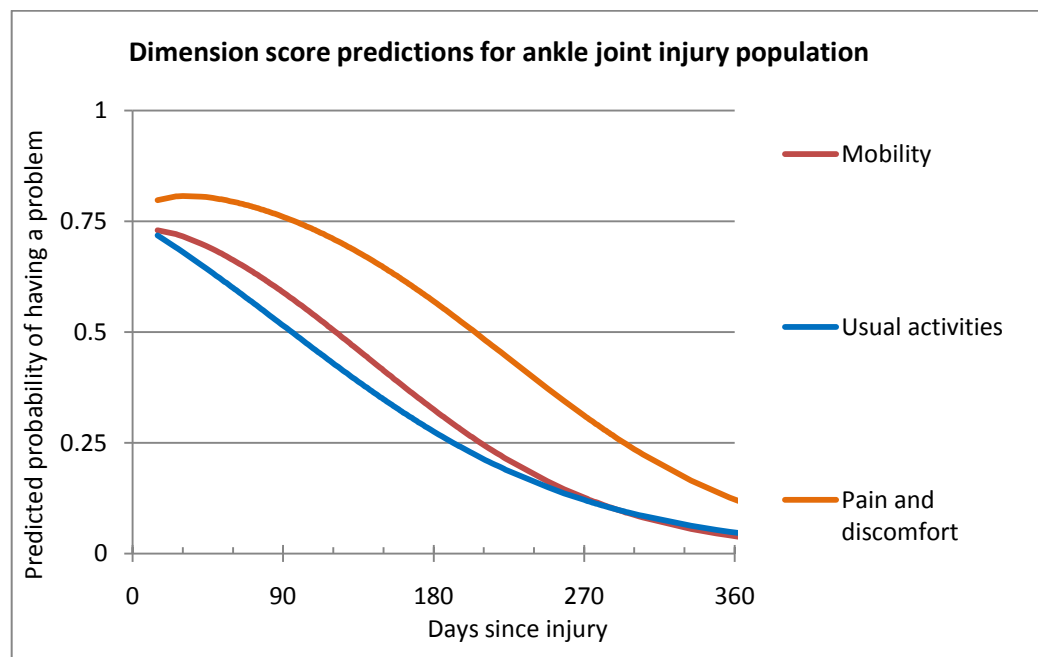


Figure 37 Dimension score predictions for ankle/ foot dislocations/ strains/ sprains adjusted to a 35 year old population

29. Dislocation / sprain / strain of hip

Profile

A total of 76 persons, from 4 studies, who experienced a dislocation, sprain or strain of the hip were included in the analysis. The average age at time of injury was 62 years (SD=20, range 5-92). The injury group was predominately female (34%). Injuries between the ages of 5 and 39 contributed 12% of the total count of injuries.

Age and sex profile		
Age	Male (n)	n
5-39	56% (5)	9
40 - 59	59% (10)	17
60-92	22% (11)	50
All	34% (26)	76

Table 61 Age and sex of hip dislocation/ sprain/ strain group

The average number of times the EQ-5D was applied to each person was 2.2 (range 1-3). On average, the EQ-5D was first administered 72 days following injury: the mean for subsequent observations was 214 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

The VAS estimates increased from VAS=71 (95%CI 59,82) at 30 days, to VAS=86 (95%CI 74,97) at one year (Figure 40). The large standard errors were likely from the low number of persons in this injury group n=76.

The dimension predictions showed that the levels of impairment were relatively high *mobility, usual activities* and *pain and discomfort*. There was also a slight recovery in *self-care* and *anxiety and depression* (Figure 39 dimensions, Table 62). Predictions within this injury group were limited by the accuracy of the model fitted.

This was most likely due to the low sample size.

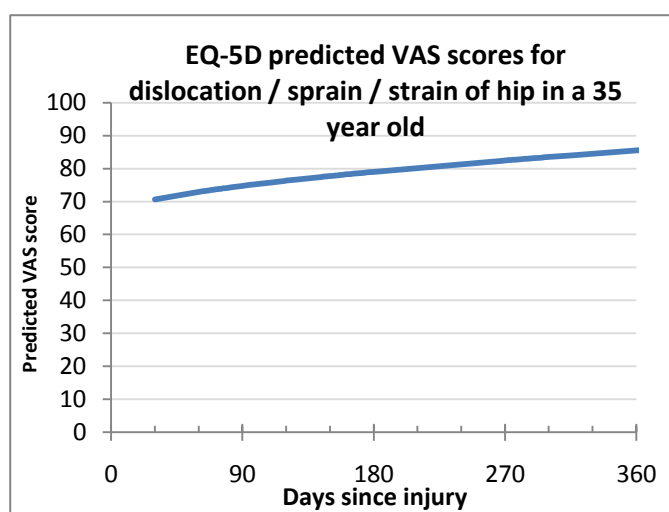


Figure 38 VAS score predictions for dislocation/ sprain/ strain of hip adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	71 (59,82)	0.886 (0.455,0.986)	0.452 (0.011,0.983)	0.972 (0.577,0.999)	0.933 (0.515,0.995)	0.334 (0.082,0.739)	<0.001 (<0.001,0.164)
120	76 (68,85)	0.603 (0.240,0.880)	0.168 (0.003,0.926)	0.654 (0.263,0.909)	0.612 (0.240,0.887)	0.130 (0.032,0.400)	<0.001 (<0.001,0.092)
360	86 (74,97)	0.055 (0.004,0.460)	0.003 (<0.001,0.446)	0.078 (0.005,0.615)	0.126 (0.011,0.659)	0.048 (0.005,0.333)	<0.001 (<0.001,0.075)

Table 62 EQ-5D norms for hip dislocation/ sprain/ strain adjusted to a 35 year old group *Predictions were not made outside of the collected data

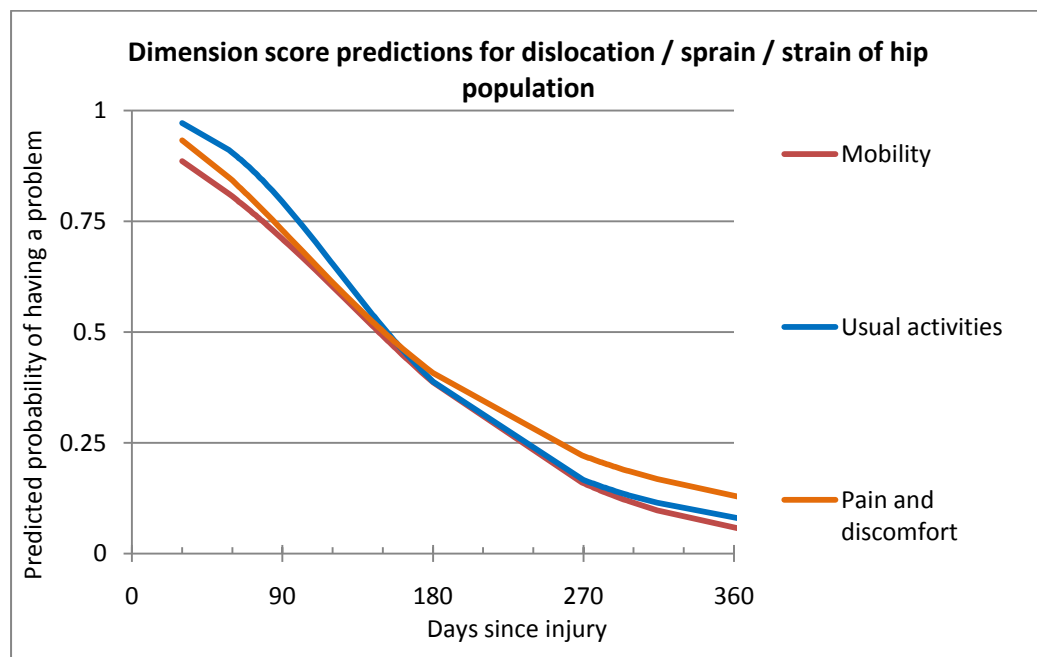


Figure 39 Dimension score predictions for hip dislocation/ sprain/ strain adjusted to a 35 year old group

30. Injury of nerves

Profile

A total of 3 persons, from one study, who experienced a injury of the lower limb nerves were included in the analysis. The average age at time of injury was 19 years (SD=10, range 8-28). The injury group contained one male, aged 22, and two females who were 8 and 28 years old. Statistical analysis was not performed due to the scarcity of the data.

Age and sex profile		
Age	Male (n)	n
8-39	1	3
40 - 59	0	0
60-96	0	0
All	1	3

Table 63 Age and sex profile, percentages omitted due to low number or persons

On average, the EQ-5D was first administered 71 days following injury: the mean for subsequent observations was 242 days (SD=326). The first measurement of the EQ-5D was 70 days after the injury. The last follow-up EQ-5D assessment was made 300 days after the date of injury.

Injury group norm values

No estimates were produced as the injury group sample included only three people.

31. Complex soft tissue injury of the lower limb

Profile

A total of 92 persons, from 3 studies, who experienced a complex soft tissue injury of the lower limb were included in the analysis. The average age at time of injury was 42 years (SD=16, range 6-87). The injury group was contained 49 males (53%). Injuries between the ages of 5 and 39 contributed 49% of the total count of injuries.

Age and sex		
Age	Male	n
6-39	53%	45
40 - 59	59%	37
60-87	30%	10
All	53%	92

Table 64 Age and sex of complex lower limb soft tissue injury group

The average number of times the EQ-5D was applied to each person was 2.3 times (range 1-3). On average, the EQ-5D was first administered 75 days following injury: the mean for subsequent observations was 219 days. The first measurement of the EQ-5D was 61 days after the injury. The last follow-up EQ-5D assessment was made 366 days after the date of injury.

Injury group norm values

The VAS estimates increased over time, but the accuracy of the predictions was affected by the group containing only 92 persons (Table 64). Problems in *pain and discomfort* were most common in the group, with *mobility* and *usual activities* also being affected (Figure 41). No strong association was found with the remaining dimensions, although the sample size may have been a factor (Table 64), and

influences the precision of the predictions presented.

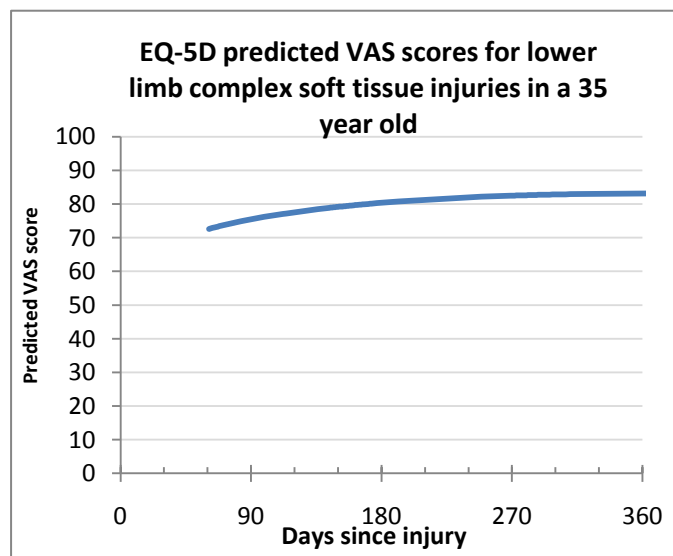


Figure 40 VAS score predictions for lower limb complex soft tissue injuries adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*
120	77 (71,83)	0.697 (0.324,0.917)	<0.001 (<0.001,0.182)	0.319 (0.161,0.532)	0.562 (0.329,0.771)	0.009 (<0.001,0.114)	<0.001 (<0.001,0.140)
360	83 (74,92)	<0.001 (<0.001,0.075)	<0.001 (<0.001,0.103)	0.028 (0.003,0.221)	0.184 (0.030,0.627)	<0.001 (<0.001,0.026)	0.004 (<0.001,0.405)

Table 65 EQ-5D norms for lower limb complex soft tissue injuries adjusted to a 35 year old group *Predictions were not made outside of the collected data

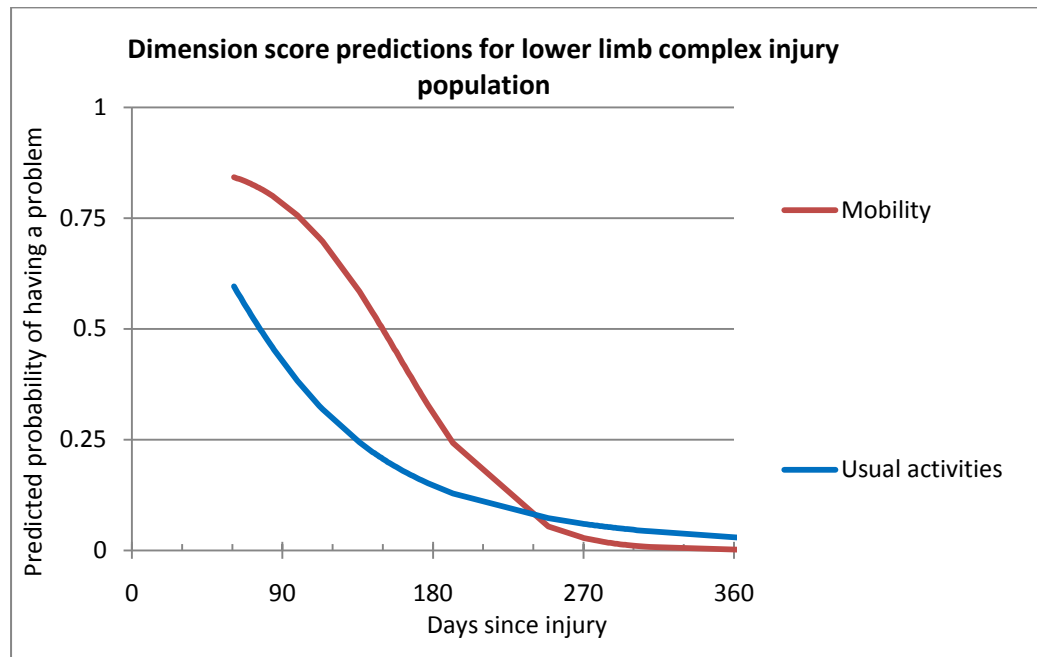


Figure 41 Dimension score predictions for lower limb complex soft tissue injuries adjusted to a 35 year old group

External injuries

32. Superficial injury (inc. contusions)

Profile

A total of 528 persons, from 5 studies, who experienced a superficial injury were included in the analysis. The average age at time of injury was 38 years (SD=22, range 5-98). The injury group was 47% male. Injuries between the ages of 5 and 39 contributed 60% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	50%	317
40 - 59	56%	114
60-98	29%	97
All	47%	528

Table 66 Age and sex of superficial injuries

The average number of times the EQ-5D was applied to each person was 2.0 times (range 1-4). On average, the EQ-5D was first administered 62 days following injury: the mean for subsequent observations was 226 days. The first measurement of the EQ-5D was 25 days after the injury. The last follow-up EQ-5D assessment was made 453 days after the date of injury.

Injury group norm values

Predicted VAS scores 30 days after a superficial injury were VAS=77 (95%CI 72,82), and there was a very slight improvement over the first 100 days (Figure 42).

Impairment was greatest for this group in *pain and discomfort* (Table 66).

Predictions were not produced for *self-care* or *cognitive function* due to the initial results during the fitting process producing estimates that were not feasible to fit a model. This was possibly due to the to responses recorded for these dimensions not being associated with superficial injury, but other factors present in the participants lives.

The *mobility*, *usual activities* and *anxiety and depression* indicated that the impact of the injury was mild, and that recovery was usually complete

for the group after 180 days (Figure 43).

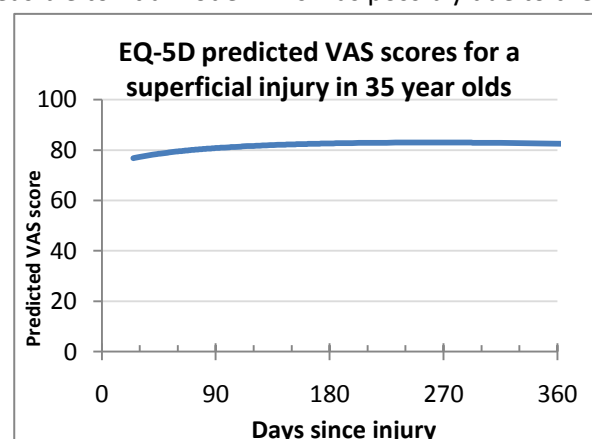


Figure 42 VAS score predictions for superficial injuries adjusted to a 35 year old population

	VAS	Mobility	Self care	Usual activities	Pain and discomfort	Anxiety & depression	Cognitive function
Day	(95% CI)	Predicted probability of having problems(95% CI)					
3	*	*	†	*	*	*	†
30	77 (72,82)	0.085 (0.030,0.221)	†	0.405 (0.242,0.592)	0.697 (0.482,0.851)	0.098 (0.042,211)	†
120	82 (77,86)	0.020 (0.006,0.062)	†	0.108 (0.043,0.248)	0.202 (0.092,0.390)	0.035 (0.014,0.089)	†
360	83 (78,87)	0.009 (0.002,0.042)	†	0.029 (0.009,0.042)	0.082 (0.029,0.212)	0.013 (0.003,0.048)	†

Table 67 EQ-5D norms for superficial injuries adjusted to a 35 year old group *Predictions were not made outside of the collected data † Models not fit to these dimensions

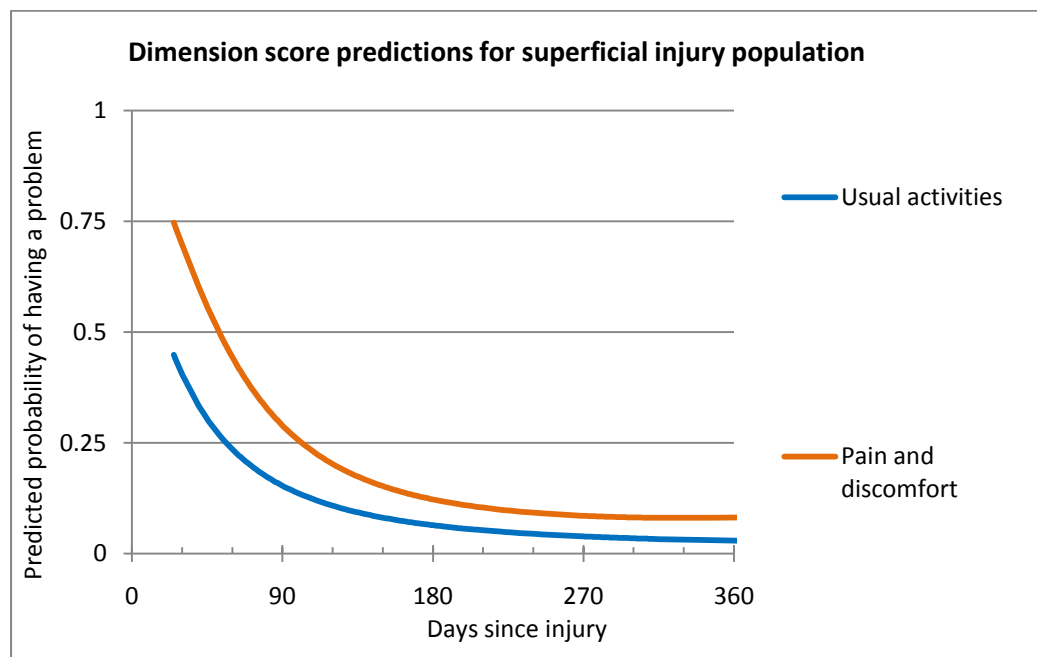


Figure 43 Dimension score predictions for superficial injuries adjusted to a group aged 35 years

33. Open wounds

Profile

A total of 347 persons, from 5 studies, who experienced an open wound were included in the analysis. The average age at time of injury was 40 years (SD=19, range 5-87). The injury group was predominately male (69%). Injuries between the ages of 5 and 39 contributed 53% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	76%	183
40 - 59	68%	108
60-96	50%	56
All	69%	347

Table 68 Age and sex of open wound injury group

The average number of times the EQ-5D was applied to each person was 1.7 (range 1-4). On average, the EQ-5D was first administered 62 days following injury: the mean for subsequent observations was 223 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 437 days after the date of injury.

Injury group norm values

With no measure of severity, and a wide range of severity present, a model was not fitted to this group.

34. Burns

Profile

A total of 103 persons, from 5 studies, who experienced a burn were included in the analysis. The average age at time of injury was 37 years (SD=16, range 8-86). The injury group was predominately male (67%). Injuries between the ages of 5 and 39 contributed 59% of the total count of injuries.

Age and sex profile		
Age	Male	n
8-39	67%	61
40 - 59	68%	34
60-86	63%	8
All	67%	103

Table 69 Age and sex of burn injury group

The average number of times the EQ-5D was applied to each person was 1.9 times (range 1-3). On average, the EQ-5D was first administered 54 days following injury: the mean for subsequent observations was 225 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

With no measure of severity, and low participant numbers n=103, a model was not fitted to this group.

35. Poisoning

Profile

A total of 40 persons, from 3 studies, who experienced a poisoning were included in the analysis. The average age at time of injury was 37 years (SD=18, range 6-76). The injury group sample contained 21 males (53%). Injuries between the ages of 6 and 39 contributed 53% of the total count of injuries.

Age and sex profile		
Age	Male (n)	n
6-39	52% (11)	21
40 - 59	53% (8)	15
60-76	50% (2)	4
All	53% (21)	40

Table 70 Age and sex of poisoning injury group

The average number of times the EQ-5D was applied to each person was 2.4 times (range 1-3). On average, the EQ-5D was first administered 74 days following injury: the mean for subsequent observations was 221 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

A model was not fitted due to low participant numbers.

36. Multitrauma

Profile

The injury group included multiple severe injuries that spanned more than one Eurocost code.

A total of 93 persons, from 3 studies, were coded as experiencing multiple major trauma. The average age at time of injury was 38 years (SD=15, range 18-70). The injury group was predominately male (57%). Injuries between the ages of 5 and 39 contributed 52% of the total count of injuries.

Age and sex profile		
Age	Male	n
18-39	60%	48
40 - 59	67%	30
60-70	27%	15
All	57%	93

Table 71 Age and sex of multitrauma injury group

The average number of times the EQ-5D was applied to each person was 2.3 times (range 1-4). On average, the EQ-5D was first administered 46 days following injury: the mean for subsequent observations was 195 days. The first measurement of the EQ-5D was one day after the injury. The last follow-up EQ-5D assessment was made 422 days after the date of injury.

Injury group norm values

Due to numbers predominately, a model was not fitted to this group.

Other injuries

37. Foreign body

Profile

A total of 42 persons, from 3 studies, injured by a foreign body were included in the analysis. The average age at time of injury was 44 years (SD=20, range 5-77). The injury group was predominately male (79%). Injuries between the ages of 5 and 39 contributed 36% of the total count of injuries.

Age and sex profile		
Age	Male (n)	n
8-39	67% (10)	15
40 - 59	84% (16)	19
60-96	88% (7)	8
All	79% (33)	42

Table 72 Age of profile of foreign body injury group

The average number of times the EQ-5D was applied to each person was 2.0 times (range 1-3). On average, the EQ-5D was first administered 82 days following injury: the mean for subsequent observations was 205 days. The first measurement of the EQ-5D was 59 days after the injury. The last follow-up EQ-5D assessment was made 369 days after the date of injury.

Injury group norm values

Due to low numbers of participants a model was not fitted to this group.

38. No injury after examination

Profile

A total of 39 persons, from 2 studies, were coded as not sustaining an identifiable injury on examination, despite their admittance to an Emergency Department with a perceived injury. The average age at time of injury was 38 years (SD=18, range 8-96). The injury group contained 18 males (62%). Injuries between the ages of 5 and 39 contributed 67% of the total count of injuries.

Age and sex profile		
Age	Male (n)	n
8-39	38% (10)	26
40 - 59	50% (4)	8
60-96	80% (4)	5
All	46% (18)	39

Table 73 Age and sex of group with no known injury after examination

The average number of times the EQ-5D was applied to each person was 2.4 times (range 1-3). On average, the EQ-5D was first administered 73 days following injury: the mean for subsequent observations was 217 days. The first measurement of the EQ-5D was 60 days after the injury. The last follow-up EQ-5D assessment was made 303 days after the date of injury.

Injury group norm values

Due to a low number of participants a model was not fitted to this group.

39. Other / unspecified injury

Profile

A total of 135 persons, from 4 studies, who experienced an unknown or unspecified injury were included in the analysis. The average age at time of injury was 40 years (SD=13, range 5-90). The injury group was 46% male. Injuries between the ages of 5 and 39 contributed 55% of the total count of injuries.

Age and sex profile		
Age	Male	n
5-39	55%	74
40 - 59	44%	34
60-90	22%	27
All	46%	135

Table 74 Age and sex of unclassifiable injuries

The average number of times the EQ-5D was applied to each person was 2.1 (range 1-3). On average, the EQ-5D was first administered 56 days following injury: the mean for subsequent observations was 230 days. The first measurement of the EQ-5D was 10 days after the injury. The last follow-up EQ-5D assessment was made 365 days after the date of injury.

Injury group norm values

Due to a low number of participants a model was not fitted to this group.

40. Amputations

Profile

A total of 24 persons, from 2 studies, who experienced an amputation were included in the analysis. The average age at time of injury was 42 years (SD=10, range 19-61). The injury group contained 19 males. Injuries between the ages of 5 and 39 contributed 55% of the total count of injuries.

Age and sex profile		
Age	Male (n)	n
5-39	89% (8)	9
40 - 59	79% (11)	14
60-90	0 (0)	1
All	79% (19)	24

Table 75 Age and sex of amputation injury group

The average number of times the EQ-5D was applied to each person was 1.7 (range 1-3). On average, the EQ-5D was first administered 77 days following injury: the mean for subsequent observations was 177 days. The first measurement of the EQ-5D was 30 days after the injury. The last follow-up EQ-5D assessment was made 367 days after the date of injury.

Injury group norm values

Due to the very low number of participants (n=24) fitting a regression model was not attempted.

General results and trends

The facets of HRQoL, represented by the EQ-5D measure, were affected differently depending on the injury sustained. In Table 76, the knee fracture injury group experiences a burden on their HRQoL that is similar to that experienced by the knee strain injury at 360 days post injury. Both the knee strain and the knee fracture group appear to have a relatively high likelihood of problems at 360 days in *pain and discomfort* (probability=0.537 and 0.441, respectively) and *usual activities* (probability=0.354 and 0.275, respectively). Despite the knee fracture having a greater acute effect on HRQoL immediately post injury (Table 52 and 58), the results show a similar level of problems can be present in less 'severe' injuries at 360 days. It also apparent that despite the initial impact of an injury differing, most injury groups appeared to have a moderate to high chance of experiencing a greater probability of having a problem in at least one facet of the EQ-5D.

Predicted EQ-5D norms at 360 days after injury adjusted to an injury group 35 years old at 360 days							
	EQ-5D dimensions Predicted probability of problems (95%CI)						EQ-5D VAS (95%CI)
	Mobility	Self-care	Usual activities	Pain and discomfort	Anxiety and depression	Cognitive Function	
Concussion	0.047 (0.018,0.115)	0.003 (<0.001,0.018)	0.265 (0.091,0.565)	0.281 (0.107,0.565)	0.115 (0.051,0.237)	0.025 (0.003,0.187)	75 (69, 82)
Other skull- brain injury	0.004 (<0.001,0.030)	<0.001 (<0.001,0.001)	0.019 (0.005,0.070)	0.028 (0.003,0.236)	0.103 (0.037,0.257)	0.363 (0.001,0.996)	80 (75, 85)
Open wound head	<0.001 (<0.001,0.096)	<0.001 (<0.001,0.294)	0.021 (0.002,0.197)	0.056 (0.004,0.464)	0.012 (<0.001,0.196)	0.003 (<0.001,0.255)	80 (75-85)
Eye injury	<0.001 (<0.001,0.0.461)	<0.001 (<0.001,0.949)	<0.001 (<0.001,0.136)	0.028 (0.001, 0.378)	*	0.022 (<0.001,0.502)	83 (75, 91)
Fracture facial bone	<0.001 (<0.001, 0.068)	<0.001 (<0.001, 0.357)	0.006 (<0.001,0.088)	0.066 (0.006,0.464)	0.012 (0.010,0.114)	<0.001 (<0.001,0.031)	83 (75, 91)
Vertebral column fracture	0.091 (0.024,0.286)	0.009 (0.002,0.041)	0.301 (0.110,0.600)	0.767 (0.469,0.924)	0.142 (0.068,0.274)	0.037 (0.009,0.133)	72 (65, 79)
Whiplash, neck sprain, distortion of cervical spine	0.003 (<0.001,0.062)	<0.001 (<0.001,0.063)	0.099 (0.021,0.358)	0.349 (0.108,0.702)	0.076 (0.019,0.260)	0.014 (<0.001,0.584)	83 (75, 90)
Internal organ injury	0.022 (0.002,0.196)	<0.001 (<0.001,0.114)	0.022 (0.002,0.224)	0.101 (0.010,0.565)	0.114 (0.020,0.454)	0.006 (<0.001,0.320)	85 (76, 94)
Fracture of rib/ sternum	0.016 (0.002,0.105)	0.004 (<0.001,0.053)	0.025 (0.003,0.163)	0.169 (0.040,0.49.6)	0.040 (0.004,0.089)	<0.001 (<0.001,0.024)	83 (78, 88)
Fracture of clavicle/ scapula	*	<0.001 (<0.001,0.022)	0.094 (0.019,0.357)	0.052 (0.008,0.276)	<0.001 (<0.001,0.008)	<0.001 (<0.001,0.024)	88 (81, 95)
Fracture of upper arm	0.021 (0.006,0.080)	0.007 (0.001,0.040)	0.202 (0.032,0.662)	0.260 (0.049,0.705)	0.022 (0.006,0.079)	0.002 (<0.001,0.025)	82 (75, 88)
Fracture of elbow/ forearm	<0.001 (<0.001,0.009)	0.001 (0.002,0.047)	0.182 (0.073,0.385)	0.286 (0.093,0.611)	0.030 (0.001,0.089)	<0.001 (<0.001,0.027)	84 (79, 89)
Fracture of hand/ fingers	0.002 (<0.001,0.041)	<0.001 (<0.001,0.018)	0.022 (0.004,0.116)	0.133 (0.045,0.335)	0.002 (<0.001,0.034)	0.001 (<0.001,0.071)	83 (78, 88)
Dislocation/ sprain/ strain shoulder/ elbow	0.010 (0.001,0.069)	0.025 (0.005,0.107)	0.098 (0.027,0.297)	0.321 (0.128,0.605)	0.023 (0.004,0.112)	0.005 (<0.001,0.059)	82 (77,88)
Fracture of the pelvis	0.071 (0.009,0.383)	0.005 (<0.001,0.069)	0.148 (0.030,0.496)	0.471 (0.124,0.849)	0.053 (0.010,0.226)	0.005 (<0.001,0.063)	78 (69, 87)
Fracture of the hip	0.775 (0.575,0.897)	0.212 (0.124,0.340)	0.632 (0.484,0.759)	0.754 (0.614,0.855)	0.156 (0.080,0.282)	†	65 (61, 70)
Fracture of the femur shaft	0.156 (0.025,0.575)	0.039 (0.06,0.220)	0.488 (0.172,0.814)	0.601 (0.233,0.882)	0.025 (0.004,0.157)	†	81 (73, 88)
Fracture of the knee/ lower leg	0.226 (0.106,0.420)	0.010 (<0.001,0.034)	0.275 (0.101,0.561)	0.441 (0.207,0.704)	0.056 (0.020,0.136)	0.030 (0.008,0.102)	80 (73, 86)
Fracture of the ankle	0.103 (0.023,0.358)	<0.001 (<0.001,0.008)	0.055 (0.015,0.179)	0.006 (0.001,0.033)	†	<0.001 (<0.001,0.004)	82 (77, 86)
Fracture of the foot	0.072 (0.009,0.390)	<0.001 (<0.001,0.030)	0.047 (0.003,0.454)	0.208 (0.048,0.576)	0.007 (<0.001,0.068)	0.001 (<0.001,0.013)	85 (80, 98)
Dislocation/ sprain/ strain of knee	0.180 (0.098,0.306)	†	0.354 (0.245,0.480)	0.537 (0.360,0.705)	0.063 (0.032,0.120)	0.038 (0.008,0.163)	79 (76, 82)

Dislocation/ sprain/ strain of ankle/ foot	0.038 (0.011,0.124)	0.005 (<0.001, 0.040)	0.046 (0.015,0.133)	0.118 (0.048,0.264)	0.009 (0.001,0.068)	0.002 (<0.001,0.073)	85 (75, 90)
Dislocation/ sprain/ strain of hip	0.055 (0.004,0.460)	0.003 (<0.001,0.446)	0.078 (0.005,0.615)	0.126 (0.011,0.659)	0.048 (0.005,0.333)	<0.001 (<0.001, 0.075)	86 (74, 97)
Complex soft tissue injury of the lower limb	0.001 (<0.001, 0.075)	<0.001 (<0.001, 0.103)	0.028 (0.003, 0.221)	0.184 (0.003,0.627)	<0.001 (<0.001,0.026)	0.004 (<0.001,0.405)	83 (74, 92)
Superficial injury	0.009 (0.002,0.042)	†	0.029 (0.009,0.092)	0.082 (0.029,0.212)	0.013 (0.003,0.048)	†	83 (78, 87)

Table 76 Predictions for injury groups at 360 days. *Collected data did not include this time point †A model was not produced for this facet of the EQ-5D

Discussion

This study elicited the HRQoL pathways to recovery across the spectrum of injury types within the first year post injury. Presented in this chapter is a discussion of the results from this study. First I have presented a discussion of the general findings. Second, the results are broken down by general injury location and type. Third, I have provided an exploration of the strengths and weaknesses inherent in the study, and then placed this study within the context of what exists in the literature. Lastly, I discussed what the possible implications of this study are, what questions this research was unable to address, and where further research would be advantageous.

Principal findings

General trends

As can be expected, the biggest driver of injury outcome is the type of injury itself, with injuries included in this study ranging from superficial bruises (contusions) through to paralysis and catastrophic severe multiple traumas. This diversity was reflected in both the predictions made and the ability to produce a relationship between outcome and time through to one-year after an injury. In injury categories like poisoning (n=40), amputations (n=24) and lower limb nerve injuries (n=3) predictions were hindered by a low number of participants. In other cases the categories themselves contained a diverse spectrum of injuries, making predictions for the group difficult. These problems I discuss in greater detail in a later section of the discussion (pg 106).

Predictions were produced in 22 of the injury categories explored at 30 days post injury and a total of 24 at 360 days. Injury categories where predictions were not produced were influenced by the rarity of an injury, the scope of severity within a Eurocost category or the small effect of a more minor injury in prospective prediction of HRQoL outcomes.

The impact of pain and discomfort, usual activities and mobility

Across the majority of the injury categories where predictions were made, *pain and discomfort* was the most severe dimension at 30 days post injury (n=21, 78%) of the five EQ-5D dimensions, plus cognition, evaluated. This trend continued at 360 days post injury, with the majority of the injury categories where the predicted probability in any dimension exceeded 0.09 containing *pain and discomfort* as the worst affected dimension (n=18, 86%). The decision of not including studies without a predicted probability in any dimension above 0.09 removed 5 studies at 360 days post injury, as it can be assumed that any impairment is likely to be the base rate in the population, with the effects of the injury no longer being discernable. Although an overlap of confidence limits with other dimensions made highlighting one dimension as 'more severe' problematic, *pain and discomfort* was consistently the most severely affected EQ-5D dimension after injury at both 30 days and 360 days after injury.

Interestingly in several injury categories pain and discomfort only became the most prominently affected dimension at one-year post injury. In pelvis fractures, *usual activities* and *mobility* problems were significantly elevated at 30 days post injury (probability=1.00 and 1.00, respectively). Impairment in *pain and discomfort*, despite having a greater error estimate, was also highly elevated (probability=1.00). At 360 days predictions of any problems in *mobility* (probability=0.071, 95%CI

0.009, 0.383), or *usual activities* (probability=0.148, 95%CI 0.030, 0.496) showed that despite large variation in final outcomes, recovery had progressed strongly within this group. Conversely, *pain and discomfort*, which showed less severe problems at 30 days, contained the most severe predictions of any dimension at 360 days (probability=0.471, 95%CI 0.124, 0.849). A similar relationship was also found in fractures of the femur and lower leg, where initial poor outcomes in *usual activities*, were replaced by a slower rate of recovery in *pain and discomfort* at 360 days post injury.

While *pain and discomfort* was the most severely affected dimension in the majority of injury regions, this was not true for internal organ injuries, hip strains, as well as fractures of the ankle, lower leg/ knee, femur and pelvis. For internal organ injuries the predominately-affected dimension was *usual activities* (probability at 30 days=0.923). Although this assertion is limited by a lack of precision around the predictions for any problems in *pain and discomfort* (probability=0.905 95%CI 0.450,0.991). The remaining dimensions contained only slight increases, with wide confidence intervals, showing that while the impairment of the remaining dimensions was slight, there was a degree of variation in severity across the population. For many injury categories *pain and discomfort*, *mobility* and *usual activities* were all elevated beyond the other dimensions, with *pain and discomfort* appearing to be the most affected dimension in injury.

Injury and anxiety and depression, cognitive function and self-care

Burström established that in a general Dutch population, aged 30-39, 28.4% (SE=1.9) would be expected to report any problems in *anxiety and depression* (Burström, Johannesson et al. 2001). With this in mind it is probable that the majority of impairment in this dimension is a background rate present in this population. It appeared, when injuries were grouped by Eurocost, *anxiety and depression* was not significantly affected across most of the injury groups. For predictions at 30 days post injury only whiplash type injuries (probability=0.497 95%CI 0.256, 0.738) had a probability of problems that was high, and inherent within this prediction was a large level of variation in the presence of impairment amongst the collected sample.

In general, the dimensions of *self-care* and *cognitive function* were also affected to a lesser degree than the dimensions of *mobility*, *usual activities* and *pain and discomfort*. Where injured persons experienced high levels of impairment in *self-care*, it was usually immediately post injury with a rapid reduction of impairment within the first 30 days. The rapid improvement in *self-care* can be seen in fractures of the hip, lower and upper leg, and forearm within this study.

When comparing *usual activities* to *self-care* it becomes apparent that the dimension of *usual activities* is consistently effected more severely after injury. This is a finding that is mirrored in the general population (Dolan, Gudex et al. 1995; Kind 1996).

The recovery profile dichotomy: strains and fractures

Within limb injuries, recovery curves differed between strains and fractures across the dimensions. In upper limb fractures initial levels of impairment in *usual activities* and *pain and discomfort* were high, with a rapid decrease in impairment reaching a plateau around 180 days post injury. Within dislocations, sprains and strains of the shoulder and elbow much less severe impairment was present immediately post injury, but the pathway to 'no problems' was relatively gradual.

The presence of impairment in a dimension was elevated in the lower limb, and so too was the differing nature of relationships between strains and fractures for the lower limb. At 30 days post injury impairment in *mobility* (probability=0.996, 95%CI 0.969, 1.00) and *usual activities* (probability=1.00, 95%CI 0.995, 1.00) were severe in fractures of the knee and lower leg. In comparison the predicted probability for a strain, in the same anatomical location, were 0.774 (95%CI 0.557, 0.903) for *mobility* and 0.834 (95%CI 0.685, 0.921) for *usual activities*. While the level of impairment decreased rapidly in the fracture group, the recovery was much slower in the group with strains and the two injury types exhibited similar levels of impairment at 180-270 days post injury. When *pain and discomfort* is compared between strains and fractures a different relationship is present. The predicted probability of any problem in *pain and discomfort* after a knee or lower leg fracture was 0.954 (95%CI 0.789, 0.991) at 30 days and 0.441 (95%CI 0.0207, 0.704) at 360 days post injury. In strains of the same anatomical location the predicted probabilities were 0.946 (95%CI 0.861, 0.980) and 0.537 (95%CI 0.360, 0.705) at 30 and 360 days, respectively. Thus despite impairment in *mobility* and *usual activities* being significantly more severe, it appears that the impact on *pain and discomfort* is difficult to differentiate between strains and fractures in the knee and lower leg. In fact within injuries of the ankle *pain and discomfort* after a strain (probability=0.807 95%CI 0.680, 0.892) is more severe than it is 30 days after a fracture (probability=0.061 95%CI 0.016, 0.206).

As a comparison, within a derived aggregate measure of the HRQoL the greater absolute severity of a fracture over a strain is established both in novel measures (Haagsma, van Beeck et al. 2008), and within the EQ-5D (Polinder, Meerdering et al. 2005).

Findings specific to injury regions

Injuries of the head, face, skull and brain

The predictions imply that this aggregate injury group did not experience severe impairment in HRQoL. This is likely reflective of the lack of stratification of severe and less severe head injuries within the Eurocost groupings. Thus the very wide confidence intervals produced are indicative of the variation present within each injury category. An exception was *pain and discomfort* for those sustaining fractures of the facial bone (probability at 30 days=0.846, 95%CI 0.384, 0.980).

Within the injury category of 'other skull or brain injury' were TBIs, along with injuries to the skull without a clinically diagnosed effect on cognition. The HRQoL consequences of TBI can be drastic and long lasting (Tomberg, Toomela et al. 2005). As TBI was included in this group, it is not surprising that the probability for any problems in *cognitive function* showed a diverse range of outcomes at one year 0.363 (95%CI 0.001, 0.996) in the skull-brain injury category. This result likely represents the diversity of injury types present in the Eurocost group used (Polinder, Meerdering et al. 2008b). It is highly likely that within this category were severely debilitating brain injuries, through to skull injuries with minimal sequelae related to cognitive function. Indeed, this is reflected in the confidence intervals around the prediction (95%CI 0.001, 0.996).

The concussion injury group predictions are especially of interest, as this population is likely to be affected by both the nature of the injury and the variability, in both symptoms, and reported symptoms (Broglia, Macciocchi et al. 2007). The population itself was difficult to collect data from. This is evidenced by the lack of data at 30 days in a variety of studies that contributed concussed participants (Lyons, Towner et al. 2007; Derrett, Langley et al. 2009). Thus while impairment across the dimensions and VAS were low for concussion in all but *self-care*, it is likely most of this association is an artefact related to this young population, and its propensity to both under report symptoms, and place itself at risk of other events that would impact the EQ-5D (Broglia, Macciocchi et al. 2007).

Injuries of the back, neck and abdomen

The VAS, which reports the participant's current overall subjective rating of health status, was the lowest for the injury group which included vertebral column fractures, dislocations, sprains and strains. Despite this there was a very large increase in subjective self-assessed health from 3 days (VAS=42, 95%CI 36, 49) to that predicted at 120 days post injury (VAS=70, 95%CI 64, 76). The injured

person's assessment of his or her health then experienced little gain though to 360 days post injury (VAS=72, 95%CI=65, 79). This plateau was reflected in the dimension score predictions, with recovery in the dimensions (excluding *cognitive function*) appearing to plateau within the first 120 days post injury (Figure 10). However the descriptive nature of this study means we cannot determine if this is due to an adaption to physical limitations allowing impairment to be mitigated, or recovery of previous function (Menzel, Dolan et al. 2002). *Cognitive function*, the sixth EQ-5D dimension, did not appear to have an association with injuries of the torso. Noticeably, *pain and discomfort* was the only dimension significantly impacted at 360 days post injury, yet the VAS score remained significantly below that which would be expected in a healthy population.

Assessing subjective health states is problematic for SCI especially, where both adaption (Menzel, Dolan et al. 2002), and a very large scope of severity may be present in the sequelae from two similar injury events. For instance the presence of complications such as spasticity and/or incontinence can greatly worsen HRQoL outcomes despite the anatomical damage from different injury events being very similar (Westgren and Levi 1998). The greatly varied impacts of SCI are shown in the large confidence intervals around the predictions produced (Table 24).

Injuries involving internal organs and rib fractures appeared to predominately affect the dimensions of *pain and discomfort* and *usual activities*, although a lack of numbers limited the results. It is likely that a comprehensive picture of the HRQoL outcomes for this injury category was not achieved in this analysis due to the injury category being too general.

Upper limb fractures

Within fractures of the upper arm, elbow, and forearm, very similar levels of impairment were present in *usual activities* and *pain and discomfort*. For fractures of the wrist and hand a similar pattern, of much less severe impairment, was present. Although by 120 days defining the effect of the injury on HRQoL was difficult due to a lack of precision around the predictions for the EQ-5D facets and possible base rates of impairment in the population.

Upper limb strains

Dislocations, sprains and strains of the shoulder showed a slight level of impairment in *self-care*, *usual activities*, and *pain and discomfort*. Initial impairment in this injury group was less than fractures, but recovery to 'no problems' was slower. This led to higher levels of impairment at 360 days post injury.

Lower limb fractures

Pain and discomfort did not appear to be the worst dimension affected in fractures of the lower limb, contrary to the majority of the other injury categories. The caveat remaining was that these three dimensions were not different to the point of having 95%CI that did not cross. Within fractures of the lower limb (excluding foot) the levels of impairment in *mobility*, *pain and discomfort* and *usual activities* were all elevated above the other dimensions to a similar degree. Noticeably, while *self-care* was elevated in relation to less severe injuries, it did not appear to be affected to the same degree as the other dimensions within this subset. The predictions showed that while a slight impairment in *anxiety and depression* was present in fractures of the knee, lower leg and femur, this dimension and *cognitive function* experienced little discernable effect from fractures of the lower limb.

Lower limb strains

As with fractures of the lower limb, HRQoL outcomes were driven by impairment in *mobility*, *usual activities* and *pain and discomfort*. Dislocation, sprains and strains of the hip proved a problematic group due to the presence of two distinct subsets within the injury category. Preliminary scatter plots showed a small number of severely impaired young males were present, whilst within the same injury category existed a larger group of moderately impaired, mainly older female, injured persons. While the results presented are adjusted to a 35 year old population, neither this adjustment, nor an adjustment to a 75 year old population, would accurately mirror the makeup of this population well.

Strengths and weaknesses of the study

The EQ-5D

The questionnaire

The EQ-5D is widely used internationally in a variety of clinical and general population studies. Because this study involves datasets that were sourced internationally, it is imperative that the EQ-5D show minimal variation in interpretation between the populations it was applied to. While variance is undoubtedly likely to occur in the meaning a participant ascribes to response options due to contextual factors like localised customs and language, diligent processes were put into developing the EQ-5D and its regional variants to minimise any regional effect (Rabin and Charro 2001).

The EQ-5D construct of quality of life

Quality of life is a construct. More specifically HRQoL is a specific construct that can take on different variants depending on where it is used and how it is measured. This allows many general HRQoL measures to co-exist. As a specific comparison the EQ-5D shares many similarities with the Health Utilities Index (HUI) (Feeny, Furlong et al. 1995) in that both are relatively short, aimed at supplementing more condition-specific measures and have been promoted for use in an injury context (Van Beeck, Larsen et al. 2007). Yet despite the similarities in the measures inherent differences will be present in the construct of HRQoL they describe. Without a gold standard of HRQoL to compare to, the validity and reliability of the EQ-5D is best assessed from the comparison of the measure to current measures like the HUI, and the theoretical discriminate validity of the measure.

Within hip injuries, knee, ankle and TBI several studies have commented on the discriminative validity of the EQ-5D in identifying those with clinical recovery (Hollingworth, Mackenzie et al. 1995; Lash, Horne et al. 2002; Tidermark, Bergstrom et al. 2003; Tidermark and Tidermark 2003; Bell, Temkin et al. 2005). Likewise, literature supports the ability of the EQ-5D to identify differences in severity, across anatomical locations and within injuries in general (Meerding, Looman et al. 2004).

General HRQoL questionnaires are also faced with maintaining sensitivity within 'healthy', moderately impaired and severely 'unhealthy' populations. To this end the EQ-5D has been criticised for an apparent lack of sensitivity (Janssen, Birnie et al. 2007). This was seen in the ability of the EQ-5D to describe health states in a healthy American population. It is worth noting here that this lack

of sensitivity compared to larger HRQoL measures is not necessarily a problem. This is because the focus within the dimensions was on the presence of 'any problems', with an emphasis on the pathway to 'no problems'. Therefore further detail on the severity of impairment in any dimension would not have aided this study.

Even within a single healthcare system, variation is present in personal and cultural beliefs, preferred treatment protocols and healthcare utilisation (Hawkes 2009; Lilford and Richards 2009). Furthermore there are countless other influences on HRQoL that are distributed throughout a population (Teachman 1980). This diversity implies that for two identical injuries, within the same health system, a variation on HRQoL outcomes can be expected due to factors like co morbidities, income, etc. that may or may not be related to the injury event. Usually the collection and analysis of a multitude of variables enables the effect of these influences to be lessened. Within this study only the EQ-5D responses, age, sex, injury and time from injury were collected. This prevents the removal of elements that may share an association with both the injury and HRQoL. This did not prevent the study aim of producing population level norm data being completed. The EQ-5D is a general non-disease specific profile of HRQoL. This means that both the dimensions and the VAS are not directly targeted at eliciting solely the effects of an injury. Instead the EQ-5D results presented here represent the health profile of a group that has experienced an injury. Inherent within this group may be confounders that bias the outcomes presented. This bias is not entirely unwelcome though, as injury specific studies are better placed to directly assess the causes of poor outcome in an injury, while this study assesses the broader picture of what the greater injury population experiences.

Precision of predictions

Across the predictions made the confidence bounds produced for the VAS showed a moderate level of imprecision. This study explored the spectrum of injury and it is highly likely that for many injuries there is little impact of that specific injury and that person's subjective assessment of their health state weeks, or possibly even a day, later. This problem was only compounded when the association explored in this study was an injured population's health state and time since the injury. Despite this, differences in VAS are present between injuries, as an example predicted VAS scores 30 days post pelvis fracture (VAS=61 95%CI 53, 70) are discernibly different from superficial injury (VAS=77 95%CI 72, 82). Comparisons of VAS scores between injuries of similar severity though are both problematic, and as a general rule, not useful, due to the wide errors associated with VAS predictions within this study.

Within the dataset, responses were clustered around 10, 30, 90, 120, 365 days post injury. Where the clusters of responses appeared affected where good predictions could be made. This could simply be because the presence of only a handful of responses at a late time point may not be well represented in the tail of a regression curve. As the few predictions for a single, very late time point, would be heavily influenced by the large number of responses that may be clustered at an earlier time. To prevent this, predictions were only presented when the specified model was well represented in an exploratory raw data plot of time and EQ-5D response.

Predictions within the study were adjusted to a 35 year old population except for hip fractures, which were adjusted to represent a 75 year old population. This was an arbitrary decision to enable a comparison between different injury categories without departing greatly from the average and median age of injury for each category. There was variation in mean age between injury groups, and more importantly multiple distinct age profiles present within an injury group. For example pelvis fractures contained a small young group of males, with severe levels of impairment and relatively fast rates of recovery, as well a larger group of predominately older females with a slower, more linear move towards no impairment. In such cases subset analysis beyond Eurocost groupings would have enabled a refining of the precision through the avoidance of discrete groups affecting the predictions. However, doing this would have most likely required a larger dataset that extended well beyond 10,000 persons.

Bias inherent in the original studies poses an issue in a meta-analysis. Data collection was completed by other researchers and avoiding bias in data collection was dependent on these earlier researcher's methodologies (Tierney and Stewart 2005). This made assessing the presence of bias in the aggregate dataset problematic and for the most part assessment was reliant on the identification of inconsistencies in the original studies (Derrett, Black et al. 2009a). Publication bias presents additional problems in a meta-analysis (Macaskill, Walter et al. 2001), but this is largely avoided here due to the majority of the injured persons coming from studies that were descriptive (83%, n=8740) rather than controlled trials where publication bias is more prominent.

As a prediction of HRQoL, where the vast spectrum of injury has been condensed into 40 discrete categories, the wide 95% confidence limits produced on the predictions are not problematic as relationships between facets of quality of life across injuries are still evident.

Validity of the statistical model

Hierarchical structures are present in every factor of life. The classic example of students within classes, within schools is a relationship between an outcome like marks, and the likelihood that kids

share characteristics with others in their class, and classes share influences with other classes in a school. The multilevel mixed effects model (MM) enables recognition to be given to the presence of overarching influences that act on each branch of the hierarchy differently. An example of this being: the effect of a brilliant teacher or an oppressive bully on a student's academic performance.

As an alternative to the MM several strategies were available to fit simple models to the IPD dataset acquired. Collecting explanatory variables for the groups within the hierarchies was not possible due to the data having been already collected. For instance doing so would have required first identifying variables that could account for differences between studies, which is already a flawed notion, and then collecting this variable for all 21 studies that were included. Alternatively dummy variables could have been assigned to all but one study, in a fixed effects approach, maintaining the last study as the reference group. This technique is both inefficient, and is limited by the assumption that there is no variability from unknown factors, variance instead being solely derived from within study variability (Field 2001), and any inference from the results applies only to the included studies.

The model used in this meta-analysis also incorporated random effects, allowing the estimation of errors within each study, as well as error that would be present between studies (as if each study in the analysis was sampled from a 'super population' of every possible injured person) (Hedges 1992). By incorporating random effects the results of this study are more representative of the domain of injury as a whole, allowing an unconditional inference towards each of the injury categories to be explored. Conversely this also means the standard errors, and thus 95%CI, are larger, making statistically grounded conclusions more difficult (Field 2001).

Using the Eurocost injury classifications

The Eurocost injury group classifications contain 39 official categories, to which the specific category of amputations was appended in this analysis (Polinder, Meerdering et al. 2008b). Collapsing the many types and anatomical locations of injury into this number of categories introduced problems due to the range of effects the injuries included could have on HRQoL. Controlling for severity was an option, but due to the lack of a single measure of severity being collected this was not possible.

At 30 days post injury predictions could not be made for 17 injury categories (concussion, SCI, upper arm fracture, wrist fracture, nerve or complex soft tissue injuries to upper or lower limb, open wounds of the face or body, burns, poisoning, multitrauma, foreign body injuries, 'other injuries', amputations and where there was no injury after clinical examination). Of these, predictions could not be made at any time after injury for 12 injury categories (open wounds of the face or body, upper or lower limb nerve injuries, complex soft tissue injuries of the upper limb, burns, poisonings,

multitrauma, foreign body injuries, 'other injuries' and where there was no injury after examination). While lack of discernable effect of the injury was probable in less severe injury categories, for most of the population presentation at an emergency department was required, and a relationship most likely did exist within subsets of injury types present within the Eurocost categories. The study population was a dataset of 10,496 persons. A method to avoid the limitations of the Eurocost injury sub-type groupings would have been to construct additional injury sub-types during analysis. This approach was limited, as with only 10,496 persons regression analysis would have been severely limited by small group sizes.

It is also likely in the study population that inaccuracies were present in the way Eurocost was coded. As a trauma patient may first experience triage by a mobile paramedic, and receive a diagnosis biased towards acute threat, this assessment may then differ from a hospital-based diagnosis during follow up care. Throughout the studies it was not possible to consistently elicit where along the pathway of health system interaction the injury type had been assigned. In total 94 persons were assigned a Eurocost code of multiple traumas, from a total pool of 1277 that were sourced from all injury studies. While this is a feasible number of multiple traumas, it is high likely that throughout the included studies the person's injury was only coded to the injury assumed to be their most severe. Without the knowledge of how the injury type was assigned, the accuracy of the assigned group in this meta-analysis cannot be evaluated.

Strengths and weaknesses in the context of current literature

The first fundamental hurdle of this study was the discrepancy of what constitutes HRQoL. HRQoL can extend from the simple subjective question of “how do you rate your health, 0-100?”, through to the use of functional based frameworks that infer HRQoL like asking a person about their ability to wash or bath themselves (Fries, Spitz et al. 1982; Fitzpatrick, Davey et al. 1998). The boundaries of where health-related quality of life ends, through to the balance between subjectively and more objectively based assessments, is both varied and debatable (Guyatt, Feeny et al. 1993). Choosing a measure for this study was an essential step. However, doing so necessarily limits the data to those studies that have used the EQ-5D, and limits the inference to the EQ-5D construct of what HRQoL entails. Consequently this study is better defined as ‘EQ-5D assessed HRQoL after injury’.

An estimation of the burden of injury is an important step in validating the benefits of prevention as well as influencing the delivery of care. Studies, such as the Global Burden of Disease project, have highlighted the importance and benefits of understanding the true impact of ill health (Sanchez, Perepere et al. 2007). As recently as the late 1990’s a comprehensive review on the use of HRQoL measures found that while HRQoL assessment had exponentially increased over the preceding decade, it was largely limited to specific conditions like rheumatology (Garatt, Schmidt et al. 2002). Currently, there is a lack of HRQoL information across all injury types regardless of measure used (Lyons, Towner et al. 2007; Van Beeck, Larsen et al. 2007). When this is further restricted to studies using the EQ-5D in particular, the lack of literature is even more apparent. A comparison of predictions of HRQoL using the EQ-5D in other studies is not realistic, as 76% of all injured persons that were located in the literature search as having been given the EQ-5D are included in the final dataset of this study. Likewise, an exploration of HRQoL using an alternative measure across a non-specific injury population was not present in the literature.

The EQ-5D measure includes a summary score, where an aggregate score from 0 to 1 is produced from a derived tariff of injury severity according to dimensions impaired (Zethraeus and Johannesson 1999). The use of the tariff may have greatly added to the descriptive power of this study when comparing injury groups. As the dataset was internationally sourced, and different combinations of impairment in a dimension are ranked in differing ways from country to country (Szende, Oppe et al. 2007), the index score was not utilised to ensure the results were not biased to a specific population’s valuation of health states.

Meaning of the study: implications and unanswered questions

Injury outcomes are as diverse as the injuries themselves. Within this study we have found a great range in severity, from minor injuries with minimal impairment (finger or hand fractures), through to severe injuries with a substantial impact on both global subjective health state as well as impairment across multiple dimensions (femur fractures). Many findings were analogous to prior expectations: as an example *mobility* impairment is worse in lower limb injuries than upper limb, or strains are initially less severe than fractures. But within the complexity of HRQoL are more surprising results. Pain and discomfort, even in the absence of significant impairment, was present and influencing quality of life after injury to a greater degree than the other dimensions. Likewise recovery from strains was slow, with impairment across many of the affected dimensions being indistinguishable from fractures 7 or 8 months after injury. With the ability to compare injuries, and injury recovery rates, a better picture can be drawn of the pathways to recovery outside of a clinical or fiscal focus; therefore allowing a better understanding from the perspective of the injured person.

The different HRQoL outcomes from strains and fractures are an area where more research is needed. It would be interesting to explore these two injury types with a greater number of explanatory variables. Knowledge of re-injury and when and if a subsequent surgery was required for the original injury (which may have involved a long waiting time for some strain injuries) (Derrett, Stokes et al. 2005), would greatly benefit in an understanding of what underlying factors influence the pattern found here. Descriptive studies into the underlying factors that influence the predictions here across other injury groups would also be of benefit. This would also aid in developing HRQoL outcome knowledge on relatively rare injuries, as even with a general injury population of more than 10,000 some injury categories had only a handful of injured persons.

To my knowledge, this is the first individual patient data meta-analysis of injury outcomes using a measure of HRQoL. It is important to consider that, even with a dataset of 10,496 persons, some injury groups did not provide enough participants to accurately model predictions. A call for inclusion of general HRQoL measures, like the EQ-5D, is warranted in all injury studies. Future general injury population studies without vastly larger sample sizes will continue to fail to collect enough data on less common injuries to draw conclusive predictions. Yet, HRQoL measures enables important inferences to be drawn about the wider effects of an injury on a population. This is especially relevant in studies relating to a specific injury, where often only a disease specific measure is applied. While a disease specific measure is likely to be more sensitive to the disease it was developed for, the addition of a general HRQoL measure greatly increases the relevance of the findings within the greater field of injury outcome.

Injury outcomes are an essential piece of knowledge that both build the case for prevention, as well as aiding policy makers and practitioners in assessing the needs of an injury population beyond the clinically assessed return of prior function. HRQoL measures have in recent years greatly grown in importance. And as more widespread adoption of HRQoL measures like the EQ-5D in future injury research continues, we will be continue to be better placed to make decisions on the prioritisation, distribution and targets of healthcare resources to both prevent and care for injured populations.

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Appendix

I. Sample EQ-5D

OWN HEALTH QUESTIONS		Best imaginable health state
By placing a checkmark in one box in each group below, please indicate which statements best describe your own health state today.		100
Mobility		
☐ I have no problems in walking about	☐	90
☐ I have some problems in walking about	☐	
☐ I am confined to bed	☐	80
Self-Care		
☐ I have no problems with self-care	☐	70
☐ I have some problems washing or dressing myself	☐	
☐ I am unable to wash or dress myself	☐	60
Usual Activities (e.g., work, study, housework, family, or leisure activities)		
☐ I have no problems with performing my usual activities	☐	50
☐ I have some problems with performing my usual activities	☐	40
☐ I am unable to perform my usual activities	☐	
Pain/Discomfort		
☐ I have no pain or discomfort	☐	30
☐ I have moderate pain or discomfort	☐	20
☐ I have extreme pain or discomfort	☐	10
Anxiety/Depression		
☐ I am not anxious or depressed	☐	0
☐ I am moderately anxious or depressed	☐	
☐ I am extremely anxious or depressed	☐	Worst imaginable health state

The EQ-5D VAS is 20cm long in a questionnaire. Above is the American questionnaire; the EQ-5D is validated for use in many regions, with small changes to ensure cultural interpretations do not differ.

II. Data use agreement



DATA USE AGREEMENT BETWEEN

and

James Black, University of Otago

This Data Use Agreement is made and entered into on 14 October 2008 by James Black, hereafter "Recipient", pertaining to the use of data provided by [REDACTED] hereafter "Holder".

1. This agreement sets forth the terms and conditions pursuant to which Holder will disclose certain protected health information, hereafter "PHI" in the form of a Limited Data Set to the Recipient.
2. Permitted Uses and Disclosures
 - 2.1 Recipient may make use of the dataset within the constraints of the project: Meta-analysis of injury outcome using the EQ-5D.
 - 2.2 In addition to the Recipient, the individuals, or classes or individuals, who are permitted to use or receive the Limited Data Set for purposes of the Research Project include: Sarah Derrett, Peter Herbison, Suzanne Polinder and Ronan Lyons. To the extent that the classes of persons who are not part of the research projects workforce who are directly involved in the Research Project, the Recipient shall enter into a data agreement with the other classes of persons before such release of the Limited Data Sets.
3. Recipient Responsibilities
 - 3.1 Recipient may make no disclosures of the Limited Data Set that represents the dataset at the individual level. The Recipient will not use or disclose the Limited Data Set to any third party, for any purpose other than permitted by this Agreement pertaining to the Research Project or as required by law;
 - 3.2 Recipient will use appropriate administrative, physical and technical safeguards to prevent use or disclosure of the Limited Data Set other than as provided for by this Agreement;
 - 3.3 Recipient will report to the Holder any use or disclosure of the Limited Data Set not provided for by this Agreement of which the Recipient becomes aware within 15 days of becoming aware of such use or disclosure;
4. Term and Termination
 - 4.1 The terms of this Agreement shall be effective as of 14/11/08, and shall remain in effect until all PHI in the Limited Data Set provided to the Recipient is destroyed or returned to the Holder.

IN WITNESS WHEREOF, the parties hereto execute this agreement as follows:

Date: <u>14/11/08</u>	By: <u>[Signature]</u> Recipient: James Black
Date: <u>14/11/2008</u>	By: <u>[Signature]</u> Peter Herbison
Date: <u>14 Nov 2008</u>	By: <u>[Signature]</u> Sarah Derrett

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III. Letter to researchers

Dr Nick Alderman
St Andrew's Hospital
Northampton
United Kingdom



Dear Dr Alderman

My name is James Black and I am an Assistant Research Fellow at the Injury Prevention Unit at the University of Otago. Along with Dr Sarah Derrett and Associate Professor Peter Herbison we have recently completed a systematic literature review on the use of EQ-5D in injury. This was presented at the 25th EuroQol Group Scientific Committee meeting in September this year. With support from the Euroqol group, and in light of feedback from the conference, we are now undertaking an Individual Patient Data (IPD) meta-analysis of the EQ-5D and injury outcomes. This study aims to provide descriptive datasets of injury outcome EQ-5D norms for injured populations and specific injury subgroups. This study will also result in a report to be written by the original authors as well as Dr Suzanne Polinder and Professor Ronan Lyons. Partial funding for the study is being given by the EuroQol Group, of which a principal investigator of the project, Sarah Derrett, is a member.

While conducting a systematic search of electronic databases your dataset [redacted] was revealed as a potential source of relevant data. The inclusion of your data would be of great benefit to our study. On this note I would like to know if you would be able to provide non-identifiable data that could then be incorporated into our meta-analysis. The data we would like would be completely anonymous, so there is no possible means of breaching patient confidentiality. Acknowledgement of your contribution would be, if you were willing, via inclusion in the *EQ-5D Injury Outcome Collaborators Group*, which will be acknowledged in any subsequent publications resulting from the meta-analysis.

While time, access to data and prior commitments may make this request difficult we will gladly remove as much of the burden in data collection and processing as is possible. We also would only seek non-identifiable individual data, insuring your participants' anonymity is secure. If you have any questions regarding this email, or feel it is best directed to someone else, please feel free to contact me directly by phone, fax, or by email.

If your dataset is able to be included in this study please reply to this email, and I will promptly get back in touch with the details of the project and the variables we are seeking.

Thank you very much for your time, and I look forward to your reply,

Best Regards,

A handwritten signature in blue ink, appearing to be 'J. Black'.

James Black
cc. Sarah Derrett and Peter Herbison, University of Otago,
Suzanne Polinder, Erasmus MC and,
Ronan Lyons, Swansea University

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