



■ HIP

Baseline quality of life in people with hip fracture: results from the multicentre WHiTE cohort study

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Aims

To assess the variation in pre-fracture quality of life (QoL) within the UK hip fracture population, and quantify the nature and strength of associations between QoL and other routinely collected patient characteristics and treatment choices.

Methods

The World Hip Trauma Evaluation (WHiTE) study, an observational cohort study of UK hip fracture patients, collects a range of routine data and a health-related QoL score (EuroQoL five-dimension questionnaire (EQ-5D)). Pre-fracture QoL data are summarized and statistical models fitted to understand associations between QoL, patient characteristics, fracture types, and operations.

Results

Fitting a multiple linear regression model indicated that 36.5% of the variance in pre-fracture EQ-5D scores was explained by routinely collected patient characteristics: sex (0.14%), age (0.17%), American Society of Anesthesiologists (ASA) score (0.73%), Abbreviated Mental Test Score (AMTS; 1.3%), pre-fracture mobility (11.2%), and EQ-5D respondent (participant, relative, or carer; 23.0%). There was considerable variation in pre-fracture EQ-5D scores between operations within fracture types. Participants with trochanteric fractures reported statistically significant but not clinically relevant lower pre-fracture QoL than those with intracapsular fractures. Participants with intracapsular fractures treated with internal fixation or total hip arthroplasty (THA) reported better QoL than those treated with hemiarthroplasty with the overall fittest group receiving THA.

Conclusion

Pre-fracture QoL varies considerably between hip fracture patients; it is generally higher in younger than older patients, patients with better mobility, and those patients who live more independently. Pre-fracture QoL is significantly associated with a range of patient characteristics (e.g. age, mobility, residency). These data explain ~35% of the variation in QoL.

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Article focus

- This article focuses on the potential variation in pre-fracture quality of life (QoL) within the UK hip fracture population.
- It assesses the associations between QoL and other routinely collected patient characteristics and treatment choices.

- Patient characteristics such as age and mobility can only partly account for this variation.

Strengths and limitations

- The great strengths of the study were the prospective nature of data collection and the inclusion of patient-reported outcomes for this patient group.
- One potential limitation is the accuracy of the data reporting which is common

Key messages

- Pre-fracture QoL varies considerably between hip fracture patients.

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for studies of this size, although this was deemed to be acceptable upon examination of the dataset.

Introduction

Health-related quality of life (QoL) is now recognized as the most important measure of patient outcome after hip fracture.¹⁻⁵ The EuroQol five-dimension questionnaire (EQ-5D)^{6,7} is the most widely used tool for measuring QoL^{1,2,6-9} and is part of the UK Core Outcome Set for hip fracture studies,¹⁰ which has been adopted by the National Institute for Health and Care Excellence in Hip Fracture Guidelines.¹¹ The measurement properties of EQ-5D in the UK hip fracture population have been extensively studied, with previous work describing the characteristics and responsiveness of the measure,¹ the post-fracture recovery profile,² and the merits of death-adjusted and unadjusted scores.¹² There has not, however, been such a detailed examination of the variation of EQ-5D at baseline more generally in the population sustaining hip fracture, and particularly the relationship between EQ-5D and other widely reported population characteristics such as pre-fracture mobility and residency.

The World Hip Trauma Evaluation (WHiTE) cohort was established in 2014, with the same inclusion criteria as the UK National Hip Fracture¹³ Database, and recruited participants into the study from a representative sample of hospitals that also reported cases to the registry. WHiTE provides comprehensive follow-up of all participants including QoL,⁴ fracture classification, operation,¹³ and medication,¹⁴ and has been shown to be representative of the wider UK hip fracture population.¹⁵

The aim of this study was to model variation in QoL to determine if baseline QoL can be predicted by baseline characteristics commonly collected in other hip fracture studies, or whether it is an important independent predictor of outcome. Specifically we considered the following objectives: 1) to assess the variation in pre-fracture QoL within the UK hip fracture population; 2) to assess and quantify the nature and strength of associations (correlations) between QoL and other routinely collected baseline (pre-fracture) characteristics of patients sustaining hip fracture; and 3) to assess the extent to which pre-fracture QoL is associated with subsequent choice of treatment.

Methods

Design, setting, and participants. The WHiTE study is an observational cohort study that collects information on assessment, treatment, and recovery of patients admitted to participating UK NHS hospitals after hip fracture. Patients were eligible to participate in WHiTE if they were aged 60 years or older and were to be treated operatively for a hip fracture. WHiTE also collected outcome data from a number of embedded randomized controlled trials: WHiTE One,¹⁶⁻¹⁸ WHiTE Two,^{19,20} WHiTE3Hemi,^{5,21} WHiTE4,²² and WHiTE5.²³

Consent. Participants gave their consent to participate in the WHiTE study or, for those without capacity, agreement was provided by an appropriate consultee. The WHiTE study was approved by research ethics committees (RECs; WHiTE cohort approved by Camberwell St Giles Research Ethics Committee with reference 11/LO/0927).

Treatment. Participants enrolled in the WHiTE cohort study only were treated in accordance with local standard care pathways. The National Institute for Clinical Excellence (NICE) have issued standardized care guidelines that are used in the majority of hospitals, and are summarized in the WHiTE cohort study protocol.⁴ A minority of participants were enrolled in embedded randomized studies and were randomly allocated to a treatment; all treatment options were in routine use in the NHS.^{5,22}

Sample size and data. The data reported here are based upon the data extract for the pre-specified analysis of the WHiTE cohort of the first 6,000 complete outcome datasets. Full details are reported in the published protocol.⁴

Data collection. Data were transcribed from clinical reporting forms completed by recruitment centre research teams at baseline, or entered directly during follow-up telephone calls, by the central trial team into the WHiTE database (OpenClinica, V3.7; OpenClinica LLC, Waltham, Massachusetts, USA). Data were extracted from the database and saved to a comma separated (csv) format for analysis.

The main focus of the analysis reported here is QoL assessed by the EuroQol five-dimension five-level questionnaire (EQ-5D-5L);^{6,7} a generic, validated, cross-disciplinary standardized health utility instrument widely used to assess QoL after hip fracture. EQ-5D has two parts: a visual analogue scale (VAS), which measures self-rated health; and a health status instrument, which is the focus of the analysis reported here, consisting of a five-level response (no problems, slight problems, moderate problems, severe problems, and extreme problems) for five health domains related to daily activities (mobility, self-care, usual activities, pain and discomfort, and anxiety and depression). Each WHiTE participant was asked to indicate their health state by ticking the box next to the most appropriate statement in each of the five dimensions; combining these together provides a five-digit number that describes the individual's health state. The five-digit responses, from the EQ-5D health classifications, were converted into an overall score using a published utility algorithm for the UK population.²⁴

Participants in WHiTE were asked to provide (retrospective) pre-fracture assessments of QoL, using EQ-5D, at enrolment into the study. In addition to an assessment of pre-fracture EQ-5D, a number of other important participant characteristics were collected at baseline. Foremost among these were the demographic variables of age, sex, alcohol consumption, smoking status, and reported diabetes or renal failure. Additionally participants were asked about their residence and mobility

prior to the fracture; fracture type, surgical treatment, American Society of Anesthesiologists (ASA) grade (I, II, III, IV, V),²⁵ and Abbreviated Mental Test Scores (AMTS; 1 to 10)²⁶ were also recorded. Some participants were unable to complete the EQ-5D themselves, so this was completed by either the next of kin (NOK), a relative, carer, or other proxy. Proxy-reported EQ-5D index scores have previously been shown to be an acceptable source of data in a similar population to the WHiTE cohort,²⁷ although evidence from more recent studies is mixed.^{28,29}

Statistical analysis. EQ-5D data were summarized using means and standard deviations, with 95% confidence intervals (95% CIs) constructed based on assumed approximate Normality. Group means were compared using *t*-tests, with *p*-values, nominally set at the 5% level, adjusted for multiple comparisons using the Holm–Bonferroni method.³⁰ In order to model the relationship between baseline patient characteristics and baseline EQ-5D, regression models were fitted with the latter as the response variable and the former as explanatory variables. Model fitting proceeded using a forward selection and backwards elimination algorithm. Due to the size of the dataset available for model development and the risk of overfitting, decisions for inclusion of terms were based on changes in the Bayesian information criterion (BIC).³¹ The effect of recruitment centre on baseline EQ-5D was assessed after conditioning on the important patient characteristics identified during model development. For the purposes of inference, the minimum clinically important difference for EQ-5D was considered to be 0.075.³² All analyses were undertaken in the statistical software R (R Foundation for Statistical Computing, Vienna, Austria).

Results

Description of the data. Full details of the initial WHiTE dataset are reported elsewhere.¹⁵ However, to aid interpretation of this report the dataset includes data from 8,673 participants recruited between May 2014 and April 2017, of whom 7,391 provided a baseline EQ-5D.

Participant characteristics. The mean age of WHiTE cohort participants at recruitment was 83 years (SD 8.5), and the percentage female to male sex split was 72.5:27.5. Table I shows full details of participant characteristics, together with pre-fracture mean EQ-5D scores by group; the overall mean EQ-5D was 0.65 (SD 0.29; *n* = 7,391). The majority of participants (83%, *n* = 7,159) lived in their own home or in sheltered housing, and were either freely mobile without aids (40%, *n* = 3,498) or mobile outdoors with one aid (24%, *n* = 2,063).

There were marked and highly clinically and statistically significant³² differences in pre-fracture QoL between the groups identified in Table I. QoL reduced with age (< 80 years vs 80+ years: mean difference 0.10 in favour of younger age; 95% CI 0.08 to 0.11; *p* < 0.001, paired *t*-test) and ASA score (ASA I vs ASA IV: mean difference 0.34 in favour of ASA I; 95% CI 0.30 to 0.39; *p* < 0.001, paired *t*-test), and increased with AMTS score (severe

impairment vs no impairment: mean difference 0.34 in favour of no impairment; 95% CI 0.32 to 0.36; *p* < 0.001, paired *t*-test). Variation in QoL with pre-fracture mobility followed the pattern one might expect clinically, with significant differences observed for all categories between the extremes of ‘freely mobile without aids’ to ‘no functional mobility’ (mean difference 0.47 in favour of increased mobility; 95% CI 0.43 to 0.52; *p* < 0.001, paired *t*-test). For pre-fracture residency, there were similar trends with clinically and statistically significant differences in QoL observed (own home vs nursing care: mean difference 0.33; 95% CI 0.30 to 0.36; *p* < 0.001, paired *t*-test). There were statistically significant differences in QoL between sexes, alcohol and smoking groupings, and renal function, although none of these differences reached clinical significance.

There were also large and statistically significant differences in QoL between EQ-5D respondent groups; participant responders (0.74) reported higher EQ-5D scores than both NOK or relative (0.42) and carer or nursing home (0.55) groups. These differences, in part at least, are explained simply by participants in the latter groups being older and having lower AMTS scores.

Fracture type and operation. Table II shows full details of participant fractures and operations, together with pre-fracture mean EQ-5D scores by group. The simple group means in Table II hide considerable variation in EQ-5D scores between operations within fracture type groups; Figure 1 displays these differences graphically. Participants with trochanteric fractures reported statistically significant but not clinically relevant lower pre-fracture QoL than those with intracapsular fractures (mean difference EQ-5D in favour intracapsular types 0.04; 95% CI 0.03 to 0.05; *p* < 0.001, paired *t*-test).

Participants with intracapsular fractures treated with internal fixation or total hip arthroplasty (THA) reported better QoL than those treated with hemiarthroplasty, with the overall fittest group being those receiving THA. The overwhelming majority of participants with trochanteric fractures were treated with either a sliding hip screw (SHS) or intramedullary nail (IM nail) so that estimates in those treated with arthroplasty are very imprecise. The participants treated with an IM nail reported clinically similar QoL (mean difference EQ-5D in favour of IM nail 0.05; 95% CI 0.01 to 0.08; *p* = 0.05, paired *t*-test). Fewer participants had a subtrochanteric fracture and so there was considerable imprecision in the estimates of QoL.

Modelling. In order to fully understand the complexity of the relationships observed between the patient baseline data and QoL, we proceeded to fit linear regression models using all the characteristics reported in Table I as explanatory variables and EQ-5D as the response variable. The best fitting model accounted for 36.5% of the variance in EQ-5D scores, with the following terms proving to be significant: sex (0.14%); age (0.17%); ASA (0.73%); AMTS (1.3%); pre-fracture mobility (11.2%); and EQ-5D respondent (23.0%), where numbers in parentheses are

Table 1. World Hip Trauma Evaluation cohort participant characteristics at baseline.

Characteristic	Group	n	%	QoL EQ-5D		
				mean	95% CI	p-value*
Sex (n = 8,673; 100%)	Female	6,290	72.5	0.64	0.63 to 0.65	-
	Male	2,383	27.5	0.68	0.66 to 0.69	< 0.001
Age (years) (n = 8,673; 100%)	< 80 (median = 74; IQR = 70 to 78)	3,095	35.7	0.71	0.70 to 0.72	-
	80+ (median = 87; IQR = 84 to 91)	5,578	64.3	0.61	0.60 to 0.62	< 0.001
Smoker (n = 7,713; 88.9%)	No	6,981	80.5	0.65	0.64 to 0.65	-
	Yes	732	8.4	0.68	0.66 to 0.70	0.002
Alcohol (n = 7,685; 88.6%)	0 to 7 units	6,841	78.9	0.64	0.63 to 0.64	-
	8 to 14 units	457	5.3	0.76	0.74 to 0.78	< 0.001
	15 to 21 units	173	2.0	0.74	0.70 to 0.78	< 0.001
	> 21 units	214	2.5	0.70	0.66 to 0.73	0.018
Diabetes (n = 7,742; 89.3%)	No	6,556	75.6	0.65	0.64 to 0.66	-
	Yes	1,186	13.7	0.64	0.62 to 0.66	0.213
Renal failure (n = 7,735; 89.2%)	No	7,244	83.5	0.65	0.65 to 0.66	-
	Yes	491	5.7	0.60	0.57 to 0.62	< 0.001
AMTS (n = 8,293; 95.6%)	0 to 3: Severe impairment	1,446	16.7	0.37	0.36 to 0.39	-
	4 to 6: Moderate impairment	728	8.4	0.52	0.50 to 0.55	< 0.001
	7 to 10: No impairment	6,119	70.6	0.72	0.71 to 0.72	< 0.001
ASA score (n = 8,165; 94.1%)	I	188	2.2	0.85	0.82 to 0.89	-
	II	2,307	26.6	0.76	0.75 to 0.77	< 0.001
	III	4,586	52.9	0.61	0.60 to 0.62	< 0.001
	IV	1,071	12.3	0.51	0.49 to 0.53	< 0.001
	V	13	0.1	0.43	0.22 to 0.64	< 0.001
Pre-fracture mobility (n = 8,570; 98.8%)	No functional mobility	191	2.2	0.31	0.25 to 0.36	-
	Freely mobile: without aids	3,498	40.3	0.78	0.77 to 0.79	< 0.001
	Mobile outdoors: one aid	2,063	23.8	0.64	0.63 to 0.66	< 0.001
	Mobile outdoors: two aids/frame	1,419	16.4	0.54	0.52 to 0.55	< 0.001
	Indoor mobility: help outside	1,325	15.3	0.44	0.42 to 0.45	< 0.001
Pre-fracture residency (n = 8,587; 99.0%)	Unknown	74	0.9	0.52	0.44 to 0.61	< 0.001
	Own home/Sheltered housing	7,159	82.5	0.69	0.68 to 0.70	-
	Residential care	778	9	0.40	0.38 to 0.42	< 0.001
	Nursing care	525	6.1	0.36	0.33 to 0.39	< 0.001
	Rehab unit	10	0.1	0.59	0.37 to 0.81	0.999
	Index hospital	76	0.9	0.52	0.45 to 0.60	< 0.001
	Other hospital in Trust	25	0.3	0.58	0.46 to 0.70	0.533
EQ-5D respondent (n = 6,610; 76.2%)	Other	14	0.2	0.48	0.29 to 0.67	0.076
	Participant	4,720	54.4	0.74	0.73 to 0.74	-
	NOK/Relative	1,703	19.6	0.42	0.41 to 0.43	< 0.001
	Carer/Nursing home	187	2.2	0.55	0.50 to 0.59	< 0.001

*Paired *t*-tests, with first category as comparator, using Holm's correction for multiple testing.

AMTS = Abbreviated Mental Test Score, ASA = American Society of Anesthesiologists, CI = confidence interval, NOK = next of kin; IQR, interquartile range; EQ-5D, EuroQol five-dimension questionnaire; QoL, quality of life.

the percentage of the variance accounted for by the individual terms. Excluding EQ-5D respondent yielded an almost equally well fitting model, which accounted for 33.1% of the variance in EQ-5D scores where the following terms proved significant: sex (0.17%); pre-fracture residency (0.63%); ASA (1.1%); AMTS (10.0%); and pre-fracture mobility (21.3%). As a final step in the modelling, the recruitment centre variable was added to the best fitting model, in order to assess whether there were systematic differences in baseline QoL between recruitment centres, which could not be explained by the variation in participant characteristics between the recruitment centres. This extended model was no improvement

on the best fitting model (change in BIC was negative), indicating that the variation in EQ-5D between recruitment centres was not important after adjusting for the differing participant characteristics between recruitment centres. This is best visualized by plotting adjusted EQ-5D values from the best fitting model by recruitment centre (Figure 2), which shows a consistent distribution of values across sites with no outliers.

Discussion

In this large, multicentre study collecting health-related QoL in people with hip fracture, we found that

Table II. Fracture and operation details of World Hip Trauma Evaluation cohort study participants.

Characteristic	Group	n	%	EQ-5D		
				mean	95% CI	p-value*
Fracture side (n = 8,588; 99.0%)	Left	4,469	51.5	0.65	0.64 to 0.66	-
	Right	4,119	47.5	0.65	0.64 to 0.66	0.414
Fracture type (n = 8,580; 98.9%)	Intracapsular	5,148	59.4	0.66	0.66 to 0.67	-
	Trochanteric	3,030	34.9	0.62	0.61 to 0.64	< 0.001
	Subtrochanteric	402	4.6	0.63	0.60 to 0.66	0.080
Pathological fracture (n = 8,351; 96.3%)	No	8,235	94.9	0.65	0.64 to 0.65	-
	Atypical	33	0.4	0.63	0.51 to 0.74	0.999
	Malignant	83	1.0	0.64	0.56 to 0.72	0.999
Operation (n = 8,558; 98.7%)	Cannulated screws	248	2.9	0.70	0.66 to 0.74	-
	Hemiarthroplasty	3,710	42.8	0.62	0.61 to 0.63	< 0.001
	Total hip arthroplasty	814	9.4	0.83	0.81 to 0.84	< 0.001
	Sliding hip screw	2,941	33.9	0.63	0.62 to 0.64	< 0.001
	Intramedullary nail	830	9.6	0.66	0.63 to 0.68	0.163
	Other	15	0.2	0.51	0.29 to 0.73	0.163

*Paired *t*-tests, with first category as comparator, using Holm's correction for multiple testing. CI, confidence interval; EQ-5D, EuroQol five-dimension questionnaire.

pre-injury, retrospectively reported QoL is strongly associated (correlated) with a range of other routinely reported patient characteristics. Participant age, ASA, AMTS, pre-fracture mobility, and pre-fracture residence were each highly statistically and clinically significantly associated with baseline EQ-5D. A model including these variables accounted for 36.5% of the variability in pre-fracture EQ-5D, which is typical of values for models reported elsewhere in orthopaedic studies more generally. Although the variance accounted for by the model is modest, it is without doubt useful and sufficient for use more generally as a predictive tool. Given the strong associations we know exist between baseline and four-month EQ-5D and death,^{1,2,12} and given that the models are likely to be improved with the addition of other relevant demographic data, it seems feasible that, in the not too distant future, long-term patient outcomes could be predicted for hip fracture patients after surgery.

The recruitment centre was not significantly associated with baseline QoL, after adjusting for differences in participant characteristics. The same recruitment and data collection processes were used at all WHiTE recruitment centres, so we would not expect to see unexplained systematic differences in EQ-5D between recruitment centres. This result is important for future analyses, as it establishes a single (homogeneous) baseline population, against which differences in QoL outcomes can be assessed. It is similarly reassuring that the variation in baseline QoL with fracture type and surgical treatment is clinically plausible; for example, pre-fracture QoL being higher in patients treated with THA rather than hemiarthroplasty.

Although the EQ-5D respondent, that is the person reporting the pre-fracture QoL, was the single most

important predictor of baseline EQ-5D, this is misleading. Clearly the very fact that it was necessary for a proxy to complete EQ-5D tells us a lot about the likely EQ-5D score; EQ-5D being considerably lower than if the participant had been able to complete the score themselves. Repeating the statistical model, without including EQ-5D respondent variable, gave a very similar model to that with the variable included. This suggests that although EQ-5D respondent is a good predictor of EQ-5D score, it provides only a small amount of information additional to that obtained from the other participant baseline characteristics. The model excluding the EQ-5D respondent variable, which is not routinely reported outside of the WHiTE cohort study, is more widely applicable and general, so will be the preferred option for future adjusted analyses.

It is informative to compare the measured EQ-5D responses of the WHiTE hip fracture population to other reference populations. Useful comparator data, from 3,691 people with a variety of health conditions (in six countries) who completed the EQ-5D questionnaire, were reported in 2012 by van Hout et al.³³ They identified a number of condition-specific health groups and reported mean (SD) EQ-5D index values (using the UK value set);²⁴ the most comparable groups were those identified as orthopaedic accident and arthritis from Denmark and England, respectively. Although the mean ages of these populations were markedly younger than the WHiTE population (38 years and 58 years vs 83 years), the reported mean EQ-5D scores were similar; 0.63 (0.42) and 0.64 (0.23) vs 0.65 (0.29) for WHiTE. Although such crude comparisons are useful, they do not convey the true variability in responses found in the WHiTE hip fracture population. At one extreme, those WHiTE participants

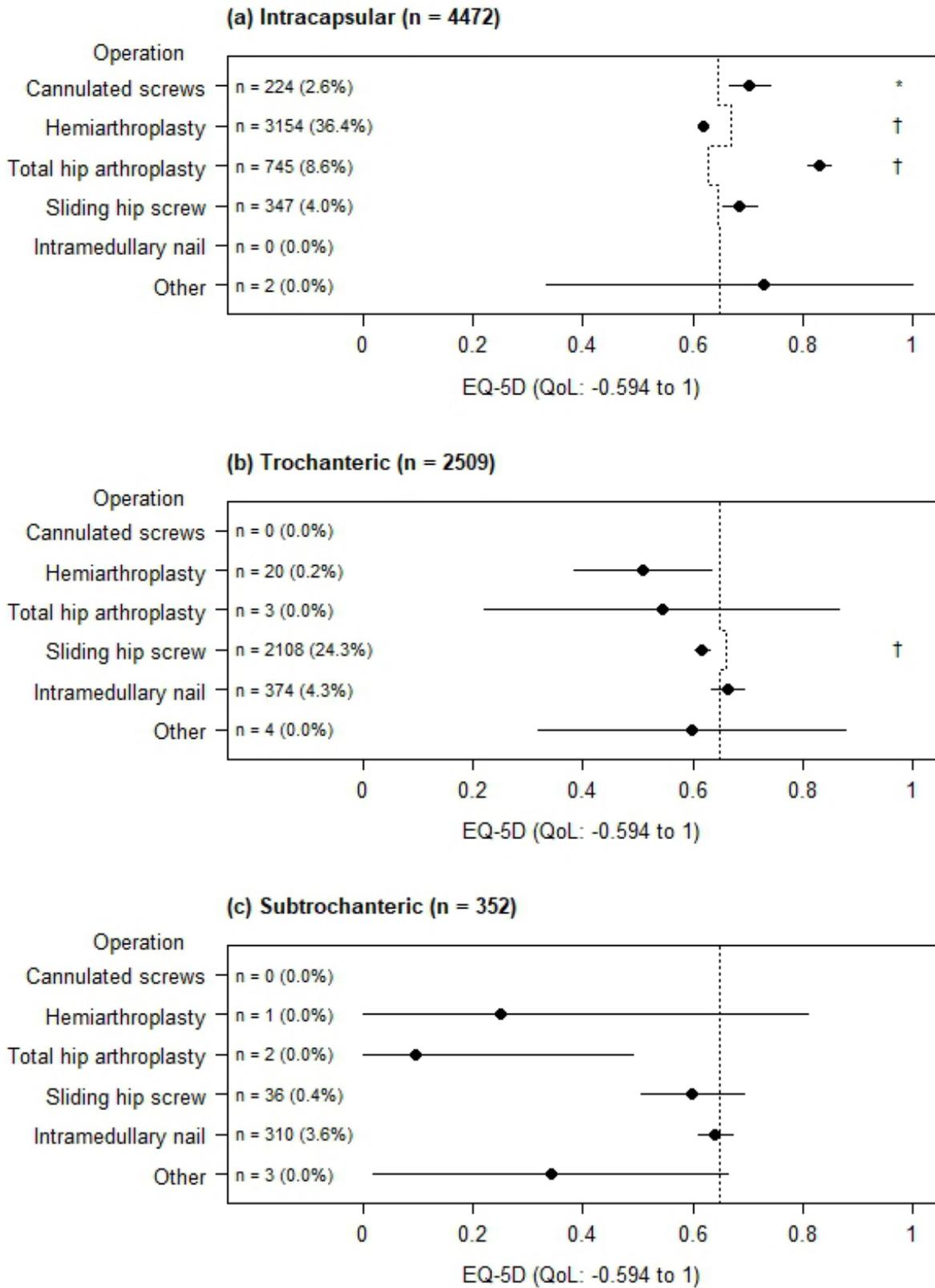


Fig. 1

Mean EuroQol five-dimension questionnaire (EQ-5D) (•), 95% confidence interval (–), and comparator group mean (---) by operation group for a) intracapsular, b) trochanteric, and c) subtrochanteric fractures. Individual EQ-5D group means were compared to all other data with significance assessed using Holm’s correction for multiple testing, with p-values reported as: *p < 0.05; †p < 0.001. QoL, quality of life.

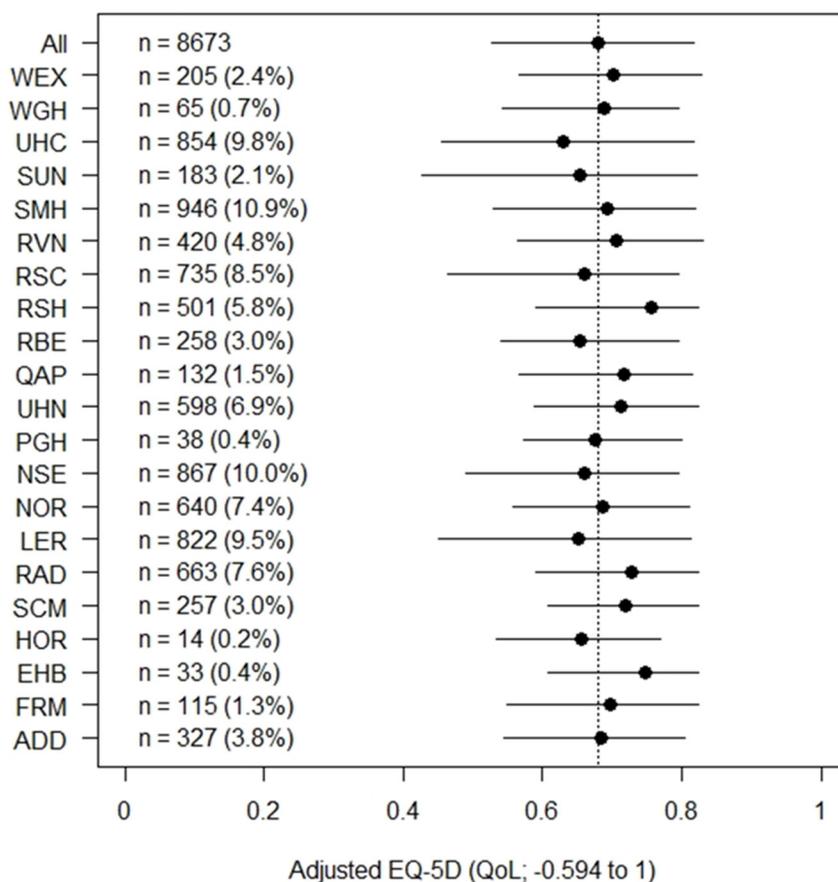


Fig. 2

Median adjusted EuroQol five-dimension questionnaire (EQ-5D) (●) and interquartile range (–) by recruitment centre; vertical line (---) is median adjusted EQ-5D across all sites. ADD, Addenbrookes Hospital; FRM, Frimley Park Hospital; EHB, Heartlands Hospital; HOR, Horton General Hospital; SCM, James Cook University Hospital; RAD, John Radcliffe Hospital; LER, Leicester Royal Infirmary; NOR, Norfolk & Norwich University Hospital; NSE, Northumbria Specialist Emergency Care Hospital; PGH, Poole General Hospital; UHN, Queen's Medical Centre Nottingham; QAP, Queen Alexandra Portsmouth; RBE, Royal Berkshire Hospital; RSH, Royal Stoke University Hospital; RSC, Royal Sussex County Hospital; RVN, Royal Victoria Infirmary; SMH, Southmead Hospital Bristol; SUN, Sunderland Royal Hospital; UHC, University Hospital Coventry; WGH, Wansbeck General Hospital.

with no functional mobility or severe cognitive impairment (Table I) had very low EQ-5D scores (0.31 and 0.37) that were comparable with stroke or Parkinson's disease populations.³³ However, WHiTE participants who were freely mobile without aids or had a low ASA score (Table I) had high EQ-5D scores (0.78 and 0.76 to 0.85) that were comparable with mild health conditions such as diabetes or the wider population.³³ A direct comparison of the WHiTE EQ-5D scores to age-matched population norms is complicated to some extent by the lack of good data for older people (> 80 years), who form the larger part of the hip fracture population. The WHiTE EQ-5D scores for the 65 to 74 years age group (n = 1,258) of 0.73 (95% CI 0.71 to 0.75) are significantly lower than the comparable data for age group matched UK population norms of 0.78 (95% CI 0.76 to 0.80)³⁴. The age group matched UK population norms for the 75 years and over group are considerably higher than the comparable data for WHiTE (0.73 vs 0.63 for UK population and WHiTE,

respectively); without more detailed analysis it is difficult to assess whether this difference in QoL is due (in totality or in part only) to health status differences or to possible age differences between the populations. However it seems clear from the 65 to 74 years age group data alone that the WHiTE population has lower QoL (as measured by EQ-5D) than the wider UK population. Metcalfe et al¹⁵ provide a detailed comparison of the WHiTE data and the UK National Hip Fracture Database, concluding that patients within the WHiTE cohort are representative of the national population of older adults with hip fractures throughout England, Wales, and Northern Ireland.

The principal limitations of this study are those common to all large cohort studies – principally the accuracy of the data reporting. There were some examples in the dataset of what seems to be most likely coding errors, for example highly unlikely fracture type and treatment combinations. However, a more wide-ranging examination of the dataset reported elsewhere¹⁵ suggested that

accuracy was good. There is also the possibility of error in the reporting of pre-fracture EQ-5D retrospectively, for example due to recall or response shift. However, in this trauma setting there is no alternative and we have previously shown that this process yields plausible estimates of QoL. The great strengths of the study that distinguish it from other large registry studies are firstly that it was collected prospectively, for the explicit research questions reported in the protocol,⁴ and secondly it included patient-reported outcomes.

In conclusion, we have confirmed that pre-fracture QoL helps describe patients with hip fracture beyond what is possible using other commonly collected demographic data. This is intuitive - we did not collect sufficient demographic information to explain all the variation in patients' QoL. However, with an ever-improving research infrastructure, increasing sophistication in the methods we use to capture data, and the increased availability of routine data from multiple sources (the internet of things), it seems likely that the modest amount of the variability in QoL attributable to the model will be increased substantially in the future. Collecting pre-fracture QoL will greatly strengthen our ability to control for confounding when reporting future studies of patients with hip fracture.

In conclusion, pre-fracture QoL varies considerably between hip fracture patients; it is generally higher in younger than older patients, patients with better mobility, and those patients who live more independently (i.e. in their own home). A comparison of data summaries suggests that the WHITE hip fracture population has lower QoL (as measured by EQ-5D) than previously reported data for an age-matched UK population. The pre-fracture QoL is significantly associated with a range of routinely collected patient characteristics (e.g. age, mobility, residency); the model explains a moderate 35% of the variation in the observed WHITE baseline QoL data. Therefore, collecting pre-fracture QoL is crucial as it captures important information on the patient population immediately prior to hip fracture that we have no other means of assessing.

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Ethical review statement

- The World Hip Trauma Evaluation (WHiTE) study was approved by research ethics committees (WHiTE cohort approved by Camberwell St Giles Research Ethics Committee with reference 11/LO/0927).

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