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ORIGINAL ARTICLE • HIP - ARTHROPLASTY

Medical morbidities in people following hip and knee arthroplasty: data from the Osteoarthritis Initiative

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Abstract
Background Total hip (THA) and knee (TKA) arthroplasty are common orthopaedic procedures most frequently for older people. Whilst it is known that this older population frequently present with medical morbidities, no studies have previously documented the prevalence of such morbidities in people who have undergone THA or TKA. The purpose of this study was to determine the prevalence and what factors are in association with the presentation of medical morbidities in these populations.
Methods Data from the Osteoarthritis Initiative, a population-based observational study, was assessed. In total 419 people who had undergone a THA or TKA were assessed to determine the prevalence of recorded morbidities within 12 months post-arthroplasty. All medical morbidities were then assessed using univariate and then multivariate logistic regression analysis to identify factors influencing the presentation of specific morbidities at 12 months following THA or TKA.
Results The most common medical morbidities included: osteoporosis (16 %), mild-to-moderate depression (8 %), cancer (8 %), diabetes (6 %), history of stroke or TIA (6 %) and asthma (5 %). The medical morbidities demonstrated are similar between those who undergo THA and TKA. Only gender and ethnic origin were identified as statistically significant predictors of medical morbidities in these populations. Gender was a predictor of history of heart failure, whilst ethnic origin significantly predicted depression.
Conclusions People who undergo THA or TKA may present with a variety of medical morbidities. Accordingly consideration should be made on how to encourage the adoption and maintenance of physical activity and healthy lifestyle choices for this population.

Keywords Medical multi-morbidities · Joint replacement · Orthopaedic · Osteoarthritis · Older people

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Introduction

Osteoarthritis is one of the most common musculoskeletal diseases worldwide with a prevalence of 20–30 % [1]. It is associated with pain, stiffness, reduced independence and a reduced quality of life [2]. End-stage surgical management for osteoarthritis is arthroplasty [3]. Total hip (THA) and knee arthroplasty (TKA) are the most common forms of arthroplasty for osteoarthritis [4]. A total of 99,575 THAs and 104,378 TKAs were performed in England, Wales and Northern Ireland alone in 2014 [4].

People who undergo arthroplasty commonly present with medical morbidities [4] due to age as well as

lifestyle choice, mirroring the normal population [5–7]. These morbidities can have an impact not only on people's recovery following major surgery, but also on their capabilities to engage in physical activity post-arthroplasty. A recent systematic review has identified that people following arthroplasty either return to their pre-surgical levels of physical activity, or a lower level of physical activity following THA or TKA [8]. This may be due to a number of reasons. One such reason has been attributed to pre-existing medical morbidities. Harding et al. [9] in their qualitative study reported that people post-TKA adopted new reasons for not engaging in physical activity and exercise, with a recurrent 'new limitation' being cardiovascular disease and other non-communicable diseases.

Whilst it is known that this population frequently present with medical morbidities, no studies have previously documented the prevalence of such morbidities in people who have undergone THA or TKA. Furthermore, no studies have explored the existence of predictors for specific medical morbidities in this population. Such analyses would provide valuable insights to determine the overall health of this population, and whether medical morbidities should be considered when designing rehabilitation programmes following THA and TKA. Given this, the purpose of this study was to answer the following research questions: what are the most common medical morbidities in people who have recently had THA or TKA, and what factors influence the presentation of specific morbidities.

Methods

Osteoarthritis Initiative dataset

Data used in the preparation of this article was obtained from the Osteoarthritis Initiative (OAI) database, which is available for public access at http://www.oai.ucsf.edu/. The OAI is a large-scale, multi-centre (four sites across the USA), longitudinal cohort study aimed to investigate the role of biomarkers in the development and progression of lower limb osteoarthritis.

Baseline data collected between February 2004 and May 2006. Data have been collected longitudinally at 12, 24, 30, 36, 48, 60, 72 and 84 months post-baseline. Data collected includes individual's demographic characteristics, previous and current medical history including medical morbidities. For this analysis, data were identified from all datasets from baseline to 84-month follow-up with the exception of Month 30 data point since this did not present morbidity data.

Cohort

The cohort of interest was people who had undergone THA or TKA in the previous 12 months with the aim to ascertain which medical morbidities people who had undergone arthroplasty initially presented within 12 months post-operatively. The morbidities for all people who had undergone THA or TKA were included. Since this study was interested in individual's health status rather than arthroplasty per se, where people had undergone multiple arthroplasty procedures within the OAI follow-up period, we only analysed the morbidities recorded within the first 12 months of their first arthroplasty procedure to avoid multiplicity of data.

Outcomes

The outcomes of interest were self-reported medical conditions which included: osteoporosis, history of myocardial infarction, heart failure, deep vein thrombosis, liver failure, stroke or transient ischaemic attack (TIA), dementia, asthma, chronic obstructive pulmonary disease (COPD), gastric ulcer, diabetes, kidney failure, cancer (any type), psoriasis, Crohn's diseases or ulcerative colitis, rheumatoid arthritis, polymyalgia rheumatica, gout, psoriatic arthritis, ankylosing spondylitis and depression [diagnosed with the Center for Epidemiologic Studies Depression (CES-D) scale] with the thresholds: less than 15 no depression; 15–21 mild-to-moderate depression; over 21 possibility of major depression [10]. In addition to these individual conditions, data on the Charlson comorbidity index, a valid and reliable tool used to predict mortality by classifying 19 comorbidities [11], was also collected.

Data analysis

The prevalence of each medical morbidity was determined with 95 % confidence intervals (CI). All medical morbidities were then assessed using univariate logistic regression analysis to identify factors influencing their presentation. The dependent variables were the presence of the following self-reported morbidities: osteoporosis, history of myocardial infarct, heart failure, deep vein thrombosis, liver failure, stroke or TIA, dementia, asthma, COPD, gastric ulcer, diabetes, kidney failure, cancer (any), psoriasis, Crohn's diseases or ulcerative colitis, rheumatoid arthritis, polymyalgia rheumatica, gout, psoriatic arthritis, ankylosing spondylitis and depression. Independent variables identified through previous research as potential explanatory factors included: age at arthroplasty, gender, ethnic origin, height and weight and arthroplasty procedure (THA or TKA). Based on these, all variables identified as

significant at $p < 0.1$ on univariate analysis were entered into a multivariate logistical regression model. All logistical regression data was expressed as odd ratios (OR) with 95 % CI and p values. The Wald statistic was used to assess statistical significance in each regression model. All analyses were undertaken using STATA version 12.0 (STATACorp LP, Texas, USA).

Results

Figure 1 illustrates the subject selection based on the a priori eligibility criteria. In total, 419 individuals were included in the analysis (110 THA/309 TKA). The demographic characteristics of the cohort are presented in Table 1. Mean age was 69.3 years (67.7 THA/69.9 TKA). The cohort consisted of 172 males and 247 females. In the THA cohort, gender composition was 50 males and 60 females. In the TKA cohort this was 122 males and 187 females. The most predominant ethnic group were Caucasians (81.4 % of the total cohort). Mean maximum adult weight reported was 88.4 kg (87.8 kg THA/88.6 kg TKA). Mean minimum adult weight reported was 62.3 kg (63.8 kg THA/61.7 kg TKA).

Prevalence of morbidities

A summary of the prevalence values and confidence intervals for each of the reported medical morbidity is presented in Table 2. The most prevalent medical

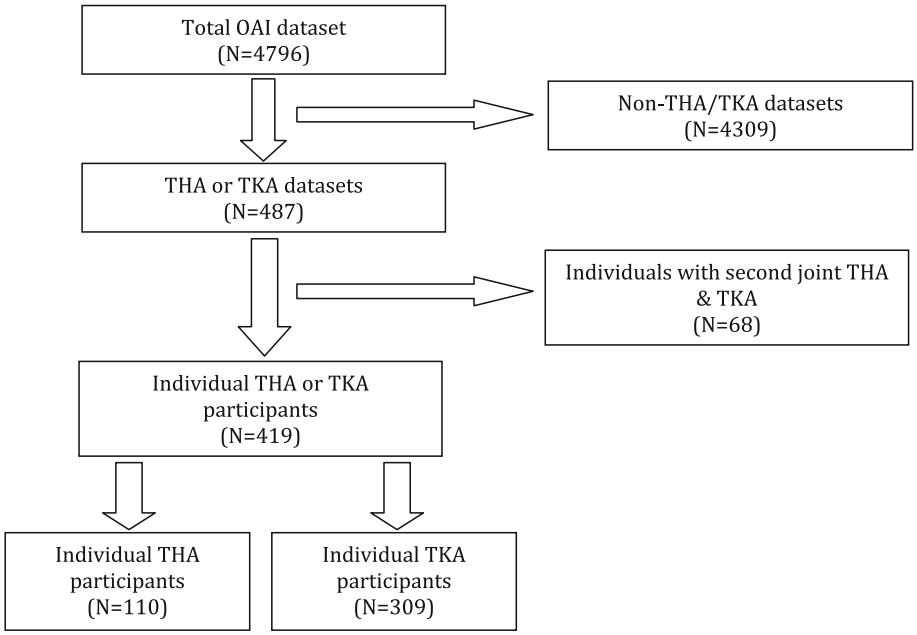

Fig. 1 Flowchart illustrating the subject selection based on a priori eligibility criteria

Table 1 Demographic characteristics

	Total cohort	THA	TKA
N	419	110	309
Mean age at arthroplasty in years (SD)	69.3 (26.9)	67.7 (9.4)	69.9 (31.0)
Gender (m/f)	172/247	50/60	122/187
Race			
Non-white	8	2	0
Caucasian	341	93	248
African-American	66	14	52
Asian	4	1	3
Mean height at aged 25 in metres (SD)	1.65 (0.26)	1.65 (0.29)	1.65 (0.25)
Mean weight at aged 25 in kg (SD)	67.8 (13.0)	69.1 (13.2)	67.3 (13.0)
Maximum adult weight in kg (SD)	88.4 (16.2)	87.8 (14.4)	88.6 (16.9)
Minimum adult weight in kg (SD)	62.3 (11.3)	63.8 (11.6)	61.7 (11.3)

F female, *kg* kilograms, *M* Males, *N* number, *SD* standard deviation, *THA* total hip arthroplasty, *TKR* total knee arthroplasty

Table 2 Frequency of morbidities (overall and by arthroplasty)

Frequency of morbidities	Total cohort ($N = 419$)		THA ($N = 110$)		TKA ($N = 309$)	
	Frequency	Prevalence (%) (95 % CI)	Frequency	Prevalence (%) (95 % CI)	Frequency	Prevalence (%) (95 % CI)
Osteoporosis	65/419	15.5 (12.4–19.3)	11/110	10.0 (5.7–17.0)	54/309	17.5 (13.7–22.1)
History of myocardial infarct	10/271	3.7 (2.0–6.7)	4/62	6.5 (2.5–15.5)	6/209	2.9 (1.3–6.1)
History of heart failure	8/271	3.0 (1.5–5.7)	0/62	0.0 (0.0–0.0)	8/209	3.8 (2.0–7.4)
History of deep vein thrombosis or PE	4/274	1.5 (0.6–3.7)	0/62	0.0 (0.0–0.0)	4/209	1.9 (0.7–4.8)
History of liver failure	4/271	1.5 (0.6–3.7)	0/62	0.0 (0.0–0.0)	4/209	1.9 (0.7–4.8)
History of Stroke or TIA	15/271	5.5 (3.4–8.9)	3/62	4.8 (1.7–13.3)	12/209	5.7 (3.3–9.8)
Dementia	0/419	0.0 (0.0–0.0)	0/110	0.0 (0.0–0.0)	0/309	0.0 (0.0–0.0)
Asthma	20/419	4.8 (3.1–7.3)	5/110	4.6 (2.0–10.2)	15/309	4.9 (3.0–7.9)
COPD	8/271	3.0 (1.5–5.7)	3/62	4.8 (1.7–13.3)	5/209	2.4 (0.1–5.5)
Diabetes	24/419	5.7 (3.9–8.4)	7/110	6.4 (3.1–12.6)	17/309	5.5 (3.5–8.6)
History of kidney failure	7/271	2.6 (1.3–5.2)	2/62	3.2 (0.9–11.0)	5/209	2.4 (1.0–5.5)
History of cancer (any)	22/271	8.1 (5.4–12.0)	5/62	8.1 (3.5–17.5)	17/209	8.1 (5.1–12.6)
Psoriasis	11/419	2.6 (1.5–4.7)	1/110	0.9 (0.2–5.0)	10/309	3.2 (1.8–5.9)
History of Crohn's diseases or ulcerative colitis	1/419	0.1 (0.0–1.1)	1/110	0.9 (0.2–5.0)	0/309	0.0 (0.0–0.0)
Rheumatoid arthritis	12/419	2.9 (1.6–4.9)	1/110	0.9 (0.2–5.0)	11/309	3.6 (2.0–6.3)
Polymyalgia rheumatica	2/419	0.5 (0.1–1.7)	0/110	0.0 (0.0–0.0)	2/309	0.7 (0.2–2.3)
Gout	9/419	2.8 (1.1–4.0)	2/110	1.8 (0.5–6.4)	7/309	2.3 (1.1–4.6)
Psoriatic arthritis	1/419	0.1 (0.0–1.1)	0/110	0.0 (0.0–0.0)	1/309	0.3 (0.1–0.2)
Ankylosing spondylitis	3/419	0.6 (0.0–2.1)	2/110	1.8 (0.5–6.4)	1/309	0.3 (0.1–0.2)
Depression (based on CES-D thresholds)						
No depression	368/419	87.8 (84.4–90.6)	94/110	85.5 (77.7–90.8)	274/309	88.7 (84.7–91.7)
Mild-to-moderate depression	35/419	8.4 (6.1–11.4)	11/110	10.0 (5.7–17.0)	24/309	7.8 (5.3–11.3)
Possible major depression	15/419	3.6 (2.2–5.8)	4/110	3.6 (1.4–9.0)	11/309	3.6 (2.0–6.3)
Mean CES-D score (SD)	6.94 (6.68)	N/E	7.64 (8.01)	N/E	6.72 (6.13)	N/E
Mean Charlson comorbidity index (SD)	0.57 (0.97)	N/E	0.56 (0.93)	N/E	0.57 (0.98)	N/E

CES-D Center for Epidemiologic Studies Depression, *CI* confidence interval, *COPD* chronic obstructive pulmonary disease, *N/E* not estimable, *PE* pulmonary embolism, *SD* standard deviation, *THA* total hip arthroplasty, *TIA* transient ischaemic attack, *TKA* total knee arthroplasty

morbidity was osteoporosis (15.5 %; 10.0 % THA/17.5 % TKA). After this, the most common morbidities were mild-to-moderate depression (8.4 %; 10.0 % THA/7.8 % TKA), a history of cancer (any type; 8.1 % total; 8.1 % THA/8.1 % TKA), diabetes (5.7 %; 6.4 % THA/5.5 % TKA) and a history of stroke or TIA (5.5 %; 4.8 % THA/5.7 % TKA). The prevalence for cardiac and respiratory morbidities was lower for a history of myocardial infarct (3.7 % total; 6.5 % THA/2.9 % TKA), a history of heart failure (3.0 % total: 0.0 % THA; 3.8 % TKA), asthma (4.8 % total; 4.6 % THA/4.9 % TKA), and COPD (3.0 % total; 4.8 % THA/2.4 % TKA).

There was a low prevalence for morbidities such as dementia (0.0 % total and THA/TKA), Crohn's disease or ulcerative colitis (0.1 %; 0.9 % THA/0.0 % TKA), psoriatic arthritis (0.1 %; 0.0 % THA; 0.3 % TKA), polymyalgia rheumatic (0.5 %; 0.0 % THA/0.7 % TKA) and ankylosing spondylitis (0.6 %; 1.8 % THA/0.3 % TKA).

Mean Charlson Co-morbidity Index was 0.57 [standard deviation (SD): 0.97] for the total cohort, 0.56 (SD: 0.93) for THA and 0.57 (SD: 0.98) for TKA. Forty-three people (10.3 %) presented with two or more morbidities in the total cohort [THA: $n = 10$ (9 %); TKA: $n = 33$ (10.7 %)].

Predictors of medical morbidities

Table 3 presents the results of the logistical regression analysis. As this demonstrates, there were significant predictors for nine morbidities (history of myocardial infarct; history of heart failure; asthma; diabetes; history of kidney failure; history of cancer (any type); rheumatoid arthritis; gout; and depression). The most frequently identified predictor characteristic was maximum adult weight. This was

Table 3 Results of the univariate logistical regression analysis (OR, 95 % CI; *p* values) for predicting specific morbidities

	Mean age at arthroplasty	Gender (male/female)	Ethnic origin	Mean height at aged 25	Mean weight at aged 25	Maximum adult weight	Minimum adult weight	Type of arthroplasty
Osteoporosis	0.98 (0.94–1.01; 0.19)	1.18 (0.66–2.11; 0.57)	0.31 (0.05–1.93; 0.21)	1.00 (1.00–1.00; 0.59)	1.00 (0.05–3.49; 0.88)	0.99 (0.94–1.01; 0.32)	0.99 (0.97–1.00; 0.22)	0.84 (0.46–1.58; 0.60)
History of myocardial infarct	0.95 (0.84–1.07; 0.42)	**6.24 (1.30–29.95; 0.02)**	0.31 (0.04–2.37; 0.26)	1.00 (0.99–1.01; 0.86)	1.00 (0.00–0.00; 1.00)	1.03 (0.99–1.08; 0.19)	1.02 (0.98–1.06; 0.30)	0.43 (0.12–1.57; 0.20)
History of heart failure	0.99 (0.87–1.11; 0.80)	**4.59 (0.91–23.16; 0.07)**	1.44 (0.20–10.27; 0.72)	**1.01 (1.00–1.02; 0.08)**	1.03 (0.99–1.09; 0.17)	**1.04 (1.00–1.09; 0.09)**	1.05 (0.99–1.10; 0.12)	0.00 (0.00–0.00; 1.00)
History of deep vein thrombosis or PE	1.00 (0.98–1.03; 0.87)	1.47 (0.20–10.61; 0.70)	1.44 (0.20–10.27; 0.72)	1.00 (0.99–1.01; 0.59)	1.01 (0.94–1.08; 0.87)	1.02 (0.96–1.08; 0.61)	1.01 (0.93–1.09; 0.86)	0.00 (0.00–0.00; 1.00)
History of liver failure	0.92 (0.78–1.10; 0.37)	0.48 (0.05–4.71; 0.53)	1.17 (0.38–3.55; 0.79)	1.00 (0.98–1.01; 0.30)	0.93 (0.84–1.04; 0.23)	0.98 (0.92–1.04; 0.53)	0.93 (0.82–1.04; 0.21)	0.00 (0.00–0.00; 1.00)
History of Stroke or TIA	1.00 (0.98–1.02; 0.99)	1.30 (0.46–3.70; 0.62)	1.17 (0.39–3.55; 0.79)	1.00 (1.00–1.00; 0.96)	1.00 (0.96–1.04; 0.97)	1.01 (0.97–1.04; 0.71)	1.00 (0.96–1.05; 0.94)	0.84 (0.23–3.06; 0.79)
Dementia	0.99 (0.97–1.01; 0.45)	0.87 (0.58–1.31; 0.51)	0.93 (0.59–1.48; 0.77)	1.00 (1.00–1.00; 0.70)	1.00 (1.00–1.02; 0.58)	1.00 (0.99–1.01; 0.67)	1.00 (0.99–1.02; 0.77)	1.09 (0.69–1.70; 0.72)
Asthma	0.98 (0.92–1.03; 0.42)	0.61 (0.23–1.63; 0.32)	1.48 (0.59–3.70; 0.41)	1.00 (0.99–1.00; 0.25)	0.97 (0.93–1.01; 0.13)	1.00 (0.98–1.03; 0.83)	**0.95 (0.90–1.00; 0.03)**	1.14 (0.40–3.26; 0.82)
COPD	1.00 (0.98–1.02; 0.92)	0.68 (0.17–2.76; 0.58)	0.78 (0.14–4.24; 0.77)	1.00 (0.99–1.01; 0.64)	0.97 (0.91–1.03; 0.29)	1.00 (0.96–1.05; 0.90)	0.96 (0.89–1.03; 0.25)	2.08 (0.48–8.94; 0.33)
Diabetes	1.00 (0.98–1.02; 0.91)	1.27 (0.55–2.94; 0.58)	**2.11 (0.95–4.65; 0.07)**	1.00 (1.00–1.00; 0.49)	1.02 (0.99–1.05; 0.24)	1.02 (0.99–1.05; 0.14)	1.01 (0.97–1.04; 0.68)	1.44 (0.57–3.64; 0.44)
History of kidney failure	1.00 (0.98–1.02; 0.92)	0.50 (0.11–2.29; 0.38)	0.31 (0.04–2.71; 0.29)	1.00 (1.00–1.01; 0.18)	1.03 (0.98–1.08; 0.31)	**1.07 (1.02–1.13; 0.01)**	1.02 (0.96–1.09; 0.47)	1.36 (0.26–7.19; 0.72)
History of cancer (any)	1.00 (0.99–1.01; 0.84)	**2.26 (0.93–5.50; 0.07)**	0.83 (0.30–2.31; 0.72)	1.00 (1.00–1.01; 0.16)	**1.04 (1.01–1.07; 0.02)**	**1.03 (1.01–1.06; 0.02)**	**1.04 (1.01–1.08; 0.02)**	0.99 (0.35–2.80; 0.99)
Psoriasis	0.96 (0.89–1.03; 0.28)	1.71 (0.51–5.78; 0.39)	1.22 (0.32–4.61; 0.77)	1.00 (0.99–1.01; 0.87)	1.01 (0.97–1.06; 0.59)	1.02 (0.98–1.05; 0.42)	1.01 (0.96–1.06; 0.82)	0.22 (0.03–1.75; 0.15)
History of Crohn's diseases or ulcerative colitis	1.26 (0.82–1.93; 0.28)	0.00 (0.00–0.00; 1.00)	0.34 (0.01–108.95; 0.71)	0.99 (0.96–1.02; 0.35)	0.99 (0.85–1.15; 0.85)	1.00 (0.89–1.13; 0.99)	1.01 (0.85–1.18; 0.95)	0.00 (0.00–0.00; 1.00)
Rheumatoid arthritis	1.02 (0.99–1.04; 0.24)	0.71 (0.21–2.41; 0.59)	1.01 (0.27–3.81; 0.99)	1.0 (0.99–1.01; 0.84)	0.97 (0.92–1.02; 0.21)	**0.97 (0.93–1.00; 0.07)**	0.95 (0.90–1.01; 0.12)	0.26 (0.03–2.07; 0.21)
Polymyalgia rheumatic	1.00 (0.92–1.08; 0.94)	0.00 (0.00–0.00; 1.00)	0.32 (0.01–16.62; 0.57)	0.99 (0.98–1.01; 0.36)	0.92 (0.78–1.09; 0.33)	1.00 (0.91–1.09; 0.93)	0.92 (0.77–1.09; 0.32)	0.00 (0.00–0.00; 1.00)
Gout	1.00 (0.98–1.02; 0.95)	0.33 (0.08–1.32; 0.12)	2.03 (0.62–6.71; 0.25)	1.00 (1.00–1.01; 0.13)	**1.05 (1.00–1.10; 0.04)**	1.03 (0.99–1.08; 0.13)	**1.05 (0.99–1.10; 0.08)**	0.83 (0.17–4.08; 0.82)
Psoriatic arthritis	1.06 (0.84–1.35; 0.61)	0.00 (0.00–0.00; 1.00)	0.00 (0.00–0.00; 1.00)	1.00 (0.98–1.02; 0.84)	1.05 (0.91–1.21; 0.52)	1.00 (0.89–1.13; 0.97)	1.07 (0.91–1.25; 0.43)	0.00 (0.00–0.00; 1.00)
Ankylosing spondylitis	0.93 (0.81–1.07; 0.33)	0.70 (0.06–7.81; 0.77)	2.20 (0.28–17.52; 0.46)	1.00 (0.98–1.01; 0.50)	1.03 (0.95–1.12; 0.46)	1.04 (0.97–1.12; 0.23)	1.01 (0.92–1.11; 0.83)	4.81 (0.43–54.02; 0.20)
Depression (based on CES-D thresholds)	**0.97 (0.94–1.01; 0.09)**	0.62 (0.33–1.16; 0.14)	**3.10 (1.76–5.47; 0.00)**	1.00 (1.00–1.00; 0.96)	1.00 (0.97–1.02; 0.74)	1.01 (1.00–1.03; 0.33)	0.99 (0.97–1.02; 0.53)	1.33 (0.71–2.52; 0.38)

Bold signified statistical significance at $p < 0.05$

CES-D Center for Epidemiologic Studies Depression, *COPD* chronic obstructive pulmonary disease, *N/E* not estimable, *OR* odds ratio, *PE* pulmonary embolism, *TIA* transient ischaemic attack

a significant predictor for: a history of heart failure (OR 1.04; 95 % CI 1.00–1.09), history of kidney failure (OR 1.07; 95 % CI 1.02–1.13), history of cancer (any type) (OR 1.03; 95 % CI 1.01–1.06) and rheumatoid arthritis (OR 0.97; 95 % CI 0.93–1.00). With the exception of rheumatoid arthritis, the higher the maximum adult weight, the greater likelihood of experiencing these morbidities. Conversely, minimum adult weight was a significant predictor for asthma (OR 0.95; 95 % CI 0.90–1.00), history of cancer (any type) (OR 1.04; 95 % CI 1.01–1.08) and gout (OR 1.05; 95 % CI 0.99–1.10). With the exception of asthma, the higher the minimum adult weight, the greater the likelihood of experiencing these morbidities. Mean weight at 25 years of age was a significant predictor of history of cancer (any type) (OR 1.04; 95 % CI 1.01–1.07) and gout (OR 1.05; 95 % CI 1.00–1.05). Higher weight equated to greater the likelihood of experiencing these morbidities. Mean height at 25 years of age was associated with a history of heart failure (OR 1.01; 95 % CI 1.00–1.02) with greater height associated with greater likelihood of experiencing this morbidity.

Gender was identified as a significant predictor for a history of myocardial infarct (OR 6.24; 95 % CI 1.30–29.95), a history of heart failure (OR 4.59; 95 % CI 0.91–23.16) and a history of cancer (any type) (OR 2.26; 95 % CI 0.93–5.50), where males were more likely to experience these morbidities. Ethnic origin was identified as a significant predictor for diabetes (OR 2.11; 95 % CI 0.95–4.65). However, when analysed individually, none of the categories of race were identified as specific predictors. Age at arthroplasty was only a predictor for depression (based on CES-D thresholds (OR 0.97; 95 % CI 0.94–1.01); where lower age was associated with a greater likelihood of depression. The type of joint replacement received, i.e. THA or TKA, was not identified as a predictor in this dataset.

The findings of the multivariate logistical regression model are presented in Supplementary Table 1. This indicated that only gender, ethnic origin and mean weight at aged 25 years were significant predictors of morbidities. The model indicated that males were 0.21 times at lower likelihood of having a history of heart failure compared to females (OR 0.21; 95 % CI 0.94–23.95). Ethnic origin was a significant predictor overall for experiencing depression (OR 3.58; 95 % CI 1.92–6.66). However, when assessed by categorising individual ethnic groups, there was no statistically significant difference in predictive values between Caucasian, African-American or Asian groups ($p = 0.99$). Finally mean weight at aged 25 was a statistically significant predictor of gout, where an increase in one kilogram was associated with an increased likelihood of experiencing gout by 0.1 times (OR 1.05; 95 % CI 1.00–1.10).

Discussion

The findings of this study indicate that people who undergo THA or TKA present with a number of important morbidities. The morbidities demonstrated were similar between those who underwent a THA or TKA. The most common morbidities included: osteoporosis, mild-to-moderate depression, cancer, diabetes, history of stroke or TIA and asthma. Medical morbidities which least frequently present in this population include dementia, Crohn's disease, polymyalgia and psoriatic arthritis. Only gender and ethnic origin were identified as statistically significant predictors of morbidities, with gender a predictor of history of heart failure, whilst ethnic origin significantly predicted depression.

This study is the first paper to identify what specific morbidities people following THA and TKA present with. The results suggest that the most common medical co-morbidities are non-communicable diseases. Morbidities such as osteoporosis, depression, cancer, diabetes, and stroke/TIA are all diseases frequently seen within this age group in the normative population and non-arthroplasty cohorts [5–7], where mean age for a hip and knee arthroplasty is 70 years [4]. This paper is therefore valuable as it provides an insight into possible morbidities which may influence rehabilitation and recovery [12]. These diseases could have a detrimental effect on post-operative outcome, potentially increasing risks of complications such as wound infections and reduced exercise capability, both in the short- and longer-term post-THA and TKA [13, 14]. This should be considered when designing generic rehabilitation pathways, accounting for these possible conditions, providing the flexibility to adapt progression based on these morbidities' physiological impact.

A secondary value of this analysis was that we have identified potential predictors for these morbidities in this population. On univariate analysis, weight at age 25 years and maximum weight were identified as recurrent significant predictors. Whilst these were not supported on multivariate analysis, previous studies have also identified the importance of these factors [15]. It is widely recognised that weight management programmes are an important component for the non-surgical management of hip and knee osteoarthritis [16]. This data would therefore further support this, providing added rationale for the potential benefit that weight management for this post-arthroplasty cohort, could have on reducing the associated risks with these morbidities.

The type of arthroplasty undergone (THA or TKA) was not a significant predictor of morbidity. This suggests homogeneity in the co-existing medical conditions experienced by these populations. Thus, when generic

rehabilitation programmes are designed and delivered following THA and TKA, consideration on the underlying morbidities this population present should not be a distinguishing factor between regimes. Consequently, the rehabilitation needs for this population in terms of muscle strength, loss of range of motion, gait re-education and improving balance and functional performance [17] should be the primary concern for each cohort.

Previous research has identified that a patients' physical activity either maintains at a pre-surgical levels or reduces following THA or TKA. The burden on individuals in this study, their families and health services, of the most commonly identified morbidities can be reduced through the adoption of physical activity and lifestyle programmes. Previous research has provided a rigorous evidence-base in support of the adoption of physical activity strategies in the management of osteoporosis [18], depression [19], diabetes [20] and asthma [21]. However, encouraging and maintaining physical activity programmes in this population have been highlighted as challenging, particularly for long-term adherence [8]. Given the encouragement to adopt a 'making-every-contact-count' approach to health promotion [22], clinicians such as orthopaedic surgeons, physiotherapists, occupational therapists, community nurses and general practitioners could have a significant role in highlighting the threat of these morbidities within routine follow-up consultations post-arthroplasty. Further research is warranted on strategies to target such morbidities to improve both the physical and mental health of this population, given the potential beneficial impact these could have on long-term primary and secondary care management.

This study presented with three limitations. The data of medical morbidities derived from the OAI dataset were self-reported. Consequently, the morbidities reported may have been influenced by systematic errors through individual's capability to recall medical history. Secondly the OAI dataset identified morbidities which where a priori defined as important. Therefore these individuals may have presented with other morbidities which were not assessed as part of the data collection process. Nonetheless, the morbidities recorded are those most frequently reported in previous non-arthroplasty cohorts with comparable age- and sex-matched characteristics [5–7]. Also the Charlson Co-morbidity Index was low (total cohort mean: 0.57) suggesting that the reported morbidities were potentially attributable to the morbidities reported. Finally, the OAI database is a cohort of individuals from North America. Whilst this providers valuable data, there may be limited generalisability to other continents such as Asia, Africa and Europe. Further validation work may, therefore, be warranted to ascertain how these findings relate to other nationalities before considering the translation of these results into public health strategies.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

Ethics approval Committee on Human Research, University of California, San Francisco (IRB Approval Number 10-00532 Approved 10th March 2015).

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