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ARTHROPLASTY

Clinical frailty is independently associated with joint-specific function and health-related quality of life in patients awaiting a total hip or knee arthroplasty

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Aims

The aims were to assess whether preoperative joint-specific function (JSF) and health-related quality of life (HRQoL) were associated with level of clinical frailty in patients waiting for a primary total hip arthroplasty (THA) or knee arthroplasty (KA).

Methods

Patients waiting for a THA (n = 100) or KA (n = 100) for more than six months were prospectively recruited from the study centre. Overall,162 patients responded to the questionnaire (81 THA; 81 KA). Patient demographics, Oxford score, EuroQol five-dimension (EQ-5D) score, EuroQol visual analogue score (EQ-VAS), Rockwood Clinical Frailty Score (CFS), and time spent on the waiting list were collected.

Results

There was a significant correlation between CFS and the Oxford score (THA $r = -0.838$; $p < 0.001$, KA $r = -0.867$; $p < 0.001$), EQ-5D index (THA $r = -0.663$, $p =< 0.001$; KA $r = -0.681$; $p =< 0.001$), and EQ-VAS (THA $r = -0.414$; $p < 0.001$, KA $r = -0.386$; $p < 0.001$). Confounding variables (demographics and waiting time) where adjusted for using multiple regression analysis. For each 8.5 (THA, 95% CI 7.1 to 10.0; $p < 0.001$) and 9.9 (KA, 95% CI 8.4 to 11.4; $p < 0.001$) point change in the Oxford score, there was an associated change in level of the CFS. For each 0.16 (THA, 95% CI 0.10 to 0.22; $p < 0.001$) and 0.20 (KA, 95% CI 0.12 to 0.27; $p < 0.001$) utility change in EQ-5D, there was an associated change in level of the CFS. EQ-VAS (THA, B = –11.5; $p < 0.001$, KA B = –7.9; $p = 0.005$) was also associated with CFS.

Conclusion

JSF and HRQoL in patients awaiting THA or KA for more than six months, were independently associated with level of clinical frailty. With further prospective studies, clinical frailty may prove to be a useful metric to assist in the prioritization of arthroplasty waiting lists.

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Keywords: arthroplasty, hip, knee, waiting, frailty, quality of life, function

Introduction

Frailty is a multidimensional syndrome of loss of reserves that is characterized by a vulnerability to a major decline in health and independence following a stressor event.[1,2] Increasing age is tightly bound with frailty, with a quarter to a half of people aged over 85 years estimated to be frail.[3,4] Reduced physical function is a key contributor of frailty, and is represented in frailty scoring systems.[1,3,5,6] Frail individuals have an increased risk of morbidity, mortality, and institutionalization, as well as higher complication rates and longer hospital stays following orthopaedic surgery.[4,7-9] The risk of adverse outcomes with increasing frailty levels has been recognized following total hip athroplasty (THA) and knee arthroplasty

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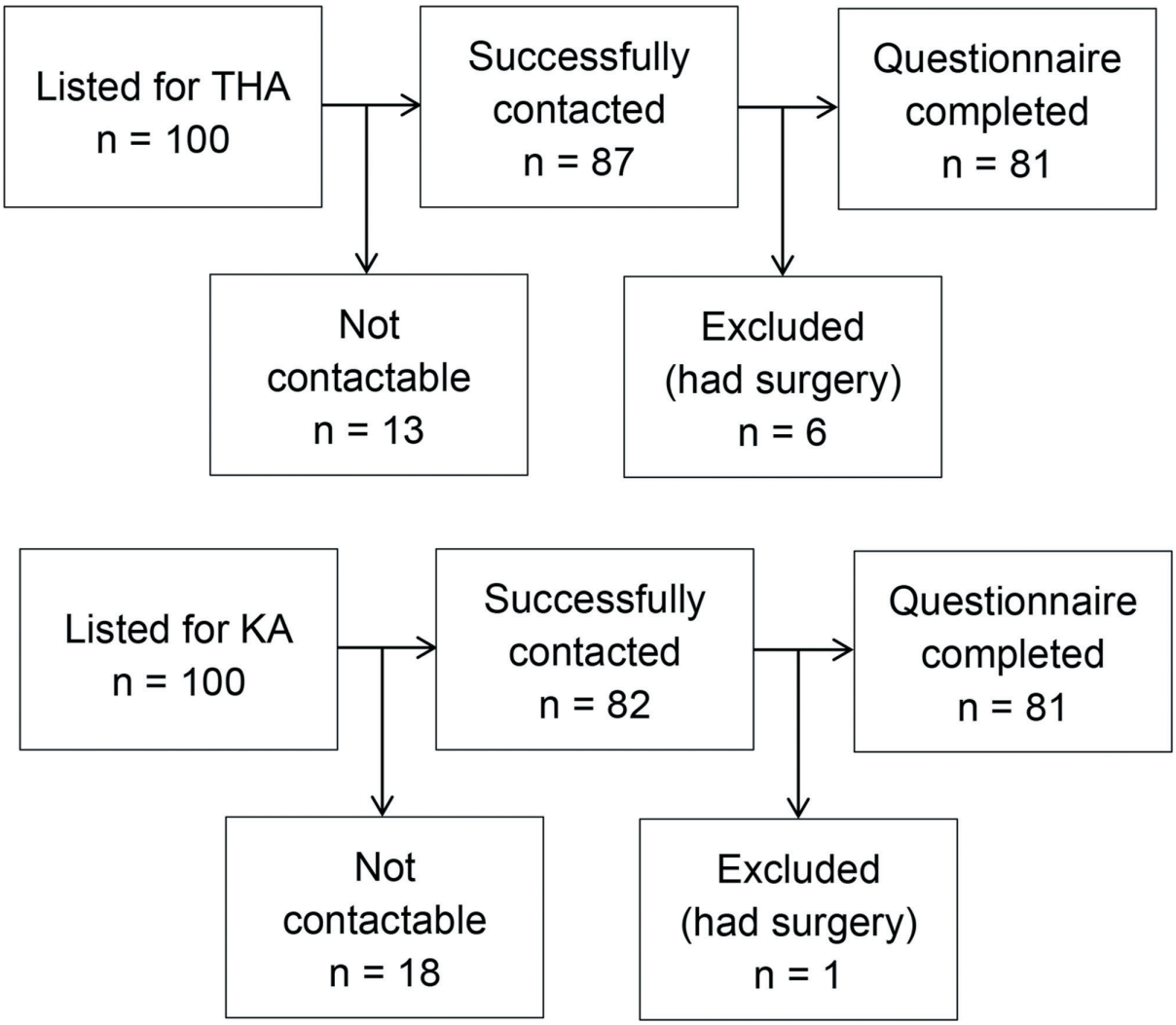

Fig. 1
Subject recruitment flowchart.

(KA).[10-13] Increasing frailty also has a consistent inverse association with quality of life.[14]

Patient-reported outcome measures (PROMs) are the primary means for quantifying treatment success following hip and knee arthroplasty. These focus on the patient's perspective through factors such as pain, function, satisfaction, and quality of life.[15] Joint-specific function (JSF) and health-related quality of life (HRQoL) are PROMs that can be improved following hip and knee arthroplasty.[16] Despite the known relationship between physical function, frailty, and quality of life, the relationships between joint-specific PROMs and frailty in patients awaiting a hip or knee arthroplasty has not been explored, to the authors' knowledge.

The primary aim of this study was to assess whether JSF or HRQoL were associated with clinical frailty in patients waiting for a THA or KA. The null hypothesis was that there was no association between worsening JSF and increasing clinical frailty. The secondary aim was to assess whether HRQoL was associated with clinical frailty in patients waiting for a THA or KA.

Methods

Ethical approval was obtained from the regional ethics committee (Research Ethics Committee, South-East Scotland Research Ethics Service, Scotland (20/SS/0125)) for the arthroplasty database used in this study. Data collection was carried out in accordance with the GMC guidelines for good clinical practice and the Declaration of Helsinki.

A single-centre, cross-sectional study of patients on NHS waiting lists for either a primary THA or KA (total knee arthroplasty (TKA), or partial knee artroplasty (PKA)) was conducted at the Royal Infirmary of Edinburgh, UK, during September and December 2021.

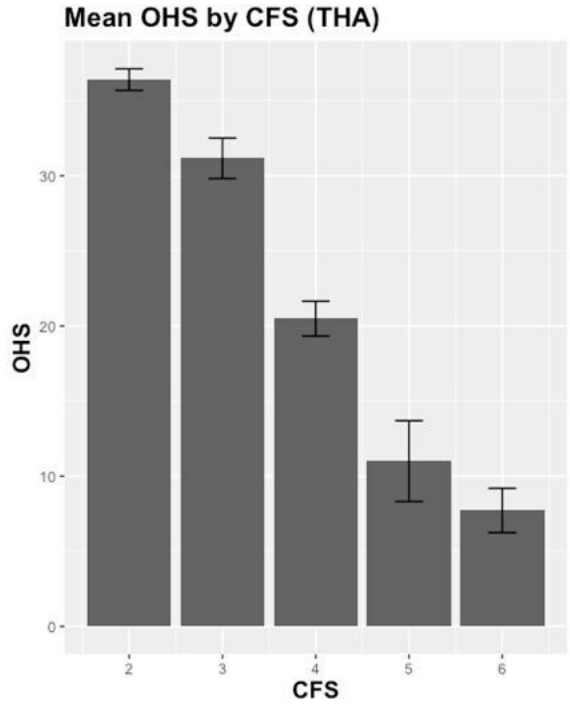

Fig. 2

Mean Oxford Hip Score in patients awaiting a total hip arthroplasty (n = 81) by Clinical Frailty Score level.

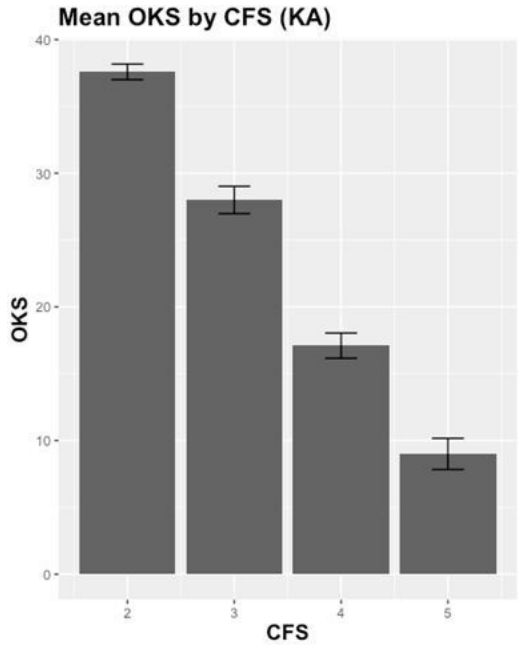

Fig. 3

Mean Oxford Knee Score in patients awaiting a knee arthroplasty (n = 81) by Clinical Frailty Score level.

A total of 200 patients were randomly selected from the waiting lists, with a 50/50 split between THA and KA patients (100 THAs and 100 KAs). Patient demographics (age, sex, postcode), patient comorbidities, and time spent on the waiting list were collected from patient's electronic records. The 2020 version of the Scottish Index of Multiple Deprivation (SIMD) was used as a relative measure of the area deprivation according to the patients' postcode.[17] Charlson Comorbidity Index (CCI) was used as a measure of the patients' overall comorbidity.[18]

Patients were contacted by telephone and asked to complete an interviewer administrated verbal questionnaire. The questionnaire assessed patient's current Rockwood Clinical Frailty Scale (CFS) score,[1] Oxford Hip Score (OHS)[19] or Oxford Knee Score (OKS),[20] EuroQol five-domain three-level (EQ-5D-3L) score, EuroQoL visual analogue scale (EQ-VAS) score,[21] alcohol consumption status (yes/no), and smoking status (yes/no).

The Rockwood CFS is a validated measure of patient frailty.[22] It is a scale from 1 (very fit) to 7 (severely frail). Scores are determined by assessing patient activity levels, comorbidity, and amount of assistance required for activities of daily living (ADLs).[23]

The OHS and OKS each consist of 12 questions that assess patient JSF in hips and knees, respectively. Each question is scored using a Likert scale (0 to 4), and a summative score is calculated from 48 (least symptomatic) to 0 (most symptomatic). The minimal clinically important difference (MCID) is 5 points for the OHS and OKS.[24,25]

The EuroQol general health questionnaire evaluates five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[21] The three-level version (3L) of the EQ-5D questionnaire was used, with responses to the five domains recorded at three levels of severity (no/slight problems; moderate/severe; or unable/extreme problems).[26] Permission was obtained from the EuroQol Research Foundation (the Netherlands) to use the UK interviewer-administrated version of the EQ-5D-3L. This index is on a scale of -0.594 to 1, where 1 represents perfect health and 0 represents death. Patients scoring less than zero for the EQ-5D score were defined to be in a state worse than death. The MCID in the EQ-5D score after THA is 0.08.[27] The EQ-VAS was also completed, again using the UK interviewer-administrated version, that assesses how good or bad the patient's health is on that day, with ranges from 100 (best health) to 0 (worst health).[21]

Statistical analysis. Statistical analysis was performed using R software version 4.1.2 (R Foundation for Statistical Computing, Austria). Nonparametric tests were used to assess continuous variables for differences between groups using a Mann-Whitney U test, as all continuous variables had a non-normal distribution (age, time on the waiting list, Oxford score, EQ-5D, and EQ-VAS).

Dichotomous variables were assessed using a chi-squared test for between group comparisons (sex, alcohol status, smoking status). Pearson's (continuous

Table I. Patient demographics.

Variable	Cohort **(n = 162)**	THA **(n = 81)**	KA **(n = 81)**
Mean age, yrs (SD)	66.6 (11.3)	64.5 (12.8)	68.8 (9.2)
Sex, n (% of group)			
Female	86 (53.1)	41 (50.6)	45 (55.6)
Male	76 (46.9)	40 (49.4)	36 (44.4)
SIMD, n (% of group)			
1 (most)	25 (15.4)	16 (19.8)	9 (11.1)
2	34 (21.0)	19 (23.5)	15 (18.5)
3	26 (16.0)	11 (13.6)	15 (18.5)
4	25 (15.4)	15 (18.5)	10 (12.3)
5 (least)	52 (32.1)	20 (24.7)	32 (39.5)
Mean time on list, days (SD)	300 (85)	294 (80)	307 (90)
Alcohol, n (% of group)			
No	68 (42.0)	37 (45.7)	31 (38.3)
Yes	94 (58.0)	44 (54.3)	50 (61.7)
Smoking, n (% of group)			
No	142 (87.7)	70 (86.4)	72 (88.9)
Yes	20 (12.3)	11 (13.6)	9 (11.1)
CCI, n (% of group)			
0 (least)	10 (6.2)	9 (11.1)	1 (1.2)
1	19 (11.7)	12 (14.8)	7 (8.6)
2	48 (29.6)	23 (28.4)	25 (30.9)
3	34 (21.0)	15 (18.5)	19 (23.5)
4	21 (13.0)	8 (9.9)	13 (16.0)
5	15 (9.3)	6 (7.4)	9 (11.1)
6	10 (6.2)	6 (7.4)	4 (4.9)
7	0 (0)	0 (0)	0 (0)
8	4 (2.5)	1 (1.2)	3 (3.7)
9 (most)	1 (0.6)	1 (1.2)	0 (0)
CFS, n (% of group)			
1 (least)	1 (0.6)	1 (1.2)	0 (0)
2	22 (13.6)	10 (12.3)	12 (14.8)
3	50 (30.9)	19 (23.5)	31 (38.3)
4	65 (40.1)	35 (43.2)	30 (37.0)
5	16 (9.9)	8 (9.9)	8 (9.9)
6	7 (4.3)	7 (8.6)	0 (0)
7 (most)	1 (0.6)	1 (1.2)	0 (0)
Mean OHS/OKS (SD)	23.2 (10.4)	23.0 (11.0)	23.5 (9.9)
Mean EQ-5D (SD)	0.405 (0.337)	0.343 (0.337)	0.467 (0.328)
Mean EQ-VAS (SD)	49.3 (21.3)	45.0 (22.8)	53.7 (18.8)

CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Score; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; KA, knee arthroplasty; KA, knee arthroplasty; OHS, Oxford Hip Score; OHS, Oxford Hip Score; OKS, Oxford Knee Score; SD, standard deviation; SIMD, Scottish Index of Multiple Deprivation; THA, total hip arthroplasty.

variables; age, time on the waiting list) and Spearman's (ordinal variables; SIMD, CCI, CFS) correlation coefficients were used to assess the individual relationships between the independent variables and the outcome scores (OHS/OKS, EQ-5D, EQ-VAS). Multivariate linear analysis was used to assess the independent association of factors influencing the change in the OHS/OKS, EQ-5D and EQ-VAS after adjusting for confounding variables. A p-value < 0.05 was defined as statistically significant.

A priori power calculation was performed for correlation between OHS/OKS and the CFS (primary outcome measure). Using a one-tailed (negative correlation) analysis, with a moderate effect size of 0.3 (Cohen's 1988), an α of 0.05 and a power of 85%, a minimum of 77 patients would be required. To account for a 20% failure to contact or refusal to participate, 100 patients were identified for each group (THA and TKA).

Results

A total of 162 patients (81%) completed the questionnaire (81 THAs, 81 KAs (76 TKAs, five PKAs)) during the study period (Figure 1). Of the 38 patients (19%) who did not complete the questionnaire, 31 were not contactable (minimum two phone calls that were one week apart), and seven responded to the phone calls but were excluded for having already undergone surgery (six THAs, one TKA; five privately, two in the NHS). There were no differences in sex (p = 0.133, chi-squared test), age (p = 0.222, Mann-Whitney U test), length of time on the waiting list (p = 0.083, Mann-Whitney U test), or SIMD (p = 0.865, chi-squared test) between responders (n = 169) and non-responders (n = 31) (Table I). There were 40 male (49.4%) and 41 female (50.6%) THA patients with a mean age of 64.5 years (standard deviation (SD) 12.8; 33 to 91). The mean time on the waiting list was 294 days (ten months) (SD 80 days; 185 to 576). There were 36 male (44.4%) and 45 female (55.6%) KA patients with a mean age of 68.8 years (SD 9.2; 48 to 90). The mean time on the waiting list was 307 days (ten months) (SD 90 days; 188 to 588).

Primary outcome: correlation of JSF and CFS

THA. There was a significant correlation between the OHS (r = –0.838; p < 0.001, Spearman correlation) with the CFS (Table II), with worsening JSF being associated with increased clinical frailty. Socioeconomic deprivation (SIMD) was also associated with a worse OHS (r = 0.253; p = 0.022, Spearman correlation) and smokers had significantly lower OHS (17 vs 25; p = 0.037, Mann-Whitney U test) (Table II). OHS decreased with each increase in CFS level (Figure 2). When adjusting for confounding variables an increase in the CFS was independently associated with a significant decrease in the OHS (B = –8.5, 95% confidence interval (CI) 7.1 to 10.0; p < 0.001, multiple regression) (Table III). Therefore, an increase (worse) in one level of clinical frailty was associated with a worse OHS by 8.5 points.

KA. There was a significant correlation between the OKS (r = –0.867; p < 0.001, Spearman correlation) with the CFS (Table IV), with worsening JSF being associated with increased clinical frailty. A sub-analysis of the patients awaiting a PKA (n = 5) showed a significant correlation between the OKS (r = –0.950; p = 0.013, Spearman correlation) and the CFS. Female patients had significantly lower OKS (18 vs 28; p < 0.001, Pearson correlation),

Table II. Patient and functional factors associated with OHS, EQ-5D, and EQ-VAS for patients awaiting a THA (n = 81).

	OHS		EQ-5D		EQ-VAS	
Variable	**Correlation/median**	**p-value**	**Correlation/median**	**p-value**	**Correlation/median**	**p-value**
Age, yrs	–0.074	0.513*	-0.046	0.683*	–0.016	0.886*
Sex						
Female (n = 41)	19	0.113†	0.516	0.090†	50	0.647†
Male (n = 40)	25.5		0.552		50	
SIMD	0.253	0.022‡	0.265	0.017‡	0.101	0.370‡
Time on list, days	–0.200	0.074*	–0.200	0.074*	–0.089	0.428*
Alcohol						
No (n = 37)	20	0.069†	0.082	0.030†	50	0.996†
Yes (n = 44)	26		0.516		45	
Smoking						
No (n = 70)	25	0.037†	0.516	0.012†	50	0.060†
Yes (n = 11)	17		0.082		30	
CCI	–0.125	0.265‡	–0.086	0.447‡	–0.025	0.828‡
CFS	–0.838	< 0.001‡	–0.663	< 0.001‡	–0.414	< 0.001‡

*Pearson's.
†Mann-Whitney U test.
‡Spearman's.
CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Score; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; OHS, Oxford Hip Score; SIMD, Scottish Index of Multiple Deprivation.

Table III. Multiple regression results for OHS, EQ-5D, and EQ-VAS using all patient and functional factors as predictors in patients awaiting a THA (n = 81).

	OHS (R^2 0.723)				EQ-5D (R^2 0.441)				EQ-VAS (R^2 0.327)			
	B	**95% CI for B**				**95% CI for B**				**95% CI for B**		
		LL	**UL**	**p-value***	**B**	**LL**	**UL**	**p-value***	**B**	**LL**	**UL**	**p-value***
Age, yrs	0.053	–0.137	0.244	0.578	0.000	–0.008	0.009	0.920	0.515	–0.099	1.128	0.099
Sex, female	–0.810	–3.684	2.065	0.576	–0.033	–0.157	0.092	0.604	5.839	–3.427	15.105	0.213
SIMD	0.023	–0.997	1.044	0.964	0.020	–0.025	0.064	0.379	–0.952	–4.242	2.338	0.566
Time on list, days	0.000	–0.019	0.019	0.991	0.000	–0.001	0.001	0.679	0.081	0.021	0.141	0.009
Alcohol, no	1.030	–1.997	4.057	0.500	–0.048	–0.180	0.083	0.465	6.900	–2.857	16.658	0.163
Smoking, no	–1.258	–5.724	3.208	0.576	0.081	–0.113	0.275	0.407	6.188	–8.208	20.584	0.394
CCI	0.743	–0.461	1.946	0.223	0.010	–0.053	0.062	0.717	–1.489	–5.369	2.392	0.447
CFS	–8.534	–9.976	–7.092	<0.001	–0.164	–0.226	–0.101	<0.001	–11.500	–16.149	–6.851	<0.001

*Regression analysis of each independent variable.
B, regression coefficient; CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Score; CI, confidence interval; CI, confidence interval; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; LL, lower limit; OHS, Oxford Hip Score; R^2, coefficient of determination; SIMD, Scottish Index of Multiple Deprivation; THA, total hip arthroplasty; UL, upper limit.

and those with no alcohol intake had significantly lower OKS (18 vs 26.5; p = 0.003, Pearson correlation) compared to those with alcohol intake. OKS decreased with each increase in CFS level (Figure 3). When adjusting for confounding variables an increase in the CFS was independently associated with a significant decrease in the OKS (*B* = –9.9, 95% CI 8.4 to 11.4; p < 0.001, multiple regression) (Table V). Therefore, an increase (worse) in one level of clinical frailty was associated with a worse OKS by 9.9 points.

Secondary outcome: correlation of HRQoL and CFS

THA. There was a significant correlation between the EQ-5D (*r* = –0.663; p < 0.001, Spearman correlation) and EQ-VAS scores (*r* = –0.414; p < 0.001, Spearman correlation) with the CFS (Table II), with worsening HRQoL being associated with increased clinical frailty. SIMD was also associated with a worse EQ-5D (*r* = 2.65; p = 0.017, Spearman correlation), and those with no alcohol intake had significantly lower EQ-5D utility compared to those with alcohol intake (0.082 vs 0.516; p = 0.069, Mann-Whitney U test). Patients who smoked had significantly lower EQ-5D utility (0.082 vs 0.516; p = 0.012, Mann-Whitney U test) and EQ-VAS scores (30 vs 50, p = 0.060, Mann-Whitney U test). EQ-5D and EQ-VAS decreased with each increase in CFS level (Figures 4 to 5). When adjusting for confounding variables an increase in the CFS was independently associated with significant decrease in the EQ-5D utility (B = 0.16, 95% CI 0.10 to

Table IV. Patient and functional factors associated with OKS, EQ-5D, and EQ-VAS for patients awaiting a KA (n = 81).

	OKS		EQ-5D		EQ-VAS	
Variable	**Correlation/median**	**p-value**	**Correlation/median**	**p-value**	**Correlation/median**	**p-value**
Age, yrs	–0.063	0.579*	-0.120	0.285*	0.047	0.679*
Sex						
Female (n = 41)	18	< 0.001†	0.516	< 0.001†	50	0.004†
Male (n = 40)	28		0.691		60	
SIMD	0.182	0.104‡	0.190	0.090‡	0.071	0.071
Time on list, days	–0.039	0.728*	–0.033	0.768*	0.055	0.626*
Alcohol						
No (n = 37)	18	0.003†	0.260	0.011†	50	0.147†
Yes (n = 44)	26.5		0.620		60	
Smoking						
No (n = 70)	23.5	0.533†	0.620	0.288†	50	0.368†
Yes (n = 11)	19		0.189		60	
CCI	–0.076	0.500‡	0.040	0.723‡	0.025	0.822‡
CFS	–0.867	< 0.001‡	–0.681	< 0.001‡	–0.386	<.001‡

*Pearson.
†Mann-Whitney U test.
‡Spearman's.
CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Score; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; KA, knee arthroplasty; OKS, Oxford Knee Score; SIMD, Scottish Index of Multiple Deprivation.

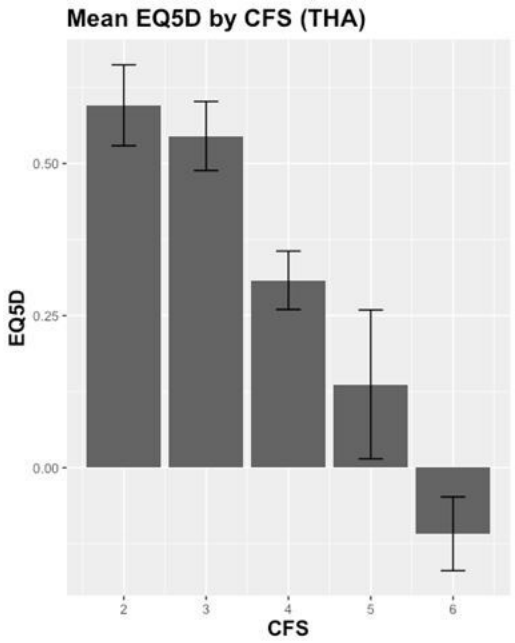

Fig. 4
Mean EuroQol five-dimension level in patients awaiting a total hip arthroplasty (n = 81) by Clinical Frailty Score level.

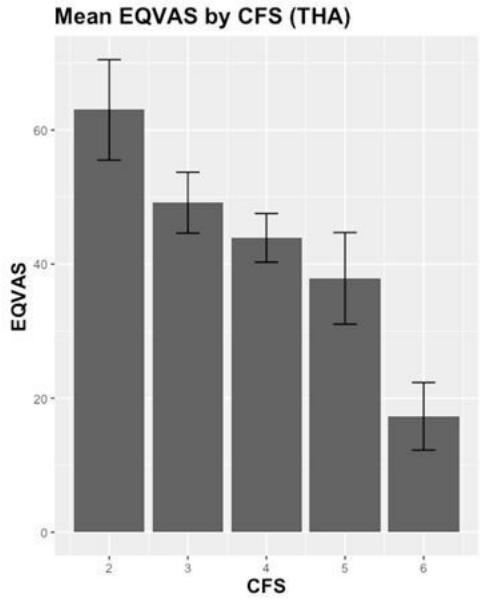

Fig. 5
Mean EuroQol visual analogue scale in patients awaiting a total hip arthroplasty (n = 81) by Clinical Frailty Score level.

0.22; p < 0.001, multiple regression) and the EQ-VAS (B = 11.5, 95% CI 6.9 to 16.1; p < 0.001, multiple regression) (Table III). Therefore, an increase (worse) in one level of clinical frailty was associated with a worse EQ-5D by 0.16 utility, and EQ-VAS by 11.5 points.

KA. There was a significant correlation between the EQ-5D (*r* = –0.681; p < 0.001, Spearman correlation) and EQ-VAS scores (*r* = –0.386; p < 0.001, Spearman correlation) with the CFS (Table IV), with worsening HRQoL being associated with increased clinical frailty. A sub-analysis of the patients awaiting a PKA (n = 5) showed no significant correlation between the EQ5D (*r* = –0.635; p = 0.250, Spearman correlation) or the EQ-VAS (*r* = –0.327; p = 0.591, Spearman correlation) and the CFS. Female patients had lower EQ-5D utility (0.516 vs 0.691; p < 0.001,

Table V. Multiple regression results for OKS, EQ-5D, and EQ-VAS using all patient and functional factors as predictors in patients awaiting a KA (n = 81).

Variable	OKS $R^2$0.801				EQ-5D $R^2$0.489				EQ-VAS $R^2$0.238			
	B	95% CI for B		p-value*	B	95% CI for B		p-value*	B	95% CI for B		p-value*
		LL	UL			LL	UL			LL	UL	
Age, yrs	0.227	0.043	0.411	0.017	0.005	-0.004	0.153	0.273	0.192	-0.497	0.880	0.581
Sex, female	-0.962	-3.404	1.480	0.435	-0.124	-0.254	0.006	0.062	-6.540	-15.664	2.584	0.157
SIMD	0.065	-0.714	0.844	0.869	0.017	-0.024	0.059	0.404	0.935	-1.977	3.846	0.524
Time on list, days	-0.005	-0.016	0.007	0.436	0.000	-0.001	0.001	0.873	0.014	-0.029	0.057	0.523
Alcohol, no	0.588	-3.021	1.846	0.632	-0.075	-0.204	0.055	0.253	-0.905	-9.999	8.186	0.843
Smoking, no	0.023	-3.553	3.599	0.990	0.101	-0.089	0.292	0.292	-8.684	-22.0453	4.678	0.199
CCI	-0.168	-1.247	0.910	0.756	0.000	-0.058	0.057	0.997	0.417	-3.612	4.447	0.837
CFS	-9.903	-11.366	-8.440	< 0.001	-0.195	-0.273	-0.117	< 0.001	-7.902	-13.367	-2.437	0.005

*Regression analysis of each independent variable.
B, regression coefficient; CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Score; CI, confidence interval; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; KA, knee arthroplasty; LL, lower limit; OKS, Oxford Knee Score; R^2, coefficient of determination; SIMD, Scottish Index of Multiple Deprivation; UL, upper limit.

Table VI. Summary of multiple regression models with regression coefficients for CFS.

Variable	R^2	CFS *B*	p-value*
THA			
OHS	0.723	–8.534	< 0.001
EQ-5D	0.441	–0.164	< 0.001
EQ-VAS	0.327	–11.500	< 0.001
KA			
OKS	0.801	–9.903	< 0.001
EQ-5D	0.489	–0.195	< 0.001
EQ-VAS	0.238	–7.902	0.009

*Multiple regression analysis of each model.
B, regression coefficient; CFS, Clinical Frailty Score; EQ-5D, EuroQol five-dimension; EQ-VAS, EuroQol visual analogue scale; KA, knee arthroplasty; KA, knee arthroplasty; OHS, Oxford Hip Score; OKS, Oxford Knee Score; R^2, coefficient of determination; THA, total hip arthroplasty; THA, total hip arthroplasty.

Mann-Whitney U test) and EQ-VAS scores (50 vs 60; p = 0.004, Mann-Whitney U test), and patients with no alcohol intake had lower EQ-5D utility (0.260 vs 0.620; p = 0.011, Mann-Whitney U test) compared to those with alcohol intake. EQ-5D and EQ-VAS decreased with each increase in CFS level (Figures 6 to 7). When adjusting for confounding variables, an increase in the CFS was independently associated with significant decrease in the EQ-5D utility (B = 0.20, 95% CI 0.12 to 0.27; p < 0.001, multiple regression) and EQ-VAS (B = 7.9, 95% CI 2.4 to 13.4; p = 0.005, multiple regression) (Table V). Therefore, an increase (worse) in one level of clinical frailty was associated with a worse EQ-5D by 0.20 points, and EQ-VAS by 7.9 points.

All regression models including CFS coefficients are summarized in Table VI.

Discussion

This study has shown that JSF and HRQoL were independently associated with level of clinical frailty in patients waiting for a THA or KA. An increase (worse) in one level of clinical frailty was associated with clinically significantly worse Oxford scores, EQ-5D, and EQ-VAS in patients awaiting a THA or KA. CFS, in combination with demographics and other relevant factors, can explain a large degree of the variation in preoperative Oxford score, EQ-5D, and EQ-VAS in this patient population.

CFS was the most heavily weighted independent variable in all six of the regression models in this study, making it the most powerful factor associated with the Oxford score, EQ-5D, and EQ-VAS for patients awaiting a THA or KA.

All of the deteriorations in Oxford score, EQ-5D, and EQ-VAS that come with an increase in one level of clinical frailty are greater than the MCID for each of these scores.[28-30] To the best of the authors' knowledge, this is the first study to show an independent association between clinical frailty, JSF, and HRQoL in this patient population.

The components of the Oxford scores, EQ-5D, and CFS have similarities, but do not directly overlap. The CFS globally assesses level of comorbidity and amount of assistance required for ADLs.[23] The Oxford scores assess joint pain and level of difficulty associated with various ADLs.[19,20] The EQ-5D contains questions on mobility, self-care, usual activities, pain, and anxiety or depression.[21] The independent associations demonstrated between CFS and the JSF and HRQoL in this study are not due to the similarities in the components of these scores and how they are constructed. However, there is likely to be an indication that frailer patients have worse JSF and HRQoL.

Oxford scores, EQ-5D, and EQ-VAS all improve following hip or knee arthroplasty.[16] Frailty is a dynamic process that is at least partially reversible,[31,32] and this has been demonstrated following heart and lung transplant surgery.[33,34] Given the improvements in JSF and HRQoL following hip or knee arthroplasty, it is possible that frailty may also be improved, due to the independent

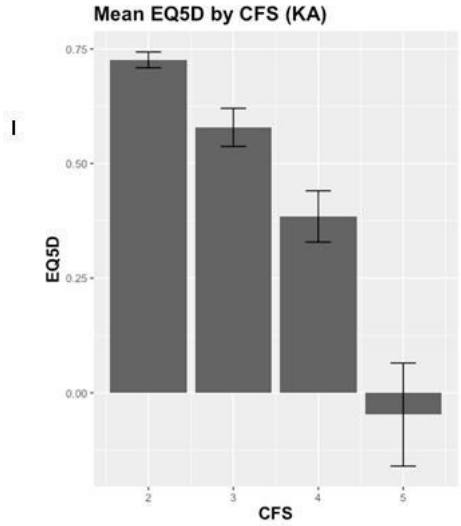

Fig. 6

Mean EuroQol five-dimension level in patients awaiting a knee arthroplasty (n = 81) by Clinical Frailty Score level.

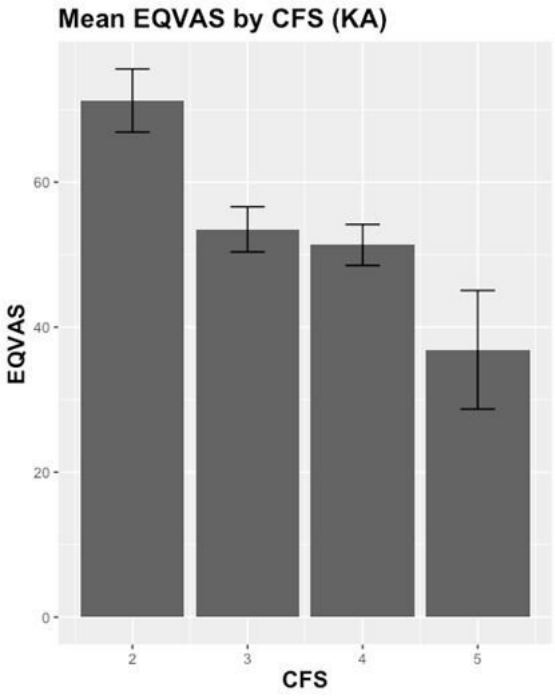

Fig. 7

Mean EuroQol visual analogue scale in patients awaiting a knee arthroplasty (n = 81) by Clinical Frailty Score level.

association between frailty and the PROMs shown in this study.

The COVID-19 pandemic has resulted in an increase in surgical waiting list times, with over 750,000 patients currently awaiting orthopaedic surgery in the NHS.[35] Patients with lower (worse) EQ-5D scores preoperatively have greater improvements in EQ-5D and Oxford score postoperatively, and it has been suggested that this can be used as a tool for prioritizing waiting list patients.[36] Oxford scores, however, have been ineffective at predicting postoperative outcomes.[37] Frailer patients have increased morbidity, mortality, and institutionalisation risks, as well as higher complication rates, longer hospital stays, and more expensive community social care costs.[4,7-9,38] To the authors' best knowledge, frailty has yet to be investigated as a prioritization tool for arthroplasty waiting lists. Given the association between frailty, JSF, and HRQoL, frailty may be a valuable contributor to a multidimensional tool for arthroplasty waiting list prioritization.

There are limitations in this study. The regression models in this study varied in their ability to explain the variation in Oxford score, EQ-5D, and EQ-VAS between 24% and 80%. It is probable there are more variables that could be valuable to these models in explaining this variation, such as clinical examination[39] or radiological findings.[40] These were not collected as there were no available mechanisms to perform these assessments. Only preoperative data were collected, so the effect of arthroplasty surgery on frailty level was not assessed. Prospective studies, including postoperative data, are warranted to further understand the relationship between frailty, JSF, HRQoL, and arthroplasty surgery.

In conclusion, JSF and HRQoL in patients waiting for THA or KA for more than six months were independently associated with level of clinical frailty. With further prospective studies, clinical frailty may prove to be a useful metric to assist in the prioritization of arthroplasty waiting lists.

Take home message

- Worsening joint-specific function and health-related quality of life were associated with increased level of clinical frailty, and therefore may be a useful metric in assisting the prioritization of arthroplasty waiting lists.

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