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Association between symptom duration and patient-reported outcomes before and after hip replacement surgery

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Abstract (249 currently)

Background: Patients experience discomfort and compromised quality of life whilst waiting for hip replacement. Symptom duration may affect quality of life attained following surgery, but no population-level evidence exists on the impact of symptom duration on pre- and post-surgical outcomes.

Methods: National observational data collected before and after hip replacement surgery in England between 2009 and 2016 was used to investigate determinants of symptom duration prior to surgery, and the relationship between symptom duration and pre- and post-surgical patient-reported outcomes. Multivariable linear regression models were used to estimate associations between patient-reported outcomes and symptom duration, controlling for a range of covariates.

Results: The sample included 209,192 patients; most (69%) experienced symptoms for 1-5 years. Few patients (14%) experienced symptoms for less than a year, for longer than 5 years (6-10 years (11%)), or for more than 10 years (5%). Symptom duration decreased overall over the studied time period, and was shorter among males, older and less deprived patients.

Patients with a symptom duration less than one year had better post-surgical pain and function (Oxford Hip Score: 0.875, 95% CI 0.777 to 0.973) than those with 1-5 years symptom duration in an adjusted model. Conversely, those with symptom duration exceeding five years had increasingly poorer post-surgical outcomes (Oxford Hip Score: 6-10 years -0.730, 95% CI -0.847 to -0.613; >10 years -1.112, 95% CI -1.278 to -0.946).

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Conclusion: Symptom duration prior to hip replacement has become more standardised in England over time but increasing duration remains a significant predictor of poorer outcome after surgery.

Significance and innovations

- This is the first study to explore the impact of symptom duration on patient-reported post-surgical outcomes from hip replacement surgery using national, routinely collected data.
- Over two thirds of patients undergoing THA have a symptom duration of 1-5 years; longer symptom duration was positively associated with female sex, increasing income deprivation, and patients from a black ethnic background.
- Symptom duration prior to hip replacement became more standardised in England between 2009 and 2016, with fewer people reporting very long or very short symptom duration over time.
- Post-surgical patient-reported pain and function (Oxford Hip Score) and health-related quality of life (EQ-5D-3L) outcomes were best for patients with less than 1-year symptom duration and worst for those with 6 or more years of symptom duration.

Hip replacement is one of the most commonly performed surgical procedures in the UK. There is increasing consensus and clear guidelines for a care pathway for people with osteoarthritis of the hip prior to referral to an orthopaedic surgeon for total hip arthroplasty (THA). The recommended non-surgical care pathway prior to THA typically involves stepped care, consisting of escalating non-pharmacologic (e.g. education, lifestyle advice, physical and occupational therapy) and pharmacologic intervention (analgesics and supplements, non-steroidal anti-inflammatory drugs, and intraarticular injections)(1–4). There is evidence of an underuse of non-surgical treatments in primary care(5,6), as well as an absence of evidence for timing and prioritization of THA(1,5,7). Patients who have exhausted these options and are refractory to non-pharmacologic and pharmacologic interventions should then be considered for referral for THA. If at this point the specialist decides that surgery is an option, the procedure is then to be undertaken at the earliest available time.

Each stage in this process involves time and the potential for further delays. The total duration over which patients experience symptoms is a result of the willingness and ability of patients to initiate care and navigate through the care system, shared decision-making at various stages between patients, clinicians and surgeons, and the efficiency with which patients are processed through the health care system. The potential benefits of early THA surgery are still unclear. The presumed advantages of early THA surgery centre on a window of opportunity to intervene before the symptoms, pain and impairment of physical functioning become too severe, which is supported by evidence that shows greater pain and increased impairment of preoperative physical functioning is predictive of poorer outcomes(8). However, as severity varies by

individuals and THA is an irreversible procedure, countering these potential benefits is evidence that the procedure is not always successful or beneficial for patients(9), concerns about the need for revision due to loosening and restricted lifespan of the hip prosthesis(10), and the diminished likelihood of success and patient satisfaction following such revision surgery(11,12). Consequently, the decision to refer and undergo surgery is often based on discussions between patients, referring clinicians and surgeons(1).

There is considerable variation in the rates and timing of THA surgery, as well as the health status of patients undergoing surgery within and between countries(7,13,14). Several factors are known to influence decision to undergo surgery, including age, sex, socio-economic status, patient willingness, and clinical decision making(15–17). There is evidence that a longer formal waiting time between the decision to operate by a surgeon and the surgery date is associated with poorer outcomes after surgery(18). There is also evidence that increased waiting time is independently associated with poorer post-surgical outcomes in other elective hip surgeries such as arthroscopy(19,20). Typically, however, symptom duration is a much longer period than waiting time. Waiting time only covers the period between a patient being deemed appropriate and ready for surgery and the date of surgery, whereas symptom duration includes the time periods when patients are not yet ready, as well as the waiting time when they are ready. The relationship between symptom duration and outcomes is unclear, and it is unknown whether variations in symptom duration reflect variation in the rates and timing of THA, or whether symptom duration has become more standardised with better evidence and more guidelines.

This study used rich observational patient-reported data from 209,543 patients undergoing hip replacement in England between 2009 and 2016 to explore, 1) the determinants of symptom duration, 2) trends in symptom duration over time, and 3) the relationship between symptom duration and pre- and post-surgical health-related pain and function, and health-related quality of life outcomes in patients who have undergone THA.

Methods

Background to the PROMs programme

Since 2009, all providers of elective surgery funded by the National Health Service (NHS) in England are required to distribute and collect patient-reported outcome measures (PROMs) before and after surgery to patients undergoing four high-volume elective procedures (groin hernia, total hip arthroplasty (THA), total knee arthroplasty and varicose vein surgery). Patients undergoing THA are given a preoperative questionnaire before the date of surgery, usually at their last outpatient assessment or the date of the THA, and a subsequent postoperative questionnaire 6 months after the date of their surgery. The questionnaire includes the EQ-5D-3L index (21), a generic measure of health-related quality of life (HRQoL), the Oxford Hip Score (OHS)(22), a disease-specific measure of pain and functional disability, alongside a range of questions about the patient's living arrangements, symptoms and health status, previous surgeries, and

perceptions of the intervention. Under the NHS PROMs programme it is mandatory for providers to offer patients the chance to complete the PROMs questionnaire, but participation by patients is voluntary. If patients fail to respond to either pre- or postoperative questionnaires, one reminder is sent. Data from the PROMs questionnaire, from which all identifiable information is removed, can be linked to administrative data from Hospital Episode Statistics (HES), which contains detailed clinical and demographic information on all inpatient admissions funded by the English NHS.

Data

Data from the PROMs programme in the English NHS(23) linked at patient level to the HES data for seven financial years from 2009/2010 to 2015/2016 were used.

Exposure, symptom duration, was captured by a question in the pre-operative PROMs questionnaire that asks patients to report the length of their symptoms as a categorical variable encompassing four categories (less than one year, one to five years, six to 10 years, and over 10 years). Patients' self-reported HRQoL using the EQ-5D-3L and functional ability and pain using the Oxford Hip Scale (OHS) were used as outcome measures. The EQ-5D-3L consists of five questions which capture pain/discomfort, ability to perform usual activities and self-care, mobility, and anxiety/depression on three levels of severity. Responses were converted to an index score of HRQoL (scaled between 1 (perfect health) and 0 (equivalent to being dead) using preference weights (24). The OHS consists of 12 questions asking about function and pain related to hip issues, each of which is scored from 0 to 4 with increasing severity. The scores for each question were summed to give a range of scores between 0 and 48, with higher scores indicating greater pain and functional disability.

A range of patient and area level covariates were controlled for in analyses. Patient variables include sex, age (in 5-year bands from ages 51 to 90 years, and then all patients aged 90+ years; patients younger than 51 years were excluded), ethnicity (white, Asian, black, mixed, other, not stated), living alone, and specific health conditions (high blood pressure, stroke, diseases of the nervous system, lung disease, and kidney disease), and Elixhauser comorbidities (which describes 31 comorbidities) (25). The area level characteristics were whether the patient lives in a rural or urban area, and area level deprivation (Lower Super Output Area (26); a region with an average of 1500 individuals), captured using the income component of the Index of Multiple Deprivation (27).

All five of health conditions (high blood pressure, stroke, diseases of the nervous system, lung disease, and kidney disease) that patients self-reported in the pre-operative PROMs questionnaire were included. The 31 Elixhauser comorbidities were obtained using ICD-10 codes from linked HES data. This rich information on specific health conditions and Elixhauser co-morbidities was used to control for sources of variation in pre- and post-operative health scores.

Statistical analysis

Interval (28) and multinomial logit (29) regression analyses were used to estimate the factors associated with symptom duration. These factors include age, gender, ethnic group, living alone, and area income deprivation. Patients, who experienced symptoms for 1-5 years were used as the reference category. All results reported are from adjusted models. Marginal effects for each observation were estimated to aid interpretation of the results.

Multivariable linear regression models were used to estimate the association between the two patient-reported outcome measures (EQ-5D-3L and OHS) and symptom duration, controlling for the same covariates. For each outcome measure three models were estimated: (i) pre-surgery scores; (ii) post-surgery scores; and (iii) post-surgery scores controlling for pre-surgery scores. The latter analysis shows the association of symptom duration with the improvements in outcomes from surgery.

Changes in the distribution of symptom duration over time were also examined. The estimated differences in improvements in pain and function, and HRQoL by symptom duration were then used to calculate the overall effect of the change in the distribution of symptom duration on total gain from surgery.

As a sensitivity analysis, models on health gains from surgery were re-estimated on the sample of patients completing both the OHS and EQ-5D-3L (different numbers of respondents completed the OHS and EQ-5D-3L measures). In addition, analyses for both outcomes, OHS and EQ-5D-3L, were repeated after excluding the first two years of data because the proportion of patients who completed PROMs questionnaires was smaller in the first two financial years than in later years(30).

Further sensitivity analyses conducted estimated models excluding patients who have rheumatoid arthritis, as well as models that only included patients with rheumatoid arthritis. Rheumatoid arthritis patients were excluded as they are a group who are likely to have a shorter duration of symptoms before THA, and where THA may be an indicator of failure of pharmacologic treatment for treatment of RA and poor prognosis(31).

Results

Descriptive statistics

Between the 2009/10 and 2015/16 financial years, 320,474 patients underwent THA and completed a PROMS questionnaire that could be linked to the HES admission data. However, 47,183 patients did not complete both the pre- and post-operative questionnaire and a further 9,766 patients had missing data on one or more covariates and therefore could not be included in the analysis. Patients with congenital conditions (n=2,892), and patients with a previous similar surgery (n=31,495) were removed. Patients aged 50 years and under (n=19,946) were also excluded from the analysis as the relationship between symptom duration and outcomes in younger age groups may be different because of decisions to delay surgery related to the

limited lifespan of prostheses and/or number of possible revisions. Lastly, patients, who had had a hip fracture (n= 429) were removed. The final dataset consisted of 209,192 patients.

Over two thirds (69%) of patients reported having experienced symptoms between one and five years prior to THA, and one in seven patients (14%) reported having symptom for less than a year (Table 1). Just over five percent of patients had experienced symptoms for more than ten years. Older patients tended to have experienced symptoms for a shorter period of time. Minority ethnic groups tended to have experienced symptoms for longer. There were only small differences in symptom duration across other characteristics, although the proportion of patients who lived alone was higher in those with symptom duration of less than one year (29%) than those with longer symptom duration (24-26%).

The proportions of patients with symptom durations of less than one year and over 10 years declined over time (Figure 1). Conversely, the proportion of patients that reported having experienced symptoms between one and 10 years increased. The largest percentage point increase over time was observed in patients experiencing symptom duration of one to five years (1%), whilst the largest percentage point reduction was for patients experiencing symptom duration of under one year (<1%).

Determinants of symptom duration

Older patients reported experiencing shorter symptom duration (Table 2; models adjusted for patient- and area-level covariates), with, for example, patients aged 81 years and over experiencing symptoms for on average 1.3 years shorter (95% CI -1.5 to -1.2) than patients aged between 51 and 55 years. Between the ages of 51-55 until 71-75 symptom duration decreased with age, however, this trend was not sustained for ages 76 and over. Males reported experiencing symptom duration on average three weeks (-0.062, 95% CI -0.087 to -0.037) shorter than females; this finding was driven by patients who experienced symptoms for less than one year. Longer symptom duration was positively associated with income deprivation, and patients from a black ethnic background. On average, patients from a black ethnic group experienced symptoms eight months longer (0.672, 95% CI 0.419 to 0.926) than patients from a white ethnic group. A 10-percentage point higher level of income deprivation was associated with a two week (0.391 95% CI 0.248 to 0.533) longer symptom duration. Patients that lived alone were more likely to experience symptoms for under one year and over 10 years.

The relationship between symptom duration and patient-reported outcomes

Patients reporting symptom duration of one to five years reported the highest pre-surgery OHS and longer symptom duration was associated with lower post-surgery OHS after adjustment for patient- and area-level covariates (Table 3). Conditioning on pre-surgery scores, longer symptom duration was associated with lower post-surgery OHS. Patients experiencing symptoms for six to 10 years or 10 years and over reported lower improvements on the OHS (-0.730 (95% CI -0.847 to -0.613) and -1.112 (95% CI -1.278 to -0.946)

respectively), compared to the mean improvement of 21.05 in the base category of one to five years. Patients, who experienced symptoms for less than one year reported an improvement in OHS that was 0.875 (95% CI 0.777 to 0.973) points higher compared with those reporting one to five years symptom duration.

A similar pattern was observed for the EQ-5D-3L (Table 4). Pre-surgery EQ-5D-3L scores were highest for patients reporting experiencing symptoms for one to five years, and lower post-operative EQ-5D-3L scores were associated with increasing symptom duration. Controlling for pre-operative EQ-5D-3L scores, reporting a symptom duration of less than one year was associated with an increase in EQ-5D-3L score of 0.022 (95% CI 0.019 to 0.025) following surgery, compared with patients experiencing symptoms for one to five years. In patients reporting a symptom duration of six to 10 years and 10 years or more, the increase in EQ-5D-3L score following surgery was 0.020 (95% CI -0.023 to -0.017) and 0.034 (95% CI -0.039 to -0.029) lower than patients experiencing symptoms for one to five years, respectively.

Sensitivity analysis

Results estimated from separate samples using all available EQ-5D-3L and OHS scores yielded similar results (see online appendix). Similarly, removing the first two years of data did not change the results for the EQ-5D-3L or the OHS; effect sizes were almost identical, and the 95% confidence intervals were marginally wider (Table 5). Excluding patients with rheumatoid arthritis attenuated the results using OHS slightly but did not affect the results of the EQ-5D-3L analysis (Table 5).

The analysis restricted to patients with rheumatoid arthritis showed consistent but stronger associations between symptom duration and surgical outcomes than in patients without rheumatoid arthritis (Table 5). In rheumatoid arthritis patients, compared with people reporting symptom duration of one to five years, those reporting symptom duration less than one year had an additional improvement in OHS of 1.378 (0.687 to 2.069), while those reporting symptom duration of six to 10 years or longer than 10 years, had reductions in the improvement on OHS of -1.459 (-2.520 to -0.398) and -2.611 (-4.076 to -1.149), respectively.

Symptom duration over time

The composition of symptom duration changed over time, with fewer patients reporting very short or very long symptom duration (Figure 1). The proportion of patients receiving surgery who reported having either less than one year, or more than 10 years symptom duration was lower in 2015/16 than in 2009/10. These results suggest that in 2015/16 there were 332 (-290.2 OHS units) fewer patients reporting symptom duration of less than one year, 215 (-157.07 OHS units) additional patients reporting symptom duration of six to ten years, and 282 (313 OHS units) fewer patients reporting symptom duration greater than 10 years. This translates, within the 2015/16 financial year, to a net reduction in overall improvement of 134 units in OHS (0.07% of the total gain during the period).

Discussion

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This study used patient-reported outcome measures collected routinely pre- and post-surgery in England to estimate the association of symptom duration with pain and function, and health-related quality of life. Previous studies have focussed on waiting times, but this study extends the pre-surgical period by focussing on the reported time from symptom duration to the date of surgery.

Our findings indicate that several patient characteristics, including age, gender and ethnicity, are associated with symptom duration. This is consistent with findings of inequalities in the use of specific NHS services relative to need by people of lower socioeconomic status(32) and minority ethnic groups(33), including secondary care, preventive care, and treatments which include hip replacements(34). Furthermore, the rate of deterioration in health increases with age(35). With the exception of those reporting a symptom duration of less than one year, patients who reported longer symptoms also reported poorer health prior to surgery. Finally, longer symptom duration was associated with poorer post-surgical patient-reported outcomes and smaller improvements in these outcomes from surgery, after controlling for pre-surgery scores.

Our findings suggest that discrepancies in health exist for patients reporting the extremes of symptom duration. Patients with symptoms under one and over 10 years are likely to report poorer pre-surgical health outcomes than those reporting a symptom duration between one and 10 years. In addition, patients reporting symptoms for over 10 years also experience smaller improvements from surgery. The difference in OHS score was approximately one point; a one-level improvement on one of the twelve questions. This improvement could, for example, be the difference between being able to walk 'around the house' versus 'not at all' 'before the pain in your hip becomes severe', or being able to 'put on a pair of socks, stockings or tights' with 'little difficulty' instead of 'moderate difficulty'. The composition of patients with these extreme symptom durations appears to decrease over time. However, our results suggest that this change in symptom duration results in a net health loss representing 0.07% of the gains in OHS and 0.05% of the gains in EQ-5D-3L scores from surgery in 2015/16.

Previous studies have focused on the length of the period between the decision to operate and the date of the operation. This study extends this work by showing how symptom duration, which typically encompasses a longer period than just waiting time, is associated with potential benefit from surgery, and by identifying patient characteristics associated with differences in symptom duration. To our knowledge, this is the first study to examine symptom duration in the context of THA outcomes. Our findings align with the findings of Nikolova, Harrison and Sutton (2016) (18), who found that longer waiting times following the decision to operate were associated with poorer post-surgical outcomes for both THA and total knee arthroplasty, as well as those of Fortin et al. (1999) (8), who reported that poorer pre-operative health resulted in poorer improvement from surgery. However, Nikolova, Harrison and Sutton (2016) (18) reported that an additional week of elective wait for surgery resulted in larger reduction of post-surgical OHS (-0.0951) and EQ-5D-3L (-0.0620) than our findings. This suggests that the waiting time once a patient is deemed ready for surgery may play a more important role than the duration of symptoms.

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One limitation of this study is the reliance on self-reported data on symptom duration. Patients may not be able to accurately remember how long they have experienced symptoms and they were therefore asked to indicate the duration in four wide time bands. These broad bands of symptom duration would be likely, however, to reduce our ability to detect a significant impact of symptom duration on outcome, yet we were still able to detect an effect. More granular data would enable the impact of symptom duration and post-surgical outcomes to be explored in more detail. Issues with recall could also potentially introduce measurement error or recall bias. Random error in recalling the duration of symptoms by patients would make it more difficult to find a relationship. However, systematic recall bias, for example people with poorer pre-surgical health systematically reporting longer symptom duration, could have biased our results. More accurate measurement of the length of symptom duration would require linkage of PROMs data to administrative data from all general practices in England.

A further limitation is the amount of missing data because not all patients undergoing hip replacement responded to the PROMs questionnaires. Previously reported response rates suggest that 73% of patients complete the pre-surgical questionnaire and 86% complete pre- and post-surgical questionnaires(36,37). Non-responders to the pre-surgical questionnaire are more likely to be female, from non-white ethnic backgrounds and more deprived areas(36); those who complete the pre- but not post-surgery questionnaires are more likely to be male, under 64 years of age, from non-white ethnic backgrounds and more deprived areas(37). The complete case analysis is presented as the main analysis, but the results remained stable in sensitivity analysis when the first two financial years of data that had lower response rates were omitted. A further aspect of missing data stems from patients who did not state their ethnicity. This means that complete data is not available on all patient characteristics, however, the distribution of patients who did not state their ethnicity was only 10% across all categories of reported symptom duration.

Conclusion

An increasing number of guidelines suggest alternatives to surgical care for patients who may need a THA with the aim to delay surgical intervention until all alternative care pathways have been exhausted. This increases the length of time over which patients experience symptoms and may ultimately reduce the potential health gains from surgery and patient health in the long run. This study found patients experiencing longer symptom duration to report poorer health prior to surgery and lower health gains from surgery. Although the treatment pathway from symptom onset to THA is complex and causes of delays are multifactorial, interventions that minimize unnecessary delays to surgery that further extend symptom duration, such as inappropriate care or ineffective referral and triage processes, have the potential to improve patient outcomes.

References

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1. Conaghan PG, Dickson J, Grant RL. Care and management of osteoarthritis in adults: summary of NICE guidance. *BMJ*. 2008 Mar 1;336(7642):502–3.
2. Fernandes L, Hagen KB, Bijlsma JWJ, Andreassen O, Christensen P, Conaghan PG, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Ann Rheum Dis*. 2013 Apr 16;annrheumdis-2012-202745.
3. Hochberg MC, Altman RD, April KT, Benkhalti M, Guyatt G, McGowan J, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res*. 2012 Apr;64(4):465–74.
4. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis Cartilage*. 2008 Feb 1;16(2):137–62.
5. Brand CA, Harrison C, Tropea J, Hinman RS, Britt H, Bennell K. Management of osteoarthritis in general practice in Australia. *Arthritis Care Res*. 2014 Apr;66(4):551–8.
6. Snijders GF, den Broeder AA, van Riel PLCM, Straten VHHP, de Man FHR, van den Hoogen FHJ, et al. Evidence-based tailored conservative treatment of knee and hip osteoarthritis: between knowing and doing. *Scand J Rheumatol*. 2011 May;40(3):225–31.
7. Dieppe P, Judge A, Williams S, Ikwueke I, Guenther K-P, Floeren M, et al. Variations in the pre-operative status of patients coming to primary hip replacement for osteoarthritis in European orthopaedic centres. *BMC Musculoskelet Disord*. 2009 Feb 10;10:19.
8. Fortin PR, Clarke AE, Joseph L, Liang MH, Tanzer M, Ferland D, et al. Outcomes of total hip and knee replacement: Preoperative functional status predicts outcomes at six months after surgery. *Arthritis Rheum*. 1999 Aug 1;42(8):1722–8.
9. Williams O, Fitzpatrick R, Hajat S, Reeves BC, Stimpson A, Morris RW, et al. Mortality, morbidity, and 1-year outcomes of primary elective total hip arthroplasty. *J Arthroplasty*. 2002 Feb;17(2):165–71.
10. Labek G, Thaler M, Janda W, Agreiter M, Stöckl B. Revision rates after total joint replacement: cumulative results from worldwide joint register datasets. *J Bone Joint Surg Br*. 2011 Mar;93(3):293–7.
11. Espehaug B, Havelin LI, Engesaeter LB, Langeland N, Vollset SE. Patient Satisfaction and Function After Primary and Revision Total Hip Replacement. *Clin Orthop*. 1998 Jun;351:135.
12. Gandhi R, Davey JR, Mahomed NN. Predicting Patient Dissatisfaction Following Joint Replacement Surgery. *J Rheumatol*. 2008 Dec 1;35(12):2415–8.

13. Ackerman IN, Dieppe PA, March LM, Roos EM, Nilsdotter AK, Brown GC, et al. Variation in age and physical status prior to total knee and hip replacement surgery: a comparison of centers in Australia and Europe. *Arthritis Rheum*. 2009 Feb 15;61(2):166–73.
14. Birkmeyer JD, Sharp SM, Finlayson SRG, Fisher ES, Wennberg JE. Variation profiles of common surgical procedures. *Surgery*. 1998 Nov 1;124(5):917–23.
15. Hawker GA, Badley EM, Borkhoff CM, Croxford R, Davis AM, Dunn S, et al. Which Patients Are Most Likely to Benefit From Total Joint Arthroplasty? *Arthritis Rheum*. 2013 May 1;65(5):1243–52.
16. Hawker GA, Wright JG, Coyte PC, Williams JI, Harvey B, Glazier R, et al. Determining the need for hip and knee arthroplasty: the role of clinical severity and patients' preferences. *Med Care*. 2001 Mar;39(3):206–16.
17. Mota REM, Tarricone R, Ciani O, Bridges JF, Drummond M. Determinants of demand for total hip and knee arthroplasty: a systematic literature review. *BMC Health Serv Res*. 2012 Jul 30;12:225.
18. Nikolova S, Harrison M, Sutton M. The Impact of Waiting Time on Health Gains from Surgery: Evidence from a National Patient-reported Outcome Dataset. *Health Econ*. 2016 Aug 1;25(8):955–68.
19. Aprato A, Jayasekera N, Villar R. Timing in hip arthroscopy: does surgical timing change clinical results? *Int Orthop*. 2012 Nov;36(11):2231–4.
20. Dierckman BD, Ni J, Hohn EA, Domb BG. Does duration of symptoms affect clinical outcome after hip arthroscopy for labral tears? Analysis of prospectively collected outcomes with minimum 2-year follow-up. *J Hip Preserv Surg*. 2017 Jun 15;4(4):308–17.
21. EuroQol Group. EuroQol - a new facility for the measurement of health-related quality of life. *Health Policy*. 1990 Dec 1;16(3):199–208.
22. Dawson J, Fitzpatrick R, Carr A, Murray D. Questionnaire on the perceptions of patients about total hip replacement. *J Bone Joint Surg Br*. 1996 Mar;78(2):185–90.
23. PROMs. Patient Reported Outcome Measures [Internet]. 2016 [cited 2016 May 19]. Available from: <http://www.hscic.gov.uk/proms>
24. Dolan P. Modeling valuations for EuroQol health states. *Med Care*. 1997 Nov;35(11):1095–108.
25. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care*. 1998 Jan;36(1):8–27.

26. ONS. Super Output Area (SOA) [Internet]. Office for National Statistics. 2011 [cited 2016 May 19]. Available from:
<http://webarchive.nationalarchives.gov.uk/content/20160105160709/http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/census/super-output-areas--soas-/index.html>
27. IMD. English indices of deprivation 2010 - Publications - GOV.UK [Internet]. 2013 [cited 2013 Nov 12]. Available from: <https://www.gov.uk/government/publications/english-indices-of-deprivation-2010>
28. Stewart MB. On Least Squares Estimation when the Dependent Variable is Grouped [Internet]. University of Warwick, Department of Economics; 1982 [cited 2018 Mar 12]. (The Warwick Economics Research Paper Series (TWERPS)). Report No.: 207. Available from: <https://ideas.repec.org/p/wrk/warwec/207.html>
29. Dow JK, Endersby JW. Multinomial probit and multinomial logit: a comparison of choice models for voting research. *Elect Stud*. 2004 Mar;23(1):107–22.
30. Gomes M, Gutacker N, Bojke C, Street A. Addressing Missing Data in Patient-Reported Outcome Measures (PROMS): Implications for the Use of PROMS for Comparing Provider Performance. *Health Econ*. 2016 May 1;25(5):515–28.
31. James D, Young A, Kulinskaya E, Knight E, Thompson W, Ollier W, et al. Orthopaedic intervention in early rheumatoid arthritis. Occurrence and predictive factors in an inception cohort of 1064 patients followed for 5 years. *Rheumatology*. 2004 Mar 1;43(3):369–76.
32. Dixon A, Le Grand J, Henderson J, Murray R, Poteliakhoff E. Is the NHS equitable? A review of the evidence [Internet]. The London School of Economics and Political Science; 2003 [cited 2018 Nov 29] p. 1–38. (LSE Health and Social Care Discussion Paper). Report No.: 11. Available from: <https://pdfs.semanticscholar.org/aab4/dcf279b5673b8f730bd720b8f49221b6a94a.pdf>
33. Morris S, Sutton M, Gravelle H. Inequity and inequality in the use of health care in England: an empirical investigation. *Soc Sci Med* 1982. 2005 Mar;60(6):1251–66.
34. Cookson R, Propper C, Asaria M, Raine R. Socio-Economic Inequalities in Health Care in England. *Fisc Stud*. 2016;37(3–4):371–403.
35. Yashin AI, Arbeev KG, Kulminski A, Akushevich I, Akushevich L, Ukraintseva SV. Health decline, aging and mortality: how are they related? *Biogerontology*. 2007 Jun;8(3):291–302.
36. Hutchings A, Neuburger J, van der Meulen J, Black N. Estimating recruitment rates for routine use of patient reported outcome measures and the impact on provider comparisons. *BMC Health Serv Res* [Internet]. 2014 Dec [cited 2018 Oct 19];14(1).

37. Hutchings A, Neuburger J, Grosse Frie K, Black N, van der Meulen J. Factors associated with non-response in routine use of patient reported outcome measures after elective surgery in England. *Health Qual Life Outcomes*. 2012;10(1):34.

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Table 1: Descriptive statistics by symptom duration

All years	< 1 year	1-5 years	6-10 years	> 10 years
Patients	29,894	145,131	22,787	11,380
Percentage	14%	69%	11%	5%
Mean EQ-5D-3L score before surgery	0.342	0.362	0.361	0.345
Mean EQ-5D-3L score after surgery	0.810	0.793	0.774	0.756
Mean Oxford Hip Score before surgery	18.0	18.2	18.0	17.6
Mean Oxford Hip Score after surgery	39.9	39.3	38.6	38.1
Male (proportion)	43%	39%	41%	42%
Age group (%)				
51-55 years	3%	6%	8%	11%
56-60 years	6%	9%	13%	15%
61-65 years	12%	16%	19%	19%
66-70 years	18%	21%	22%	21%
71-75 years	22%	20%	18%	17%
76-80 years	22%	16%	12%	11%
81-85 years	12%	9%	6%	5%
86-90 years	4%	3%	2%	2%
90+ years	1%	<1%	<1%	<1%
Ethnic group (%)				
White	89%	90%	89%	89%
Mixed	<1%	<1%	<1%	<1%
Asian	<1%	<1%	<1%	<1%
Black	<1%	<1%	<1%	1%
Other	<1%	<1%	<1%	<1%
Not stated	10%	10%	10%	10%
Rheumatoid Arthritis	3%	2%	2%	2%
Rural area	29%	28%	28%	28%
Area income deprivation	11%	12%	12%	12%
Living alone	29%	26%	24%	24%

Table 2: Interval and multinomial logistic regressions of symptom duration

	Interval regression	Multinomial logistic regression (base category is 1-5 years symptoms)		
		Symptoms under 1 year	Symptoms 6-10 year	Symptoms over 10 years
	Coefficient [95% Confidence Interval]	Marginal effect [95% Confidence Interval]	Marginal effect [95% Confidence Interval]	Marginal effect [95% Confidence Interval]
Male	-0.062 [-0.087,-0.037]	0.025 [0.022,0.028]	-0.0003 [-0.003,0.002]	0.001 [-0.001,0.004]
Age (reference 51-55 years)				
56-60 years	-0.264 [-0.334,-0.193]	0.015 [0.009,0.021]	-0.005 [-0.013,0.003]	-0.021 [-0.027,-0.014]
61-65 years	-0.521 [-0.586,-0.456]	0.029 [0.023,0.035]	-0.021 [-0.028,-0.013]	-0.037 [-0.043,-0.031]
66-70 years	-0.715 [-0.778,-0.652]	0.048 [0.042,0.054]	-0.031 [-0.038,-0.023]	-0.047 [-0.052,-0.041]
71-75 years	-0.986 [-1.049,-0.923]	0.079 [0.073,0.085]	-0.051 [-0.059,-0.044]	-0.057 [-0.062,-0.051]
76-80 years	-1.249 [-1.313,-1.185]	0.114 [0.108,0.121]	-0.069 [-0.076,-0.061]	-0.066 [-0.072,-0.060]
81-85 years	-1.375 [-1.443,-1.306]	0.128 [0.120,0.136]	-0.079 [-0.087,-0.071]	-0.071 [-0.077,-0.065]
86-90 years	-1.328 [-1.416,-1.240]	0.127 [0.115,0.139]	-0.07 [-0.080,-0.061]	-0.07 [-0.077,-0.063]
90+ years	-1.343 [-1.521,-1.165]	0.125 [0.096,0.154]	-0.079 [-0.098,-0.060]	-0.068 [-0.082,-0.054]
Ethnicity (reference = White)				
Mixed	0.276 [-0.159,0.711]	0.036 [-0.018,0.089]	0.002 [-0.038,0.042]	0.033 [-0.001,0.068]
Asian	-0.22 [-0.529,0.089]	0.056 [0.012,0.100]	-0.026 [-0.054,0.002]	0.005 [-0.019,0.028]
Black	0.672 [0.419,0.926]	-0.036 [-0.061,-0.010]	0.042 [0.015,0.068]	0.037 [0.017,0.058]
Other	0.207	-0.024	-0.006	0.016

Association between symptom duration and patient-reported outcomes				
	[-0.022,0.437]	[-0.050,0.002]	[-0.030,0.018]	[-0.003,0.036]
Not Stated	-0.017	0.006	0.001	-0.000
	[-0.056,0.023]	[0.001,0.011]	[-0.003,0.006]	[-0.004,0.003]
Living Alone	0.025	0.008	0.003	0.004
	[-0.003,0.052]	[0.004,0.011]	[-0.000,0.006]	[0.002,0.006]
Rheumatoid Arthritis	-0.206	0.027	-0.004	-0.011
	[-0.309,-0.102]	[0.014,0.039]	[-0.017,0.009]	[-0.020,-0.001]
Area income deprivation	0.391	-0.029	0.023	0.021
	[0.248,0.533]	[-0.047,-0.010]	[0.008,0.039]	[0.010,0.033]
Rural area of residence	0.014	0.001	0.002	0.001
	[-0.012,0.040]	[-0.002,0.005]	[-0.001,0.005]	[-0.001,0.004]

Notes: n=209,192. Marginal effects are estimated at the mean, CIs calculated using robust standard errors. Base categories are white ethnic group and aged 51-55 years. Model also includes Elixhauser comorbidities, health conditions (high blood pressure, stroke, nervous system, lung disease and kidney disease) and dummy variables for each of the 60 months over the 5 year period.

Table 3: Multivariable regression of Oxford Hip Scores and EQ-5D-3L on symptom duration

Symptom Duration	Oxford Hip Score		
	Before surgery	After surgery	After surgery, conditional on before surgery score
	Coefficient	Coefficient	Coefficient
	[95% Confidence Interval]	[95% Confidence Interval]	[95% Confidence Interval]
< 1 year	-0.232 [-0.334,-0.130]	0.809 [0.708,0.910]	0.875 [0.777,0.973]
1 - 5 years (reference category)	.	.	.
6 - 10 years	-0.27 [-0.377,-0.163]	-0.807 [-0.929,-0.685]	-0.73 [-0.847,-0.613]
> 10 years	-0.675 [-0.826,-0.524]	-1.305 [-1.480,-1.129]	-1.112 [-1.278,-0.946]
Symptom Duration	EQ-5D-3L Index		
	Before surgery	After surgery	After surgery, conditional on before surgery score
	Coefficient	Coefficient	Coefficient
	[95% Confidence Interval]	[95% Confidence Interval]	[95% Confidence Interval]
< 1 year	-0.02 [-0.024,-0.016]	0.019 [0.016,0.022]	0.022 [0.019,0.025]
1 - 5 years (reference category)	.	.	.
6 - 10 years	-0.003 [-0.007,0.002]	-0.022 [-0.025,-0.018]	-0.02 [-0.023,-0.017]
> 10 years	-0.02 [-0.026,-0.014]	-0.039 [-0.044,-0.034]	-0.034 [-0.039,-0.029]

Notes: n= 209,192 patients for Oxford Hip Score models and n=192,255 patients for EQ-

5D-3L models. Models include the following covariates: five-year age bands from 51 to 90 and over, male, ethnicity (white, mixed, Asian, black, other and not stated), person living alone, rheumatoid arthritis marker, Elixhauser comorbidities, health conditions (high blood pressure, stroke, nervous system, lung disease and kidney disease), area income deprivation and dummy variables for each of the 60 months over the 5 year period

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Table 4: Multivariable regression of Oxford Hip Scores and EQ-5D-3L on symptom duration using data from 1st April 2011 until 31st March 2016

Symptom Duration	Oxford Hip Score after surgery conditional on before surgery		EQ-5D-3L Index after surgery conditional on before surgery	
	All years	1/4/11 - 31/3/16	All years	1/4/11 - 31/3/16
	Coefficient	Coefficient	Coefficient	Coefficient
	[95% Confidence Interval]	[95% Confidence Interval]	[95% Confidence Interval]	[95% Confidence Interval]
< 1 year	0.875 [0.777,0.973]	0.878 [0.766,0.989]	0.022 [0.019,0.025]	0.023 [0.020,0.026]
1 - 5 years (reference category)	.	.	.	.
6 - 10 years	-0.73 [-0.847,-0.613]	-0.735 [-0.867,-0.603]	-0.02 [-0.023,-0.017]	-0.02 [-0.024,-0.016]
> 10 years	-1.112 [-1.278,-0.946]	-1.103 [-1.295,-0.912]	-0.034 [-0.039,-0.029]	-0.035 [-0.040,-0.029]
Patients (n)	209,192	159,679	192,255	147,413

Notes: Models include the following covariates: five-year age bands from 51 to 90 and over, male, ethnicity (white, mixed, Asian, black, other and not stated), person living alone, rheumatoid arthritis marker, Elixhauser comorbidities, health conditions (high blood pressure, stroke, nervous system, lung disease and kidney disease), IMD income deprivation and dummy variables for each of the 60 months over the 5 year period

Table 5: Multivariable regression of Oxford Hip Scores and EQ-5D-3L on symptom duration with models, (1) excluding and (2) consisting only of patients with rheumatoid arthritis

Symptom Duration	Oxford hip score after surgery conditional on before surgery		EQ-5D-3L Index after surgery conditional on before surgery	
	Excluding rheumatoid arthritis	Rheumatoid arthritis only	Excluding rheumatoid arthritis	Rheumatoid arthritis only
	Coefficient [95% Confidence Interval]	Coefficient [95% Confidence Interval]	Coefficient [95% Confidence Interval]	Coefficient [95% Confidence Interval]
< 1 year	0.864 [0.765,0.964]	1.378 [0.687,2.069]	0.022 [0.019,0.024]	0.044 [0.022,0.066]
1 - 5 years (reference category)	.	.	.	.
6 - 10 years	-0.718 [-0.835,-0.601]	-1.459 [-2.520,-0.398]	-0.02 [-0.023,-0.017]	-0.024 [-0.056,0.008]
> 10 years	-1.087 [-1.255,-0.920]	-2.612 [-4.076,-1.149]	-0.034 [-0.038,-0.029]	-0.065 [-0.110,-0.019]
Patients (n)	204,970	4,222	188,392	3,863

Notes: Models include the following covariates: five-year age bands from 51 to 90 and over, male, ethnicity (white, mixed, Asian, black, other and not stated), person living alone, rheumatoid arthritis marker, Elixhauser comorbidities, health conditions (high blood pressure, stroke, nervous system, lung disease and kidney disease), IMD income deprivation and dummy variables for each of the 60 months over the 5-year period

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