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National PROMs data and the National Joint Registry. A report on the data completeness and quality

Abstract

Aims

Since April 2009, patients receiving NHS funded primary elective hip or knee replacements (THR or TKR) should be invited to complete Patient Reported Outcome Measures (PROMs). The aim of this descriptive study was to use National Joint Registry (NJR) data to identify patient and demographic differences between those with complete versus those with missing PROMs.

Methods

Patients undergoing publicly funded elective primary THR or TKR between April 2009 and December 2018 recorded in the NJR were eligible. NJR data was linked to the English Hospital Episode Statistics (HES), and PROMs data. Oxford Hip/Knee scores (OHS/OKS) were eligible for inclusion if recorded up to 18 weeks preoperatively (Q1) and 6-12 months postoperatively (Q2). Proportions were used to describe the completeness of PROMs data. The following variables were assessed to determine associations with PROM data completeness: age, gender, ASA grade, body mass index, socioeconomic deprivation, baseline (Q1) OHS/OKS, hospital trust.

Results

Of 570,449 eligible TKRs and 507,962 eligible THRs, complete preoperative and postoperative PROMs were available for 229,794 TKRs (40.3%) and 210,929 THRs (41.5%). No differences were observed in patient and demographic factors between those with and without complete PROMs. Patients with complete PROMs had a higher preoperative PROMs score (less pain and functional limitations) than those with preoperative but no postoperative PROMs (TKR: median OKS=19 versus 15; THR: median OHS=17 versus 14). For Q2 PROMs the median trust-level completeness was 71% OKS (60%-76%) and 72% OHS (62%-77%), with little variation between high and low volume trusts. In contrast, Q1 completeness varied between trusts (69% high volume centres vs. 57% low).

Conclusion

Up to 60% of patients did not have complete preoperative and postoperative PROMs. However, these patients were similar to those with complete PROMs in terms of patient and demographic factors as well as revision and mortality outcomes. PROMs that are collected are likely generalisable to the wider eligible THR and TKR population.

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Clinical Relevance

- Despite the PROMs National programme commencing in April 2009, up to 60% of patients undergoing primary THR and TKR do not have complete preoperative and postoperative PROMs.
- Patients with complete preoperative and postoperative OHS and OKS available are similar to patients eligible to be included in the National PROMs Programme across a range of patient-level and demographic characteristics.
- Future research should focus on understanding why National PROMs completeness remains relatively low, and investigate failure to complete preoperative PROMs at low volume hospital trusts.

Introduction

The success of joint replacement surgery is often assessed through objective outcomes, such as post-operative mortality and implant survivorship. The risk of mortality is very low[1, 2] and most implants last a long time[3, 4]. Success of surgery can also be measured through Patient Reported Outcomes Measures (PROMs), which seek to capture the patients' perspective. Research using PROMs indicates that up to 30% of total knee replacement (TKR) patients and 15% of total hip replacement (THR) patients have persistent post-operative pain and functional limitations[5].

Since April 2009, all patients receiving an NHS funded primary elective hip or knee replacement operation are invited to complete PROMs, managed through the National PROMs programme commissioned by NHS England. The EuroQoL-5D (EQ-5D) and Oxford Hip/Knee scores (OHS/OKS) are recorded up to 18 weeks before surgery (Q1) and between six to 12 months after surgery (Q2). The EQ-5D is used to assess health-related quality of life via mental, physical, and social aspects. The OHS and OKS are used to assess joint specific pain and function through 12 questions, which are combined to give a total possible score ranging from 0 (worst) to 48 (best)[6, 7].

There are several limitations with PROMs data collection that may limit generalisability of the data. Since national PROMs collection is only mandated for publicly funded joint replacements, available PROMs records may not be generalisable to privately funded operations. Further challenges relate to data linkage. PROMs data are linked to their corresponding NJR records through the English Hospital Episodes Statistics Admitted Patient Care dataset (HES). Both stages of linkage (PROMs-HES and HES-NJR) are potential causes of missing data and may limit generalisability. The completion of Q1 and/or Q2 PROMs may depend on patient characteristics and surgeon or trust-level factors. Completeness of preoperative and postoperative OKS has previously been reported as approximately 52%[8]. People who reported preoperative but not postoperative PROMs had lower preoperative OHS/OKS and EQ5D scores, were younger, and lived in areas of higher social deprivation compared with those who reported both preoperative and postoperative PROMs[9, 10]. The completeness of NJR records is high (95.7% capture rate for primary procedures)[11].

The aim of this descriptive study was an assessment of the demographic characteristics of patients with and without complete pre-operative (Q1) and post-operative (Q2) PROMs data. This comparison will inform whether the available PROMs data can be considered representative of all THR and TKR patients who were eligible for inclusion in the National PROMs Programme.

Methods

Inclusion criteria

We included all publicly funded elective primary hip and knee replacements performed in England between April 2009 (the start of the National PROMs Programme) and the end of 2018 (latest available HES data).

Exclusion criteria

We excluded joint replacements performed for trauma, elective hip resurfacings and THRs using metal-on-metal implants since these are not reflective of contemporary practice. We also excluded unicompartmental knee replacements since they are not accurately captured in the PROMs Programme[12], and patellofemoral knee replacements since they are performed in low volumes. Patients who did not consent for their NJR data to be used for research purposes were also excluded.

Q1 and Q2 PROMs should be completed within specified time windows before and after the index operation: Q1 between 18 weeks and the day before their operation, and for Q2 PROMs between six and 12 months after their operation. People who died or had a revision operation within 12 months of their primary operation were excluded since their Q2 PROMs, if available, are likely to be unrepresentative of the experience of most patients. This was also a requirement to avoid 'immortal time bias' in our comparison of people with and without complete PROMs. The requirement that patients be alive and unrevised 12 months after their primary surgery meant that patients needed at least 12 months of follow-up in the NJR and PROMs datasets, making the effective end date of our inclusion window 31/12/2017 (allowing for 12-months follow up to 31/12/2018).

Cohort definitions

We defined four nested cohorts for primary THRs and TKRs:

1. Eligible to be included in the National PROMs Programme

   Patients recorded as having a relevant procedure in the NJR who met all the criteria to be included in the National PROMs Programme and had their operation within the appropriate timeframe.

2. Eligible to be included in PROMs and with HES linkage

   The subset of patients from group 1 with a HES record which matches their primary operation.

3. Eligible to be included in PROMs, with HES linkage, and with PROMs linkage

   The subset of patients from group 2 with a Q1 and/or Q2 record which matches their primary operation, linked via HES, in the National PROMs Programme.

4. Patients with complete Q1 and Q2 PROMs

Outcomes

Our outcome measures were complete Q1 OHS/OKS PROMs, and complete Q1 and Q2 OHS/OKS PROMs. We defined complete PROMs as valid responses to all 12 questions. It should be noted that mean imputation of up to two missing OHS or OKS question values was applied by the National PROMs programme before transfer of the data to researchers, therefore our dataset did not include anyone missing only one or two values.

Patient-level factors

- NJR: Age (10-year bands <55 to ≥75), Gender, ASA grade ('I', 'II', 'III', 'IV & V')[13], Body mass index (BMI): Underweight (≥10 and <18.5 kg/m^2); normal (≥18.5 and <25 kg/m^2); overweight (≥25 and <30 kg/m^2); class I obesity (≥30 and <35 kg/m^2); class II obesity (≥35 and <40 kg/m^2); and class III obesity (≥40 and ≤60 kg/m^2)[14], hip procedure type (Cemented, Uncemented, Hybrid, Reverse hybrid).
- HES: Level of socioeconomic deprivation based on patient's home address using deciles of the 2004 Index of Multiple Deprivation (IMD)[15]
- PROMs: Q1 OHS/OKS score (for Q2 PROMs)

Ethics approval and consent to participate

Patient consent was obtained for data collection by the NJR. According to the specifications of the NHS Health Research Authority, separate informed consent and ethical approval were not required for the present study.

Statistical methods

We described the four cohorts defined above by the patient-level factors. Standardized mean differences (SMDs) were examined comparing patients in the four nested cohorts to assess for any covariate imbalance between the different groups (group 1 versus group 4), with SMDs of 10% or more considered suggestive of imbalance[16]. We described the variation in completeness of OHS

and OKS by hospital trust. Proportions were defined as the proportion of patients with complete Q1 and Q2 PROMs divided by the total number of potentially eligible patients (cohort 1 as defined above). Hospital trusts were anonymised and ranked by the proportion of eligible people (cohort 1) with complete Q1 PROMs (cohort 3), and the proportion of people with Q1 PROMs (cohort 3) who also have Q2 PROMs (cohort 4). 95% and 99.8% confidence intervals were derived using the z-distribution for proportions. Proportions and confidence intervals were displayed graphically using caterpillar plots.

We compared the unadjusted implant survival and all-cause mortality outcomes of patients from the four cohorts using Kaplan-Meier survival curves. Differences in implant survival and/or mortality outcomes between these groups in the absence of differences between patient-level factors assessed in this study may indicate there is selection bias that is not captured by the patient-level factors.

Results

In this study 570,449 elective primary TKRs and 507,962 elective primary THRs were eligible to be included in the National PROMs Programme (Cohort 1). Of these, 526,653 TKRs (92.3%) and 467,983 THRs (92.1%) could be linked with a corresponding HES record (Cohort 2), and 355,484 TKRs (62.3%) and 322,142 THRs (63.4%) were included in the National PROMs dataset (Cohort 3), (Figures 1 and 2). Complete preoperative (Q1) and postoperative (Q2) PROMs (Cohort 4), recorded within acceptable time frames were available for 229,794 TKRs (40.3%) and 210,929 THRs (41.5%). The proportion in Cohort 4 comprised 64.6% of Cohort 3 TKRs and 65.5% of Cohort 3 THRs.

Overall Q1 and Q2 completeness

Having some Q1 PROMs data (albeit with potentially incomplete Q1 OKS/OHS responses) is a requirement to be included in the National PROMs dataset. Consequently, few people who were included in the PROMs dataset did not have valid Q1 PROMs scores (1.1% of Cohort 3 TKRs and THRs). A much higher proportion of people had Q1 questionnaires either dated outside the 3-month preoperative time window for valid responses or were missing relevant dates (TKR: 14.6%, THR: 14.3%). In contrast, a higher proportion of people were missing Q2 PROMs (TKR: 18.3%, THR: 17.6%) compared with those subsequently found to have dates missing or which were outside the 6-12 month postoperative time window (TKR: 6.6%, THR: 6.1%).

Temporal trend in the availability of HES and National PROMs linkage, and complete Q1 and Q2 PROMs

The proportion of eligible operations with complete Q1 and Q2 PROMs (cohort 4) was very low in 2009 for TKRs and THRs (~5% of eligible operations, Figure 3). This increased rapidly 2009-2011, with a peak in completeness of 45% TKRs and 46% THRs in 2013. Subsequently, the proportion of operations with complete PROMs has reduced to ~40% of eligible TKRs and THRs. This trend is mirrored at a higher proportion for the completeness of Q1 PROMs (cohort 3). In contrast, the proportion of operations linked with HES (cohort 2) has been >90% since early 2010 for TKRs and THRs.

How does Q1 completeness vary between Trusts?

The completeness of preoperative (Q1) PROMs varied considerably between hospital Trusts (Figure 4). The median Trust-level completeness of Q1 OKS was 60% (Interquartile range (IQR): 49%-68%) and OHS was 59% (IQR 45%-68%). Trusts with more eligible procedures had a higher proportion of complete Q1 PROMs. However, there remained variation in completeness between high volume Trusts. Trusts with ≥2,500 potentially eligible TKRs/THRs had median Q1 completeness of 64% OKS scores (67/394 Trusts, 58%-74%) and 69% OHS scores (49/405 Trusts, 60%-74%). Lower volume Trusts (<2,500 potentially eligible procedures) had median Q1 completeness of 58% OKS scores (43%-66%) and 57% OHS scores (40%-67%).

How does Q1 completeness vary by patient factors?

We found that the demographic characteristics of people with Q1 PROMs (cohort 3) were similar to those of the larger cohort of potentially eligible patients (cohort 1) across all clinical (ASA grade, hip procedure type) and demographic (age, gender, BMI, IMD) variables (Tables 1 and 2).

How does combined Q1 and Q2 completeness vary?

In common with cohort 3 (complete Q1 PROMs), we found that people with complete Q1 and Q2 PROMs (cohort 4) were similar to those from cohort 1 (Tables 1 and 2). Standardised Mean Differences were all less than 10% suggesting no evidence of any covariate imbalance across the patients factors between the cohorts. Patients in cohort 4 had higher preoperative PROMs scores than those with preoperative but no postoperative PROMs (TKR: median OKS=19 IQR [13, 24] versus 15 [10, 21]; THR: median OHS=17 IQR [12, 24] versus 14 [9, 20]).

The trust-level variation in Q2 PROMs completeness as a proportion of patients with complete Q1 PROMs was less than we observed for Q1 completeness as a proportion of eligible patients (Figures 4 and 5). For Q2 PROMs the median trust-level OKS completeness was 71% (60%-76%) and the median trust-level OHS completeness was 72% (62%-77%). There was little difference between high and low volume trusts in the trust-level completeness of Q2 PROMs. Trusts with ≥2,500 potentially

eligible TKRs/THRs had median Q2 completeness of 73% OKS scores (20/374 Trusts, 70%-76%) and 72% OHS scores (17/378 Trusts, 70%-75%). Lower volume Trusts (<2,500 potentially eligible procedures) had median Q2 completeness of 71% OKS scores (60%-76%) and 72% OHS scores (62%-77%).

We compared the revision and mortality outcomes of patients in all four cohorts. Implant survival was very slightly higher in THR patients with complete OHS PROMs (cohort 4) compared with the other cohorts, but no difference for TKR patients (Figures 6 and 8). Patients with complete PROMs (cohort 4) had lower mortality rates than those from cohorts 2 and 3, but comparable with those from cohort 1 (Figures 7 and 9).

Discussion

Patients who have complete preoperative and postoperative Oxford Hip and Knee Scores are similar to patients eligible to be included in the National PROMs Programme across a range of patient-level and demographic characteristics, despite approximately 60% of patients missing preoperative and/or postoperative PROMs scores. However, observed differences in mortality rates indicate that patients with complete PROMs were less likely to die and therefore may be a healthier sample of the eligible patients. We also observed that a higher proportion of patients had complete preoperative PROMs scores from large volume hospital trusts compared with low volume trusts, but no similar relationship for the completeness of postoperative PROMs. Patients with worse preoperative PROMs scores were more likely to have missing postoperative scores.

Comparisons with previous research

We found that people who had preoperative but not postoperative PROMs scores had worse preoperative scores than those who had both pre- and postoperative scores. This is in agreement with previous studies from Scotland[10] and England[9]. The wide variation in completeness between hospital trusts confirms similar research from Australia[17], although we have extended this by considering the relationship between the number of joint replacement procedures performed at a centre level and PROMs completeness. Our finding of a positive relationship between total number of procedures and trust-level completeness of preoperative PROMs contradicts findings from the California Joint Replacement Registry, which reported a negative association between surgeon volume and patient odds of preoperative and postoperative PROMs completion[18]. The downward trend in completeness of PROMs scores we observed has been reported from registries for different conditions or procedures and from different countries[19].

Are patients with complete PROMs scores a biased sub-sample?

A key outcome of this research was to evaluate whether the subset of patients with complete preoperative and postoperative PROMs is a biased subset of those patients potentially eligible to be in the National PROMs Programme. We observed that patients with complete data were comparable with the wider cohort across demographic and clinical factors. Although we did observe some differences in the mortality and revision outcomes between the four cohorts, suggestive of selection bias, where people with complete PROMs had generally better mortality outcomes. Overall, this supports viewing the subset of patients with available PROMs data as generalisable to all eligible patients. We observed important higher volume trust effects on preoperative PROMs completeness, suggesting that there is potential for other trusts to improve their PROMs completion rates. We cannot discount unobserved sources of bias which may undermine the generalisability of the complete PROMs data to the wider cohort.

In the presence of missing data, it is pertinent to consider the potential importance of imputation methods to reduce the bias caused by missing data, and/or improve the power of statistical analyses. Our a priori understanding of the collection of data through the national PROMs Programme indicated that the causes of missing preoperative scores were likely to be different from missing postoperative scores. The relationship between higher volume trusts and completeness of preoperative but not postoperative scores further supports this. We also considered scores may be missing due to linkage between the NJR and HES. In reality the proportion of NJR records which could not be linked with PROMs was low and this cause of missing data is unlikely to be an important source of bias.

There are many different reasons why patients may be missing complete pre- and post-operative PROMs, and that these mechanisms apply not only at the patient-level but at the trust-level and potentially surgeon and/or implant level (the latter were not included in this study). In their comparison of approaches to address missing PROMs data, Gomes et al found that comparisons of relative provider performance were sensitive to assumptions about the reasons for missingness[20]. While it is important to acknowledge that ~60% of potential patients missing complete data is substantial, the remaining sample size is still very large and may be suitable for many between group comparisons. Studies where analysis groups are small will need to consider the statistical power implications of not imputing missing values.

Strengths and Weaknesses

The size and completeness of the NJR dataset are important strengths of this study. Registry data are observational that can be subject to unmeasured residual confounding, unlike adequately powered clinical trials of PROMs outcomes[21]. A recent NJR audit of procedure recording compliance found

capture rates were high for primary procedures (95.7%)[11]. We can therefore be confident that our starting sample did not include any meaningful unobserved bias. We were able to explore variation in completeness across patient-level factors, and also by hospital procedure volume. To our knowledge, this is the first study to report a positive association between hospital procedure volume and completeness of PROMs.

Since the National PROMs Programme is for publicly funded operations in England only we do not know whether our findings will generalise to other territories of the United Kingdom, but we do not anticipate significant differences between territories. Private sector units tend to treat patients with fewer comorbidities than publicly funded units (i.e. NHS units)[22], and have a higher proportion of day case surgery patients that tend to be younger and healthier[23], which may limit the generalisability of these PROMs data to privately funded patients. We have described variation in completeness of joint-specific PROMs, but the National PROMs Programme also includes the EQ5D as a general measure of health utility, although we would expect trust and other system-level effects on missingness to apply equally to EQ5D as to joint-specific PROMs. Our cohort 4 included a strict definition to only patients with Q1 and Q2 PROMs questionnaires completed within a specific time window, excluding 69,321 knee and 61,931 hip patients. Even using this strictest definition, we observed no clinically relevant differences in patient demographic factors. A limitation of our study is that the data available to us with linked PROMs was up to the end of 2018. Since then patients were impacted by COVID and the subsequent elective recovery, that may impact PROMs completion rates. Currently according to NHS Digital, in 2023/24 PROMs Q2 completion rates have fallen substantially to around 26% for both hip and knee replacement, hence our conclusions and findings are based on pre-COVID data[24]. Finally, we did not explore whether patients with post-operative complications are less likely to report their Q2 PROMs, as described elsewhere[18].

Conclusions

Despite the PROMs National programme commencing in April 2009, up to 60% of patients eligible to take part in National PROMs did not have complete preoperative and postoperative PROMs. However, patients with incomplete or no PROMs were broadly similar to those with complete PROMs in terms of patient and demographic factors as well as postoperative outcomes (implant survival and mortality), suggesting that PROMs that are collected are generalisable to the larger population. Future research should focus on understanding why National PROMs completeness remains relatively low, and also investigate the observation of lower completion of preoperative PROMs at low volume hospital trusts.

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Figure 1: A flowchart describing the study samples for primary knee replacements

Figure 2: A flowchart describing the study samples for primary hip replacements

Figure 3: The change in the number of patients in cohorts 2-4 between 2009 and 2017 as a percentage of the patients potentially eligible to be included in the National PROMs Programme (cohort 1), by joint

Figure 4: Caterpillar plot of the proportion of potentially eligible TKRs with complete preoperative OKS records who also have postoperative OKS records, by hospital (ordered by proportion complete). Horizontal line represents overall proportion complete

Figure 5: Caterpillar plot of the proportion of potentially eligible THRs with complete preoperative OHS records who also have complete postoperative OHS records, by hospital (ordered by proportion complete). Horizontal line represents overall proportion complete.

Figure 6: Kaplan-Meier plot of revision for any reason after primary TKR and table of number of patients at risk over time, by study cohort

Figure 7: Kaplan-Meier plot of all-cause mortality after primary TKR and table of number of patients at risk over time, by study cohort

Figure 8: Kaplan-Meier plot of revision for any reason after primary THR and table of number of patients at risk over time, by study cohort

Figure 9: Kaplan-Meier plot of all-cause mortality after primary THR and table of number of patients at risk over time, by study cohort

Table 1: Availability of HES linked and HES + PROMs linked NJR primary total knee replacements

Characteristic	Cohort 1: Whole NJR N = 570,449[1]	Cohort 2: NJR + HES N = 526,653[1]	Cohort 3: NJR + HES + PROMs N = 355,484[1]	Cohort 4: Complete Q1 & Q2 PROMs N = 229,794[1]	Standardised Mean Difference (SMD) Cohort 1 versus 4
ASA grade					
P1 - Fit and healthy	49,204 (8.6%)	44,917 (8.5%)	30,775 (8.7%)	20,241 (8.8%)	0.028
P2 - Mild disease not incapacitating	421,074 (74%)	388,292 (74%)	264,549 (74%)	171,537 (75%)	
P3 - Incapacitating systemic disease	98,479 (17%)	91,873 (17%)	59,235 (17%)	37,444 (16%)	
P4/5 - Life threatening disease	1,692 (0.3%)	1,571 (0.3%)	925 (0.3%)	572 (0.2%)	
Age at primary (years)					
<55	35,479 (6.2%)	32,783 (6.2%)	22,183 (6.2%)	11,780 (5.1%)	0.057
55 to 64	127,859 (22%)	117,751 (22%)	80,759 (23%)	50,409 (22%)	
65 to 74	228,964 (40%)	210,713 (40%)	144,240 (41%)	96,892 (42%)	
≥75	178,147 (31%)	165,406 (31%)	108,302 (30%)	70,713 (31%)	
Gender					
Female	328,487 (58%)	303,257 (58%)	204,081 (57%)	130,349 (57%)	0.017
Male	241,962 (42%)	223,396 (42%)	151,403 (43%)	99,445 (43%)	
BMI categories					
Normal weight/underweight	40,638 (9.6%)	37,359 (9.6%)	25,040 (9.3%)	16,309 (9.3%)	0.016
Overweight	141,533 (34%)	130,293 (33%)	89,717 (33%)	59,426 (34%)	
Class I obesity	138,571 (33%)	128,157 (33%)	88,563 (33%)	57,805 (33%)	
Class II obesity	71,357 (17%)	66,305 (17%)	45,874 (17%)	29,077 (17%)	
Class III obesity	29,502 (7.0%)	27,538 (7.1%)	19,054 (7.1%)	11,929 (6.8%)	
Unknown	148,848	137,001	87,236	55,248	
IMD quintile (1 = most deprived)					
1	89,300 (16%)	83,354 (16%)	55,272 (16%)	32,323 (14%)	0.053
2	105,482 (19%)	97,944 (19%)	65,588 (19%)	41,134 (18%)	
3	120,484 (22%)	111,175 (22%)	75,315 (22%)	49,197 (22%)	
4	126,210 (23%)	116,203 (22%)	78,930 (23%)	52,664 (23%)	
5	118,089 (21%)	108,334 (21%)	73,828 (21%)	50,112 (22%)	
Unknown	10,884	9,643	6,551	4,364	

[1]n (%)

Table 2: Availability of HES linked and HES + PROMs linked NJR hips

	Cohort 1: Whole NJR	Cohort 2: NJR + HES	Cohort 3: NJR + HES + PROMs	Cohort 4: Complete Q1 & Q2 PROMs	Standardised Mean Difference (SMD)
Characteristic	N = 507,962[1]	N = 467,983[1]	N = 322,142[1]	N = 210,929[1]	Cohort 1 versus 4
ASA grade					
P1 - Fit and healthy	66,526 (13%)	60,848 (13%)	43,198 (13%)	28,442 (13%)	0.042
P2 - Mild disease not incapacitating	356,553 (70%)	327,845 (70%)	228,696 (71%)	150,384 (71%)	
P3 - Incapacitating systemic disease	82,668 (16%)	77,213 (16%)	49,101 (15%)	31,390 (15%)	
P4/P5 - Life threatening disease	2,215 (0.4%)	2,077 (0.4%)	1,147 (0.4%)	713 (0.3%)	
Age at primary (years)					
<55	57,387 (11%)	52,959 (11%)	36,643 (11%)	19,384 (9.2%)	0.080
55 to 64	107,394 (21%)	98,805 (21%)	70,112 (22%)	45,581 (22%)	
65 to 74	184,532 (36%)	168,989 (36%)	118,696 (37%)	81,866 (39%)	
≥75	158,649 (31%)	147,230 (31%)	96,691 (30%)	64,098 (30%)	
Gender					
Female	308,067 (61%)	283,595 (61%)	194,333 (60%)	126,728 (60%)	0.012
Male	199,895 (39%)	184,388 (39%)	127,809 (40%)	84,201 (40%)	
BMI categories					
Normal weight/Underweight	76,375 (20%)	70,027 (20%)	48,381 (20%)	31,876 (20%)	0.026
Overweight	149,249 (40%)	137,553 (39%)	97,747 (40%)	65,310 (40%)	
Class I obesity	100,547 (27%)	92,963 (27%)	65,997 (27%)	43,280 (27%)	
Class II obesity	38,686 (10%)	35,941 (10%)	25,560 (10%)	16,069 (9.9%)	
Class III obesity	12,840 (3.4%)	11,968 (3.4%)	8,327 (3.4%)	5,053 (3.1%)	
Unknown	130,265	119,531	76,130	49,341	
IMD quintile (1 = most deprived)					
1	66,465 (13%)	61,952 (14%)	41,491 (13%)	24,236 (12%)	0.057
2	86,838 (17%)	80,381 (18%)	54,904 (17%)	34,732 (17%)	
3	109,133 (22%)	100,757 (22%)	69,631 (22%)	46,134 (22%)	
4	118,095 (24%)	108,488 (24%)	75,380 (24%)	50,542 (24%)	

5	116,780 (23%)	106,901 (23%)	74,295 (24%)	50,931 (25%)	
Unknown	10,651	9,504	6,441	4,354	
Hip type					
Cemented	168,734 (33%)	156,175 (33%)	104,137 (32%)	70,085 (33%)	0.025
Uncemented	211,984 (42%)	194,046 (41%)	136,959 (43%)	86,938 (41%)	
Hybrid	109,996 (22%)	101,945 (22%)	70,557 (22%)	47,386 (22%)	
Reverse hybrid	17,248 (3.4%)	15,817 (3.4%)	10,489 (3.3%)	6,520 (3.1%)	

[1]n (%)