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ARTHROPLASTY

Preoperative health-related quality of life is independently associated with postoperative mortality risk following total hip or knee arthroplasty

SEVEN TO EIGHT YEARS' FOLLOW-UP

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Aims

The primary aim was to assess whether preoperative health-related quality of life (HRQoL) was associated with postoperative mortality following total hip arthroplasty (THA) and knee arthroplasty (KA). Secondary aims were to assess whether patient demographics/comorbidities and/or joint-specific function were associated with postoperative mortality.

Methods

Patients undergoing THA (n = 717) and KA (n = 742) during a one-year period were identified retrospectively from an arthroplasty register. Patient demographics, comorbidities, Oxford score, and EuroQol five-dimension (EQ-5D) were recorded preoperatively. Patients were followed up for a minimum of seven years and their mortality status was obtained. Cox regression analysis was used to adjust for confounding.

Results

During the study period, 111 patients (15.5%) undergoing THA and 135 patients (18.2%) undergoing KA had died at a mean follow-up of 7.5 years (7 to 8). When adjusting for confounding, the preoperative EQ-5D was associated with postoperative mortality, and for each 0.1 difference in the utility there was an associated change in mortality risk of 6.7% (p = 0.048) after THA, and 6.8% (p = 0.047) after KA. Comorbidities of connective tissue disease (p ≤ 0.026) and diabetes (p ≤ 0.028) were associated with mortality after THA, whereas MI (p ≤ 0.041), diabetes (p ≤ 0.009), and pain in other joints (p ≤ 0.050) were associated with mortality following KA. The preoperative Oxford score was associated with mortality, and for each one-point change in the score there was an associated change in mortality risk of 2.7% (p = 0.025) after THA and 4.3% (p = 0.003) after KA.

Conclusion

Worse preoperative HRQoL and joint specific function were associated with an increased risk of postoperative mortality. Both HRQoL and joint-specific function decline with longer waiting times to surgery for THA and KA and therefore may result in an increased postoperative mortality risk than would have been expected if surgery had been undertaken earlier.

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Introduction

Total hip arthroplasty (THA) and knee arthroplasty (KA) are associated with an improvement in health-related quality of life (HRQoL) following surgery.[1] The improvement in HRQoL over the patient's lifetime results in THA and KA being some of the most cost-effective interventions in medicine due to

Table I. Patient demographics, comorbidities, health-related quality of life, and joint-specific function for the cohort undergoing total hip arthroplasty and according to mortality status.

Variable	Overall **(n = 717)**	Alive **(n = 606)**	Dead **(n = 111)**	**Difference/odds ratio**	**p-value**
Age (years: mean, SD)	66.6 (12.9)	64.9 (12.7)	76.0 (9.5)	11.1 (8.6 to 13.7)	< 0.001†
Sex, n (%)					
Male	320(44.6)	271 (44.7)	49 (44.1)	1.02 (0.7 to 1.5)	0.911*
Female	397(55.4)	335 (55.3)	62 (55.9)		
Mean BMI, kg/m² (SD)	29.8 (17)	30.3 (12.7)	27.5 (9.5)	2.8 (0.9 to 6.4)	0.144†
Comorbidities, n (%)					
MI	37 (5.2)	31 (5.1)	6 (5.4)	1.2 (0.5 to 2.9)	0.727*
COPD	39 (5.4)	28 (4.6)	11 (9.9)	2.5 (1.2 to 5.1)	0.014*
CTD	85 (11.9)	63 (8.8)	22 (19.8)	2.3 (1.3 to 3.9)	0.003*
Diabetes	56 (7.8)	40 (6.6)	16 (14.4)	2.6 (1.4 to 4.9)	0.002*
Stroke	25 (3.4)	21 (3.5)	4 (3.6)	1.1 (0.4 to 3.3)	0.847*
Liver disease	16 (2.2)	13 (2.1)	3 (2.7)	1.4 (0.4 to 5)	0.630*
Back pain	390 (54.4)	328 (54.1)	62 (55.9)	1.3 (0.8 to 2)	0.246*
Other joint pain	516 (72)	434 (71.6)	82 (73.9)	1.4 (0.8 to 2.4)	0.285*
HRQoL					
EQ-5D (mean, SD)	0.348 (0.330)	0.359 (0.330)	0.287 (0.330)	0.072 (0.005 to 0.139)	0.035†
EQ-VAS (mean, SD)	66.1 (23.2)	66.9 (23.0)	62.0 (23.6)	5.0 (0.3 to 9.7)	0.038†
Joint-specific function					
OHS (mean, SD)	20.0 (9.1)	20.3 (9.1)	18.3 (9)	2.0 (0.1 to 3.8)	0.036†
Pain-VAS (mean, SD)	49.6 (24.4)	50 (24.3)	47.3 (24.8)	2.7 (2.2 to 7.7)	0.278†

*Chi-squared test.
†Independant *t*-test
COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease; HRQoL, health-related quality of life ; MI, myocardial infarction; OHS, Oxford Hip Score; SD , standard deviation; VAS, visual analogue scale.

the quality of life gained according to the cost of treatment.[1] However, conversely a delay to surgery is proven to be associated with a clinically significant worsening of a patients HRQoL.[2] The postoperative effects of this deterioration while waiting for THA or KA are not clear. Previous studies have shown that the deterioration while awaiting surgery is not regained following surgery (i.e. they do not have a greater improvement to attain the same HRQoL, they would have had should they and had surgery earlier).[1] Therefore, the deterioration while waiting would seem to have longer lasting effects on the patients HRQoL.

COVID-19 disrupted healthcare services and has contributed to millions of patients waiting for planned hospital treatment. This has resulted in patients waiting longer for THA and KA and the effects of this are not benign.[2,3] Approximately a third of patients awaiting THA and a quarter of patients awaiting KA are in a health state "worse than death", with significantly worse HRQoL than that observed prior to COVID-19 pandemic.[2] To the authors knowledge, only one study has assessed the effect for preoperative HRQoL on postoperative mortality in patients following THA, which demonstrated a worse HRQoL was associated with increased risk of mortality at a mean follow-up of 2.4 years.[4] There is also data from hip fracture patients that their preoperative HRQoL was predictive of postoperative mortality risk at up to five years post-injury.[5,6] There are currently no available data in relation to preoperative HRQoL and mortality following KA. Therefore the longer-term consequences, beyond five years, of preoperative HRQoL on mortality following THA or KA are not known. Furthermore, the effective of joint specific function prior to surgery on mortality are also not known. It is recognized that there is a deterioration in HRQoL and joint-specific function with increasing waiting time to THA and KA, and if this is associated with an increased postoperative mortality risk this would have repercussions on waiting time targets and prioritization for patients.[7]

The primary aim of this study was to assess whether preoperative HRQoL was associated with postoperative mortality following THA and KA. Secondary aims were to assess: 1) patient demographics/comorbidities; or 2) whether joint-specific function were associated with postoperative mortality. The null hypothesis was that a clinically significant deterioration in HRQoL was not associated with an increased mortality risk.

Methods

Ethical approval was obtained for data collection (Scotland B REC and the number 20/SS/0125 A), and the study was registered and approved at the Royal Infirmary of Edinburgh and University of Edinburgh, UK. A retrospective single centre study was undertaken. Patients undergoing THA or KA during 2014 were identified from an arthroplasty outcome register held at the study centre.

Table II. Patient demographics, comorbidities, health-related quality of life, and joint-specific function for the cohort undergoing knee arthroplasty and according to mortality status.

Variable	Overall **(n = 742)**	Alive **(n = 607)**	Dead **(n = 135)**	**Odds ratio (95% CI)**	**p-value**
Mean ge, yrs (SD)	69.2 (9.8)	67.9 (9.4)	75.5 (9)	7.6 (5.9 to 9.4)	< 0.001†
Sex, n (%)					
Male	313 (42.2)	256 (42.2)	57 (42.2)	1 (0.7 to 1.5	0.992*
Female	429 (57.8)	351 (57.8)	78 (57.8)		
Mean BMI, kg/m^2 (SD)	30.8 (7.6)	30.9 (6.2)	30.7 (12)	0.1 (1.4 to 1.6)	0.846†
Comorbidities, n (%)					
MI	47 (6.3)	30 (4.9)	17 (12.6)	2.9 (1.5 to 5.5)	0.001*
COPD	33 (4.4)	21 (3.5)	12 (8.9)	2.8 (1.4 to 6.0)	0.004*
CTD	116 (15.6)	85 (14)	31 (23)	2.0 (1.2 to 3.2)	0.005*
Diabetes	116 (15.6)	84 (13.8)	32 (23.7)	2.0 (1.3 to 3.2)	0.003*
Stroke	30 (4)	16 (2.6)	14 (10.3)	4.6 (2.2 to 9.7)	< 0.001*
Liver disease	14 (1.9)	10 (1.6)	4 (3)	1.9 (0.6 to 6.2)	0.275*
Back pain	321 (43.3)	264 (43.5)	57 (42.2)	1.0 (0.7 to 1.5)	0.961*
Other joint pain	533 (71.8)	447 (73.6)	86 (63.7)	0.7 (0.4 to 1.1)	0.088*
HRQoL					
EQ-5D (mean, SD)	0.395 (0.309)	0.407 (0.308)	0.340 (0.306)	0.067 (0.009 to 0.124)	0.023†
EQ-VAS (mean, SD)	68.3 (22.2)	69.4 (22.3)	63.6 (21.4)	5.8 (1.6 to 9.9)	0.006†
Joint-specific function					
OHS (mean, SD)	20 (7.9)	20.5 (7.8)	17.8 (8.1)	2.7 (1.2 to 4.1)	< 0.001†
Pain-VAS (mean, SD)	52.5 (24.4)	52.1 (24.3)	54.4 (25.1)	2.3 (1.6 to 7.4)	0.314†

*Chi-squared test.
†Independant *t*-test.
COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease; HRQoL, health-related quality of life; MI, myocardial infarction; OHS, Oxford Hip Score; SD, standard deviation; VAS, visual analogue scale.

There were 717 patients undergoing THA and 742 underwent KA, and had preoperative patient-reported outcome measures (PROMs). Only patients undergoing primary surgery were included. Simultaneous and sequential bilateral procedures, and those undergoing a revision THA and KA during the study period were excluded. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies were followed (Supplementary Material table i).[8]

Patient demographics, BMI comorbidities, and PROMs were collected prospectively at the time of the patients preassessment for their surgery (two to four weeks prior). Comorbidities recorded were myocardial infarction (MI), chronic obstructive pulmonary disease (COPD), connective tissue disease (CTD), diabetes, stroke, liver disease, back pain, and other joint pain. These were prospectively recorded at the preassessment clinic by the patient. There were simply recorded as categorical (yes/no) and were not graded on severity.

Outcomes. HRQoL was assessed using the EuroQol five-dimension (EQ-5D) general health questionnaire (primary outcome measure), which evaluates five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[9] The three-level version of the EQ-5D questionnaire was used (EQ-5D-3L), with responses to the five domains recorded at three levels of severity (no/slight problems, moderate/severe, or unable/extreme problems).[10] Permission was obtained from the EuroQol Research Foundation (Netherland) to use the UK 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 WTD.[11] The minimal clinically important difference (MCID) in the EQ-5D score after THA is 0.08; therefore, a difference in the score of 0.08 or more was defined as clinically important.[12] The EQ visual analogue scale (VAS) was also completed that assesses how good or bad the patient's health is on that day, and ranges from 100 (best health) to 0 (worst health).

Joint-specific function was assessed using Oxford Hip Score (OHS)[13] or Oxford Knee Score (OKS),[14] according to the joint being replaced. The Oxford score consists of 12 questions (specific to the joint being assessed) that are scored from 0 (worst) to 4 (best), with a total score ranging from 0 (worst) to 48 (best).[15] The MCID in the OHS and OKS is five points.[16] Joint-specific pain was also measured using a VAS that ranged from 100 (no pain) to 0 (worst worst).

Mortality. Patient mortality status was obtained from the local (study centre) hospital electronic records which is the sole provider for national health care for the catchment population. This was done using each patient's unique Community Health Index (CHI) number. Furthermore, to ensure capture of patients that may have moved out

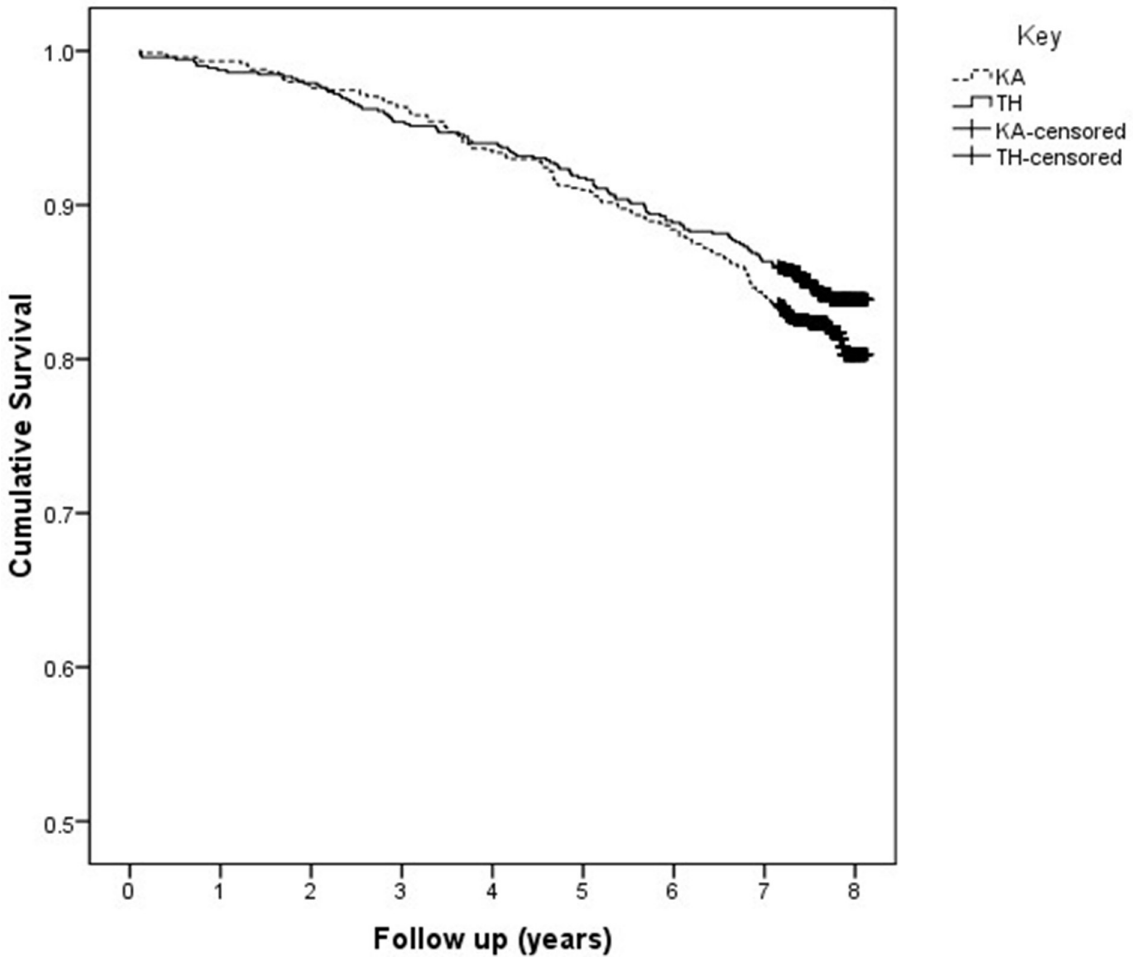

Fig. 1

Kaplan-Meier curve for mortality after total hip (solid line) and knee (dashed line) arthroplasty.

with the catchment area the National Records of Scotland were contacted to assess the patients mortality status.[17]

Statistical analysis. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software version 17 (IBM, USA). Parametric tests were used to assess continuous variables for significant differences between groups (alive vs dead) using an unpaired *t*-test (age, BMI, EQ-5D, EQ-VAS, OHS, OKS, and pain VAS) were assessed for differences. Dichotomous variables were assessed using a Chi square test between group comparisons (sex and comorbidity). Kaplan-Meier time to event methodology was used to assess patient survival following TKA or KA. Log rank (Mantel-Cox) test was used to assess differences in survival between THA and KA. Cox regression analysis was used to assess the independent association of factors influencing patient mortality when adjusting for confounding variables. Due to the co-linearity ($r > 0.7$) of the EQ-5D (primary outcome) and the Oxford scores (secondary outcome), two separate models were undertaken. Only variables that were significant or were treading towards significance ($p < 0.1$) for mortality on unadjusted analysis were included in the models (Table I and Table II). A p-value < 0.05 was defined as statistically significant.

A priori power calculation was performed using the known MCID difference in the EQ-5D of 0.08 and standard deviation of 0.3 (effect size 0.267),[12] an α of 0.05, using a 1:6 ratio (assumed 15% mortality at seven- to eight-year follow up would require a cohort of 710 (101 deceased and 609 alive) to achieve a power of 80%.[18,19]

Results

During the study period, 111 patients (15.5%) undergoing THA and 135 patients (18.2%) undergoing KA had died at a mean follow-up of 7.5 years (7 to 8) (Figure 1). There was no difference in survival between THA and KA ($p = 0.181$, log rank). The mean age of those undergoing THA was 66.6 years, of which 397 (55.4%) were female, with a mean BMI of 29.8 kg/m^2 (Table I). The mean age of those undergoing KA was 69.2 years, of whom 429 (57.8%) were female, with a mean BMI of 30.8 kg/m^2 (Table II).

Table III. Cox regression analysis (EQ-5D) for factors associated with mortality after total hip arthroplasty.

Variable	B	Hazard ratio*	95% CI	p-value
Age	0.099	1.104	1.076 to 1.132	0.000
Sex	-0.278	0.758	0.502 to 1.143	0.186
BMI	-0.021	0.979	0.947 to 1.013	0.222
Comorbidities				
COPD	0.412	1.511	0.752 to 3.033	0.246
CTD	0.583	1.792	1.071 to 2.998	0.026
Diabetes	0.645	1.906	1.083 to 3.354	0.025
EQ-5D	-0.652	0.521	0.273 to 0.993	0.048

*Hazard ratio for mortality: 0.1 change = 6.74%.
CI, confidence interval; COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease ; EQ-5D, EuroQol five-dimension.

Table IV. Cox regression analysis (EQ-5D) for factors associated with mortality after knee arthroplasty.

Variable	B	Hazard ratio*	95% CI	p-value
Age	0.027	1.028	0.692 to 1.526	0.893
Sex	0.092	1.096	1.071 to 1.123	0.000
BMI	0.016	1.016	0.994 to 1.038	0.160
Comorbidities				
MI	0.704	2.021	1.080 to 3.784	0.028
COPD	0.646	1.907	0.886 to 4.108	0.099
CTD	0.425	1.529	0.946 to 2.473	0.083
Diabetes	0.625	1.868	1.187 to 2.939	0.007
CVA	-0.142	0.868	0.204 to 3.697	0.848
Other joint pain	-0.403	0.668	0.444 to 1.006	0.050
EQ-5D*	-0.658	0.518	0.271 to 0.991	0.047

*Hazard ratio for mortality: 0.1 change = 6.80%.
CI, confidence interval; COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease; CVA, cerebrovascular accident ; EQ-5D, EuroQol five-dimension; MI, myocardial infarction.

Primary aim: HRQoL and postoperative mortality. A significantly lower (worse) preoperative EQ-5D (mean difference (MD) 0.072, 95% confidence interval (CI) 0.005 to 0.103; p = 0.035) and EQ-VAS (MD 5.0, 95% CI 0.3 to 9.7; p = 0.038) were associated with postoperative mortality in patients undergoing THA (Table I). When adjusting for confounding, preoperative EQ-5D was associated with postoperative mortality (hazard ratio (HR) 0.52, 95% CI 0.27 to 0.99; p = 0.048), and for each 0.1 difference in the utility there was an associated change in mortality risk of 6.7% (Table III). Similarly, a significantly lower preoperative EQ-5D (MD 0.067, 95% CI 0.009 to 0.124; p = 0.023) and EQ-VAS (MD 5.8, 95% CI 1.6 to 9.9; p = 0.006) were associated with postoperative mortality in patients undergoing TKA (Table II). When adjusting for confounding, preoperative EQ-5D was associated with postoperative mortality (HR 0.52, 0.27 to 0.99; p = 0.047), and for each 0.1 difference in the utility, there was an associated change in mortality risk of 6.8% (Table IV).

Secondary aim: Patient demographics/comorbidities and postoperative mortality. Comorbidities of COPD, CTD, and diabetes were significantly associated with an increased mortality risk for those undergoing THA (Table I), whereas MI, COPD, CTD, diabetes and stroke were associated with mortality in patients undergoing KA (Table II). When adjusting for confounding, patients with CTD or diabetes were more likely to die following THA (Tables III and V), whereas patients with a history of MI, diabetes, or pain in other joints were likely to die following KA (Tables IV and VI).

Secondary aim: joint-specific function and postoperative mortality. A significantly lower (worse) preoperative OHS (MD 2.0, 95% CI 0.1 to 3.8; p = 0.036) was associated with postoperative mortality in patients undergoing THA (Table I). When adjusting for confounding preoperative OHS was associated with postoperative mortality (HR 0.97, 95% CI 0.951 to 0.997; p = 0.025), and for each one-point difference in the score there was an associated change in mortality risk of 2.74% (Table V). Similarly, a significantly lower preoperative OKS (MD 2.7, 95% CI 1.2 to 4.1; p < 0.001) was associated with postoperative mortality in patients undergoing TKA (Table II). When adjusting for confounding preoperative OKS was associated with postoperative mortality (HR 0.96, 95% CI 0.93 to 0.99; p = 0.003), and for each one-point difference in the score there was an associated change in mortality risk of 4.28% (Table VI).

Discussion

This study has shown that preoperative HRQoL was independently associated with postoperative mortality up to eight years following THA and KA, with a worse HRQoL being associated with an increased risk of mortality. Patient comorbidities were also shown to be independently associated with postoperative mortality, although only diabetes was a common risk factor for following THA and KA. A novel aspect of the study was that preoperative joint specific function was independently associated with postoperative mortality, with a worse Oxford score being associated with an increased risk of mortality. The crude mortality rate following THA was 15.5% and 18.2% following KA at a mean follow-up of 7.5 years, although this was not significantly different and may be due to the older age of those undergoing KA.

A novel aspect of the current study was demonstrating the association of preoperative HRQoL with mortality risk postoperatively. Although this may be an unsurprising connection, there is a paucity evidence to support this association. To the authors knowledge, the only study assessing HRQoL and mortality after primary THA or KA is that reported by Cnudde et al.[4] They reported 42,862 THA from the Swedish hip arthroplasty register at a mean follow-up of 2.4 years. However, rather than assess the effect of the validated EQ-5D utility on mortality, they assessed the effect of each of the five dimensions: mobility, self-care, usual activity, pain/discomfort, and anxiety/depression on mortality. They found that patients with

Table V. Cox regression analysis (OHS) for factors associated with mortality after total hip arthroplasty.

Variable	B	Hazard ratio*	95% CI	p-value
Age	0.098	1.103	1.076 to 1.131	0.000
Sex	-0.309	0.734	0.485 to 1.111	0.144
BMI	-0.019	0.981	0.950 to 1.013	0.243
Comorbidities				
COPD	0.468	1.596	0.804 to 3.169	0.181
CTD	0.604	1.829	1.095 to 3.055	0.021
Diabetes	0.633	1.883	1.071 to 3.312	0.028
OHS	-0.027	0.973	0.951 to 0.997	0.025

*Hazard ratio for mortality: 1 point = 2.74%.
COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease; OHS, Oxford Hip Score.

Table VI. Cox regression analysis (OKS) for factors associated with mortality after knee arthroplasty.

Variable	B	Hazard ratio*	95% CI	p-value
Age	-0.056	0.946	0.634 to 1.411	0.784
Sex	0.088	1.092	1.067 to 1.118	0.000
BMI	0.013	1.013	0.990 to 1.037	0.282
Comorbidities				
MI	0.656	1.927	1.028 to 3.612	0.041
COPD	0.717	2.049	0.971 to 4.325	0.060
CTD	0.340	1.405	0.865 to 2.283	0.169
Diabetes	0.600	1.822	1.158 to 2.866	0.009
CVA	0.024	1.024	0.247 to 4.245	0.974
Other joint pain	-0.443	0.642	0.427 to 0.966	0.034
OKS	-0.042	0.959	0.932 to 0.986	0.003

*Hazard ratio for mortality: one point = 4.28%.
CI, confidence interval; COPD, chronic obstructive pulmonary disease; CTD, connective tissue disease; CVA, cerebrovascular accident; MI, myocardial infarction; OKS, Oxford Knee Score.

moderate or severe problems had a higher mortality risk. However, this is not how the EQ-5D utility is reported, and it is weighted according to each of the responses given.[10] This current study demonstrated that a change in the EQ-5D utility was independently associated with mortality risk up to eight years following THA and KA. Although not specific to arthroplasty, population level data supports the association of worsening subjective health with increased mortality risk.[20,21] More specifically, a worse EQ-5D utility when used to measure HRQoL has been shown to be associated with increased risk of hospitalisation and mortality in an elderly Italian population.[22] The association of the EQ-5D with mortality has also been shown in the frailer hip fracture population, being a moderate predictor of mortality at 12 months and also at five years,[5] but at this later time point, it was not significant when accounting for confounding factors.[6]

In the knowledge of the effect of HRQoL on mortality after THA or KA, this may have repercussions on prioritising patients for surgery, before their HRQoL deteriorates further, and whether it is possible to optimize patients prior to surgery and improve their HRQoL and therefore lower the risk of postoperative mortality. Due to the prolonged waits for THA and KA due to the disruption of COVID-19 on planned healthcare services, patients waiting six months or more have been shown to have a clinically significant deterioration in their HRQoL.[2] Patients are not only are having to endure a deteriorating HRQoL while awaiting their essential surgery, but the results of the current study suggest this may have longer-term repercussions on their mortality. It is recognized that the preoperative EQ-5D of patients currently awaiting THA (0.119) or KA (0.074) have a worse utility compared to patients prior to the COVID-19 pandemic,[2] which would equate to an approximate increase mortality risk of 8.1% and 5.0%, respectively. To put this into context, these increased mortality risks are similar to that observed at five years in patients with stage two breast cancer.[23] A lower HRQoL is also associated with a longer hospital length of stay and increased perioperative complications,[24,25] which may have financial and patient morbidity consequences. Furthermore, patients may not achieve the same level of HRQoL following their THA or KA; they may have done prior to their deterioration and therefore not achieve the same outcome if they had their surgery earlier.[1] In the knowledge of these potential ramifications to patients awaiting THA or KA, it would seem inappropriate to prioritize routine arthroplasty a level four in light of the increased mortality risk associated with worsening HRQoL. As priority level four currently suggests that a patient waiting longer than three months will not come to harm.[7,26] The ideal resolution may be that all patients receive their surgery within three months of being placed on the waiting list, but this is not likely to be the case for several years.[27,28] An additional option is to try and avoid deterioration in, and maybe improve, HRQoL by offering patients waiting for surgery a prehabilitation package of care, which has been shown to improve HRQoL.[29,30] This may even help optimize the outcomes of their surgery, which has been observed in surgical cancer patients and can be undertaken remotely.[31]

MI, diabetes, and CTD were shown to be associated with approximately double the mortality risk during the first eight years following THA or KA, which is consistent with previous studies.[32,33] Two systematic reviews by Berstock et al[32,33] assessed mortality up to 90 days following THA or KA, and demonstrated a similar hazard ratio for mortality associated with comorbidities of diabetes and cardiovascular disease. There are limited data reporting factors associated with longer-term mortality after THA or KA.[18,34] Buchele et al[34] assessed a cohort of 809 patients up to 20 years following THA or KA, and demonstrated diabetes and cardiac insufficiency to be associated with increased mortality risk. However, they did not assess the effect of CTD as a

group of conditions, but did show that patients with a comorbidity of gout had a higher risk to mortality. More recently, Yapp et al[18] demonstrated inflammatory polyarthropathy was associated with a hazard ratio of 1.8, similar to the current study for CTD, for increased risk of mortality at a median follow-up of 7.4 years after KA.

The second novel aspect of the current study was the association of joint-specific function with mortality. To the authors knowledge, this has not been described previously. It was not possible to include the EQ-5D and the Oxford scores in the same regression models due to the observed collinearity between the measures, and therefore the independent effect of each on mortality could not be confirmed. However, it would seem intuitive that deteriorating joint-specific function would be associated with deconditioning of the patient due to increased pain and dysfunction.[35] A clinically significant deterioration on the Oxford score of five points,[16] while awaiting surgery would be associated with an increased mortality risk of 14.5% for those awaiting a THA and 23.4% for those awaiting a KA.

The results of this study should be interpreted in the knowledge of the limitations. The cohort used to assess effect of HRQoL on mortality was relatively small compared to registry data; however, the mortality rates observed in the current study were similar to larger studies.[18,19] The study used the patient's unique CHI number to ensure follow of the patients not only within the catchment population, but also across the Nation. The effect of social deprivation and smoking were not assessed in the current study which have previously been shown to influence mortality in both the short and longer term.[18,32,33] The cause of death was also not assessed as this was not readily available for all patients. To investigate the cause of death associated with those with the worse HRQoL, it may help understand the reason(s) for the increased risk of mortality. Finally, assessment of change in the patients HRQoL following surgery was not taken into account, and whether this was also associated with postoperative mortality should be explored in future studies.

In conclusion, worsening HRQoL and joint-specific function were both associated with an increased risk of postoperative mortality up to eight years following surgery. Both HRQoL and joint specific function worsen with longer waiting time to surgery for THA and KA, and this may result in an increased mortality risk following their surgery and should be further investigated.

Take home message

- Health-related quality of life and joint specific function were associated with postoperative mortality risk, and therefore optimizing preoperatively may have benefits for the patient.

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Supplementary material

Table showing the STROBE statement: Checklist of items that should be included in reports of cross-sectional studies.

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