**The impact of waiting time on health gains from surgery: Evidence from a national patient reported outcomes dataset**

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**Abstract**

Reducing waiting times has been a major focus of the English National Health Service (NHS) for many years but little is known about the impact on health outcomes. The collection of data on Patient Reported Outcome Measures (PROMs) for all patients undergoing four large-volume procedures facilitates analysis of the impact of waiting times on patient outcomes. The availability of PROMs before and after surgery allows us to estimate the impact of waiting times on the effectiveness of treatment, controlling for pre-surgery health and the endogeneity of waiting times caused by prioritisation with respect to pre-intervention health. We find that waiting time has a negative and statistically significant impact on the health gain from hip and knee replacement surgery and no impact on the effectiveness of varicose vein and hernia surgery. The magnitude of this effect at patient level is small, 0.1% of the outcome measure range for each additional week of waiting. However, the value of this effect is substantially larger than existing estimates of the disutility experienced during the waiting period. The health losses associated with an additional week of waiting for annual populations of hip and knee replacement patients are worth £11.1 million and £11.5 million respectively.

[199 words]

# Introduction

Between 1997 and 2009, the English Department of Health virtually eliminated the very long waiting times that some patients experienced for elective treatments (Smith & Sutton, 2013). The main explanation was likely to have been the adoption of a “targets and terror” regime, comprising highly-publicised maximum waiting time limits which were rigorously monitored and accompanied by strict sanctioning of managers for under-performance. Maximum waiting times for elective treatments were reduced from over 18 months to 18 weeks with little evidence of negative side-effects (Propper, et al., 2010). However, this regime was also supported by a substantial increase in resources, encouragement of patient choice of provider, increased competition and provider diversity, and reformed provider payment methods (Smith & Sutton, 2013). In 2009, a new set of patient entitlements were published in the form of an ‘NHS Constitution’. This formalised the right to treatment within 18 weeks of first referral from a general practitioner unless cancer is suspected, in which case patients have the right to see a specialist within two weeks.

Waiting times play a critical role in the management of public health systems by managing and prioritising demand (Borowitz, et al., 2013). However, waiting for treatment can also be associated with a loss of social welfare for three reasons (Cullis, et al., 2000) (Koopmanschap, et al., 2005). First, benefits received now are worth more than those received later because of time preference. Second, individuals on a waiting list can be expected to be in less good health whilst on the waiting list than after treatment. Third, waiting for treatment can affect the effectiveness or health gain of an intervention such as surgery. (Propper, 1995) estimated the disutility of time spent on a waiting list, which may relate to either or both of the first two reasons, to be £50 per patient per month at 1991 prices by measuring the population’s willingness-to-pay for a shorter wait. However it is unlikely that this estimate includes consideration of any long term health impacts of waiting.

Findings of the impact of waiting time on outcomes in the urgent surgical context of coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) for coronary artery disease (Sari et al., 2007; Légaré et al., 2005; Sampalis et al., 2001; Koch et al., 1997) seem to point to detrimental effects for longer pre-operative waits. Two studies comparing outcomes for people who underwent a CABG with varying degrees of urgency ranging from urgent (immediate) to semi-urgent (median 52 days) found no difference between groups in mortality or morbidity (major adverse cardiac events, prolonged intensive care treatment) after attempting to control for patient characteristics which influence the length of waiting and outcomes (Sari et al., 2007; Légaré et al., 2005). Conversely, other studies report associations of poorer pre-operative SF-36 domain scores, higher rates of post-operative adverse events, an increased likelihood of not returning to work (Sampalis et al., 2001), and a lower success rate of PTCA (Koch et al., 1997). Associations of poorer outcomes with longer waits were found in the studies considering longer waiting times of 12 weeks or more (Koch et al., 1997) or greater than 97 days (Sampalis et al., 2001).

The existing evidence of the impact of waiting time on health outcomes for less urgent treatment is less conclusive. Randomised controlled trials of alternative scheduling of rheumatology appointments (Hurst, et al., 2000) or joint replacement (Tuominen, et al., 2010; Hirvonen, et al., 2007; Hirvonen et al., 2007) show that longer waiting time for treatment is not associated with poorer health status at admission, nor poorer post-treatment outcomes. Findings from studies using observational data are more equivocal. A number of studies of joint replacement have found that waiting longer for treatment is associated with poorer pre-treatment health status (Noseworthy, et al., 2005; Fielden et al., 2005), which in turn is associated with poorer post-treatment outcomes (Noseworthy, et al., 2005; Garbuz, et al., 2006; Ostendorf et al., 2004; Desmeules et al., 2012; Desmeules et al., 2010). While patients with poorer pre-treatment health status may gain more from treatment, post-treatment health status remains lower than those who received treatment more quickly (Hajat, et al., 2002; Fielden et al., 2005). Similarly, studies of patients waiting for varicose vein surgery found evidence of significant deterioration in both pre- (Kelly et al., 2001) and post-treatment outcomes (Sarin, et al., 1993). Although these conclusions are supported by findings in other clinical areas, for example chronic pain (Lynch, et al., 2008), other studies of joint replacement (Escobar, et al., 2009; Brealey et al., 2012), varicose veins, inguinal hernia and gallstones (Oudhoff, et al., 2007) find no association between waiting times and outcomes, though anxiety may increase with length of waiting time (Oudhoff, et al., 2007).

The reasons for the conflicting evidence are unclear. The randomised controlled trials have focused on comparing routine waiting times with faster access to treatment. In these studies, fast access ranged from 1 to 3 months (Hurst, et al., 2000; Tuominen, et al., 2010) whilst routine waiting times ranged from 3 to 8 months (Hurst, et al., 2000; Tuominen, et al., 2010). In contrast, the observational studies that find significant, negative impacts of waiting time on outcomes arise from long waits, typically of 6-12 months or longer (Noseworthy, et al., 2005; Hajat, et al., 2002; Sarin, et al., 1993). It is possible that the waiting times in the randomised controlled trials were not sufficiently long to influence pre-treatment health or post-treatment outcomes.

The trials also exclude high proportions of eligible participants for refusing consent, limiting the generalizability of results. In addition, there was overlap in waiting times in faster access (intervention) and routine (control) groups which may dilute any difference in outcome. However, observational studies have either been limited by small sample sizes (Noseworthy, et al., 2005; Garbuz, et al., 2006; Oudhoff, et al., 2007), a limited set of covariates to control for confounders which may affect both waiting times and outcomes (Garbuz, et al., 2006), or reliance on waiting times reported by patients (Hajat, et al., 2002).

One further potential explanation is the outcome measures used to estimate the impact on health. The randomised controlled trials used generic health-related quality of life measures (Tuominen, et al., 2010; Hurst, et al., 2000; Hirvonen, et al., 2007) whereas observational studies have used more disease-specific measures of function (Noseworthy, et al., 2005; Hajat, et al., 2002) which may be more sensitive to specific symptoms.

There are currently no estimates of the value of the long-term impacts of waiting for surgery on post-surgery health. Since 2009, providers of elective surgery funded by the NHS in England have been required to collect and submit Patient Reported Outcome Measures (PROMs) for patients undergoing four large-volume procedures: hip replacement; knee replacement; inguinal hernia; and varicose veins. We use this large and rich dataset to provide new evidence on how waiting times affect outcomes. By using a large database with pre- and post-intervention generic and disease specific measures collected on all patients in England, our analysis improves upon the previous literature. We are also able to control for a broad set of covariates which may affect waiting times and/or health outcomes. We focus our interest on the two generic measures of health-related quality of life, the EQ-5D index and EQ-VAS, and a disease-specific measure for three of the four procedures, the Oxford Hip Score, the Oxford Knee Score and the Aberdeen Varicose Vein Score. We also examine reported satisfaction with the procedure post-surgery, patient perceptions of the success of the intervention, and self-assessed general health.

# Data

We use Patient Reported Outcomes Measures (PROMs) data linked to the Hospital Episode Statistics (HES) database, which contains standardised information on all hospital admissions in the English NHS. The PROMs are patient-level data collected from all providers of NHS-funded care for four large-volume procedures: hip replacement, knee replacement, hernia repair, and varicose veins. The data have been collected since the 1st April 2009.

Patients are surveyed before and after surgery, using paper-based self-completion questionnaires. The pre--surgery questionnaires collect information on generic health-related quality of life measures (EQ5D-3L (referred to hereafter as EQ-5D), EQ-VAS, self-assessed health) and disease specific measures (the Oxford Hip Score (OHS), the Oxford Knee Score (OKS) and the Aberdeen Varicose Vein Questionnaire (AVVQ)). The pre-surgery questionnaire can be administered to patients on the day of admission by hospital staff, or at any time during the interval between a patient being passed fit for surgery and the intervention taking place ( Department of Health, 2008).

The same patient health information is collected again with the post-surgery questionnaire. In addition, the post-surgery questionnaire collects information on patient satisfaction with the procedure and their perception of the success of the intervention. These questionnaires are sent out by the Health and Social Care Information Centre via a postal survey approximately 6 months after the surgery date in the case of hip replacement and knee replacement, and 3 months after surgery for varicose vein and hernia repair.

The EQ-5D questionnaire asks patients to classify themselves as having one of three levels of health in each of five dimensions of health – mobility, self-care, usual activities (all three scored as no problems/some problems/unable), pain/discomfort and anxiety/depression (both scored as no/moderate/extreme). This results in an EQ-5D health profile for a patient. A preference-based societal utility estimate can also be assigned to the EQ5D profile (Dolan, 1997), known as the EQ-5D index. The PROMs initiative also collects information on the visual analogue scale, the EQ-VAS, which records each patient’s overall assessment of their health on a scale from 100 (best imaginable health) to 0 (worst imaginable health) and patient’s self-assessed health: “In general would you say your health is...”, with five response categories ranging from “Poor” to “Excellent”.

The PROMs database offers a very large sample size of patients containing information on health (frequency and duration of symptoms; previous surgery, disability, pre-existing conditions, post-surgery degree of recovery, disease-specific and generic measures of self-reported health) and socio-demographic characteristics (age, sex, and living arrangements). To measure other pre-existing health conditions, patients are asked “[h]ave you been told by a doctor that you have any of the following?” and are requested to tick all that apply from a list of 12 conditions. The living arrangements question asks patients to report their living arrangements in one of four broad categories: “I live with partner/spouse/family/friends”; “I live alone”; “I live in a nursing home, hospital or other long-term care home”; and “Other”.

The sample we analyse is for patients admitted for surgery between April 1, 2009 and November 1, 2010. This was the latest date for which data from the post-surgery questionnaires were available at the time we requested the data. We only keep observations for which the status of the post-surgery instrument is complete; this leaves us with 60% of hip replacement, 59% of knee replacement, 55% of varicose vein, and 63% of hernia repair records. We also discard a small number of observations with duplicate episode identifiers.

The current waiting times policy guarantee refers to the total period between referral from a general practitioner and receipt of treatment, but we focus on the delay between when the specialist decides that the patient requires treatment and the treatment date. This is commonly called ‘the inpatient wait’. We eliminated just under 1.5% of the sample with excessively long waiting times longer than 30 weeks. These are likely to be coding errors or delays caused by exceptional factors that may be related to the expected gains from treatment (e.g. the patient is not fit for surgery or is undergoing other treatments).

We augment the database by adding two continuous measures of income and education/skills deprivation from the Index of Multiple Deprivation. Socio-economic characteristics may affect waiting times (Laudicella, et al., 2012) and health outcomes. These are measured for 32,482 small geographical areas called lower-level super output areas (LSOAs) and attached to patients on the basis of their area of residence. The income deprivation measure represents the proportion of the population receiving State benefits on the grounds of low income. The education measure is a composite of educational attainment from Key Stage 2 (the stage of learning in the English National Curriculum covering ages 7 to 11 years) of higher education in children and young people and the prevalence of formal educational qualifications in the working-age population.

We analyse samples of 29,303 hip replacement patients, 32,602 knee replacement patients, 9,184 varicose vein patients, and 22,889 hernia repair patients.

# Methods

## Model set-up

The timing of the health measures is the most important consideration when modelling the impact of waiting times on patient reported outcome measures. Some of the pre-surgery health variables are time-invariant (e.g. gender, certain health conditions) or time-defined (age, length of symptoms), so we can construct a set of determinants of health as of the date of the consultant’s decision to admit. We study the impact of the length of the period of waiting which starts with the date of the consultant’s decision to admit the patient and ends with the patient’s admission to hospital for surgery.

The analysis needs to account for the fact that hospitals are likely to prioritise their waiting lists according to the health status of patients. We benefit from the rich health information in the PROMs database to control for the potential endogeneity of waiting time. We introduce a broad set of health measures and personal characteristics recorded at the date of the pre-surgery questionnaire. We also introduce a full set of provider dummy variables (or fixed effects) to control for heterogeneity across hospitals in their management of waiting lists and quality of care.

We begin by analysing how time-invariant patient characteristics correlate with waiting times using OLS regression. We then utilise OLS and ordered probit regression models to analyse post-surgery health outcomes as a function of waiting times for surgery. After controlling for a broad set of baseline health characteristics, patient demographic characteristics and provider effects, we test whether longer waits lead to worse post-surgery health outcomes as measured by generic (EQ-5D, EQ-VAS) and condition-specific (OHS, OKS, AVV) measures and self-assessed measures of health and surgery effectiveness.

Assume $h\_{ij}$ corresponds to the health status of the $i$-th patient, *i*=1,.., N, who received surgery at hospital $j$, $j=1, … , M.$ This variable is measured prior to surgery ($h\_{ij1}$) and following surgery ($h\_{ij2}$). We estimate:

$$h\_{ij2}=αh\_{ij1}+βX\_{ij}+δw\_{ij}+u\_{j}+ε\_{ij2} (1)$$

There are $M$ unobservable hospital-level effects, $u\_{j}$. $X\_{ij}$ is a vector of individual characteristics measured prior to surgery, $w\_{ij}$ is the individual’s waiting time and $ε\_{ij2}$ is the random component. Equation (1) is a value-added approach to estimating the health production function and includes the baseline health outcome which, conditional on the other individual characteristics, is assumed to be a sufficient statistic for the individual’s unobserved health history.

The effect of waiting times on health cannot be signed *a priori*. Waiting times might affect both pre-surgery health (because health deteriorates during the waiting period) and post-surgery health through a reduced capacity to benefit from the intervention. Hence, the coefficient on waiting times would be negative. Alternatively, patients might be prioritised according to their pre-intervention health to maximise the potential to gain or restore health. In this case, the coefficient on waiting times could be positive.

## Valuation of the health losses

Following estimation of the impact of waiting time on outcomes at individual level, we estimate the value of an additional week of waiting for the entire population of treated patients. To do so, we have to assume a period of time over which the health-related quality-of-life loss will be experienced. We assume that the health loss observed 3 or 6 months post-surgery is permanent and estimate its duration by applying gender and year-of-age specific life expectancy estimates taken from the 2008-2010 Interim Life Tables from the Office for National Statistics (Ofﬁce for National Statistics, 2011) to the treated population. We discount future quality-adjusted life years using the annual rate of 3.5% specified by NICE in their reference case (NICE, 2008). We apply the estimates of waiting times on the EQ-5D index to calculate the change in quality-adjusted life expectancy for an additional week of waiting per patient and value this change using the NICE estimate of £20,000 for life year (NICE, 2013).

# Results

## Descriptive statistics

Table 1 presents the summary statistics. The average age of patients undergoing hip-replacement or knee-replacement surgery was approximately 69 years, which is higher than the average age for varicose patients (53 years) or for hernia repair patients (62 years). Approximately 60 % of hip and knee patients were women. Most varicose vein patients were women (65%), while most hernia repair patients were men. The average patient in each surgical category lives in an area where 12-14% of the population receive state benefits on the grounds of low income.

Of all patients admitted to hospital for elective hip replacement, 10% have previously had hip replacement surgery. Seven percent of knee patients had previously been admitted for knee replacement surgery, and 4% of the varicose vein patients had previous surgery for the same condition. Surprisingly, we find that 87% of patients treated for hernia repair have had a previous surgery for that. The three most prevalent health problems among hip, knee and hernia patients were arthritis, high blood pressure, and heart disease. Among varicose vein patients the three health conditions are high blood pressure, arthritis, and problems with circulation. Two-thirds of hip patients and half of knee patients have had symptoms for 1-5 years. Most patients undergoing varicose veins or hernia surgery had problems for less than one year. Approximately 60% of hip or knee replacement patients have some type of disability, while approximately 10% of varicose vein or hernia repair patients suffer from disability.

A half of hip and a third of knee patients reported some problems with self-care, while most patients with vein or hernia problems did not have any issues with self-care. A third of hip and knee patients had moderate anxiety/depression, while majority of patients with vein or hernia problems suffered from anxiety/depression. Almost all hip or knee patients had some problems with mobility, while only a fifth of vein or hernia patients have mobility problems. The majority of hip or knee patients experienced some problems with performing their usual activities. Only a fifth of vein and hernia patients reported some problems with their usual activities.

Patients, on average, waited 78 days (10.8 weeks) for hip replacement, 79 days (10.9 weeks) for knee repair, 70 days (9.8 weeks) for varicose vein surgery, 61 days (8.3 week) for hernia repair. We observe large gains in unadjusted health for hip and knee patients as measured by generic and condition-specific metrics. For varicose veins and hernia repair patients we find small changes in the EQ5D score, no changes in the EQ-VAS score, and a decline in the AVV score.

Approximately 85% of hip patients, 87% of knee patients, 91% of varicose vein patients, and 95% of hernia patients reported that their problems were better following the surgery. Approximately 91% of hip patients assessed the results of the surgery as “good”, “very good”, or “excellent”. The respective percentages for knee, vein, and hernia patients are 82, 87, and 92. 80% of hip patients ranked their post-surgery health as good, very good, or excellent. 73, 90, and 86% are the respective numbers for knee, vein, and hernia patients.

## Regression Results

Table 2 reports the results from ordinary least squares (OLS) regression of waiting times on time-invariant and time-defined variables. Women waited longer than men for knee replacement surgery. We find that older patients waited longer for hip replacement surgery, but the effect is non-linear. No age effect is observed in waiting times for the other three types of surgery. Living alone is associated with longer waiting times for varicose vein surgery, but not for any of the other treatments. Patients who had had the symptoms for a longer period of time waited longer for hip and knee surgery. Patients who had previously had varicose vein surgery waited longer for treatment, while patients with previous hernia surgery waited a shorter period. Hip patients who did not have a disability experienced longer waits.

There is no consistent pattern in the effects of other pre-existing health conditions on waiting times. Lung disease, liver disease, and arthritis were associated with longer waits for hip replacement. Heart disease, stroke, and kidney disease were associated with longer waits for knee replacement surgery, while depression was associated with shorter waiting times. None of the pre-existing conditions affected waiting times for varicose vein surgery. Patients with heart disease and high blood pressure waited longer for hernia repair surgery.

Table 3 reports the estimated coefficients on the waiting times variables from the OLS regressions of the post-surgery PROMs. To obtain coefficients on similar scales across measures, we multiplied the EQ-5D index scores by 100 and rescaled the disease-specific scores to run from zero (worst state) to 100 (best state). The waiting time between the decision to admit and admission for treatment had a negative and statistically significant effect on all post-surgery measures of health for hip and knee replacement. An additional week of waiting reduced the EQ-VAS, EQ-5D, and OHS scores of hip replacement patients by 0.06%, 0.05%, and 0.1%, respectively. In the case of knee replacement, an additional week on the waiting list reduced the EQ-VAS, EQ-5D, and OKS scores by 0.06%, 0.06%, and 0.04%. The effects of waiting time on outcomes for varicose vein and hernia repair surgery were much smaller in magnitude and statistically insignificant.

Table 4 shows the estimates for the remaining patient specific covariates. They include patient gender and age, and age polynomials of second and third degree. We controlled for pre-surgery health scores and generic health measures measured prior to surgery. The coefficient estimates on the variables “general health”, “self-care”, “mobility”, “activity”, “pain/discomfort”, “anxiety” should be interpreted relative to the excluded category. A similar interpretation should be applied to the “living arrangements” and “length of symptoms” variables. We have also controlled for different pre-existing health conditions. Patients with higher health scores at the date of completion of the pre-surgery questionnaire had higher post-surgery scores. Two dimensions of the EQ5D index, self-care and anxiety, had negative and significant impacts on post-surgery scores across all four categories of patients. We find that pre-surgery problems with mobility impacted on post-surgery health for varicose vein and hernia patients.

Several pre-existing health problems were found to be negatively and significantly associated with post-surgery scores for all three outcomes. For hip patients, these conditions were heart disease, problems with circulation, diabetes, depression, and arthritis. Heart disease, circulation, and depression impacted negatively on the post-surgery health of knee patients. For varicose vein patients, these conditions were heart disease, circulation, depression, and arthritis. The post-surgery health of hernia patients was negatively affected by the presence of circulation problems and arthritis.

Hip and knee patients who had had previous surgery reported substantially lower post-surgery health. The results for varicose vein patients show lower EQ5D and EQ-VAS scores, and slightly higher AVV scores. The EQ5D and EQ-VAS scores were higher for hernia patients who had had previous surgery.

Hip patients from income-deprived areas reported lower EQ5D and Oxford Hip Scores. Hernia patients from income deprived areas had lower EQ5D and EQ-VAS scores.

Table 5 presents the marginal effects of waiting times on the three categorical variables measuring patient satisfaction with, and perception of the benefits of, their surgery. Across all types of surgery we find that longer waits decreased the probability that patients assessed the state of their post-surgery problems as “much better” compared to before. The probabilities associated with the remaining categories - “a little better”, “about the same”, “a little worse”, “much worse” - increase. The results are statistically significant for hip, knee, and varicose vein patients, but not for patients who underwent hernia repair surgery.

Longer waits decreased the probability of reporting excellent results from hip surgery and increased the probability of perceiving the outcomes as “very good”, “good”,” fair”, or “poor”. We find that longer waits lowered the probability of reporting results from varicose vein surgery as “excellent” and “very good” and increased the probability of reporting the other categories. No statistically significant results were found for knee surgery and hernia repair.

We also find that longer waits decreased the probability of patients reporting excellent or very good results from hip, knee, or varicose vein surgery. They were associated with higher probabilities of self-reporting health as “good”,” fair”, or “poor”, though the effects are not statistically significant. For hernia patients, we find that longer waiting times were associated with increased probabilities of reporting post-surgery health to be excellent or very good and decreased probabilities of reporting health to be good, fair, or poor. However, these marginal effects are not statistically significant.

## Value of the health losses

Based on the estimated life expectancy of patients, we estimate the value of reducing waiting times by a week to be approximately £153 per hip replacement patient and £149 per knee replacement patient. The volume of PROMs-eligible procedures in 2011/12 was 72,338 hip replacements and 77,441 knee replacements (Health and Social Care Information Centre, 2013). Using these volumes, we estimate that the value of the health losses associated with an increase in average waiting times of one week would be £11.1million for hip replacements and £11.5million for knee replacements.

# Discussion

The availability of pre- and post-surgery outcomes in the national PROMs dataset provides a rare opportunity to estimate the value of the health-related quality of life losses associated with waiting for elective surgery. Previous estimates have only captured the value of the disutility of time spent on a waiting list. Our contribution is to estimate the effect of the length of time that a patient waits between the specialist’s decision to treat and the receipt of treatment on the reduction in health gain from surgery using a wide range of health measures for four large volume elective procedures.

Our findings indicate that longer inpatient waiting times have a negative and statistically significant effect on all of the post-surgery outcomes for hip and knee replacement patients. We do not find any evidence of impact on health outcomes for varicose veins and inguinal hernia surgery. The results also show a decline in patient satisfaction from hip, knee, and varicose vein surgery and in reported success of surgery for hip replacement and varicose veins.

The magnitude of the effects on health outcomes for hip and knee replacement surgery at patient level appears small, at most 0.1% of the outcome measure range for each additional week of waiting. However, the value of the loss in health-related quality of life for each additional week of inpatient waiting equals £153 per hip replacement patient and £149 per knee replacement patient. These estimates are substantially larger than Propper’s (1995) estimates of the disutility of time spent on a waiting list, equivalent to £19 per week at 2013 prices. The value of the poorer long-term health outcomes associated with waiting for treatment therefore seem more important than the discomfort and delay experienced while waiting for treatment, even in a setting with maximum waiting time targets of 18 weeks.

A potential limitation of our analysis is that we focus on a limited set of procedures (hip replacement, knee replacement, varicose veins, and hernia repair). Future research would benefit from considering a wider range of interventions. We have also focused only on the length of time that patients wait between the specialist’s decision to offer treatment and the patient’s receipt of treatment, ‘the inpatient wait’. Future work could extend this analysis to include the delay between referral by a general practitioner and the date of the specialist’s decision as this is the focus of current English policy.

We have restricted our sample to patients who have completed both the pre- and post-surgery questionnaires. However, missing data on PROMs are of concern as inferences based on individuals with complete information could be misleading (Gomes, et al., 2015)Provider failure to administer the pre-operative questionnaire could potentially bias provider comparisons, but the effect of these differences would be captured by inclusion of provider fixed-effects in our analysis. Nonetheless, within-provider correlation between missing data, waiting times and outcomes could lead to biased estimates.

While we document a consistent decline in the health status of hip and knee patients as a result of waiting, we do not know what causes the change. The availability of PROMs prior to surgery does, however, allow us to control for the deterioration in health pre-surgery and endogeneity of waiting times caused by prioritisation based on pre-surgery health. However, the PROMs data collection initiative includes only one follow-up. This might not capture the full impact of waiting for treatment as individuals may recover at different rates and/or the health outcomes measured in the post-surgery questionnaire may be different from the outcomes experienced later on.

Our estimate of the decline in health-related quality of life due to an additional week of waiting is a new contribution to the literature which can be used as an indication of the value of the recent deterioration in NHS performance with respect to waiting times for elective treatment. Average waiting times reduced considerably from 42 weeks in 1999/00 to 12 weeks in 2009/10 for hip replacement and from 39 weeks to 13 weeks for knee replacement. If people today were waiting the same length of time as in 1999/00, the value of the associated health-related quality of life losses would be £635 million (£330 million for hip replacement). Since 2009/10 average waiting times for both hip and knee replacements have increased by one week, which is equivalent to a population health-related quality of life loss valued at £11.1 million for hip replacement patients and £11.5 million for knee replacement patients. The recent deterioration in NHS waiting times performance has a substantial health impact at population level, particularly if this reduction in health-related quality of life is sustained over time.

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 1: Summary Statistics** |  |  |  |  |
|  | Hip Replacement | Knee Replacement | Varicose Veins | Hernia Repair |
|  | Mean | Std. Dev | Mean | Std. Dev | Mean | Std. Dev | Mean | Std. Dev |
| **Patient Characteristics** |  |  |  |  |  |  |  |  |
| Age (years) | 68.4 | 10.9 | 69.14 | 9.8 | 52.7 | 14.1 | 61.8 | 14.69 |
| Female | 0.60 | 0.49 | 0.56 | 0.50 | 0.65 | 0.48 | 0.07 | 0.26 |
| Income deprivation | 0.12 | 0.09 | 0.13 | 0.10 | 0.14 | 0.10 | 0.12 | 0.09 |
| Education deprivation | 18.8 | 16.6 | 20.6 | 17.5 | 20.6 | 17.8 | 19.2 | 17.0 |
| Living arrangements |  |  |  |  |  |  |  |  |
|  Spouse/family/friends | 0.72 |  | 0.74 |  | 0.84 |  | 0.82 |  |
|  Alone | 0.27 |  | 0.25 |  | 0.15 |  | 0.17 |  |
|  Nursing home, Hospital | 0.02 |  | 0.01 |  | 0.00 |  | 0.01 |  |
|  Other | 0.04 |  | 0.04 |  | 0.01 |  | 0.05 |  |
| **Health History** |  |  |  |  |  |  |  |  |
| Previous surgery | 0.10 | 0.29 | 0.07 | 0.26 | 0.40 | 0.49 | 0.87 | 0.33 |
| Heart disease | 0.10 | 0.30 | 0.11 | 0.32 | 0.04 | 0.20 | 0.10 | 0.30 |
| High blood pressure | 0.40 | 0.49 | 0.46 | 0.50 | 0.18 | 0.39 | 0.29 | 0.45 |
| Stroke | 0.01 | 0.12 | 0.02 | 0.13 | 0.01 | 0.08 | 0.02 | 0.13 |
| Circulation | 0.07 | 0.26 | 0.09 | 0.29 | 0.16 | 0.37 | 0.05 | 0.22 |
| Lung disease | 0.06 | 0.24 | 0.07 | 0.25 | 0.04 | 0.19 | 0.06 | 0.24 |
| Diabetes | 0.09 | 0.28 | 0.12 | 0.33 | 0.03 | 0.18 | 0.05 | 0.22 |
| Kidney disease | 0.02 | 0.13 | 0.02 | 0.13 | 0.01 | 0.09 | 0.01 | 0.11 |
| Nervous system | 0.01 | 0.09 | 0.01 | 0.10 | 0.00 | 0.07 | 0.01 | 0.10 |
| Liver disease | 0.01 | 0.07 | 0.01 | 0.07 | 0.00 | 0.07 | 0.01 | 0.07 |
| Cancer | 0.05 | 0.21 | 0.04 | 0.20 | 0.02 | 0.14 | 0.05 | 0.21 |
| Depression | 0.07 | 0.25 | 0.07 | 0.26 | 0.07 | 0.25 | 0.04 | 0.20 |
| Arthritis | 0.71 | 0.46 | 0.77 | 0.42 | 0.18 | 0.39 | 0.18 | 0.38 |
| Disability | 0.62 | 0.48 | 0.63 | 0.48 | 0.10 | 0.30 | 0.13 | 0.33 |
| Length of symptoms |  |  |  |  |  |  |  |  |
|  <1 year | 0.15 |  | 0.05 |  | 0.97 |  | 0.67 |  |
|  1–5 years | 0.66 |  | 0.52 |  | 0.03 |  | 0.32 |  |
|  6-10 years | 0.11 |  | 0.21 |  | 0.00 |  | 0.00 |  |
|  >10 years | 0.08 |  | 0.21 |  | 0.00 |  | 0.00 |  |
| Dimensions of the EQ-5D |  |  |  |  |  |  |  |  |
| Self-care |  |  |  |  |  |  |  |  |
| no problems | 0.44 |  | 0.68 |  | 0.97 |  | 0.96 |  |
| some problems | 0.54 |  | 0.31 |  | 0.03 |  | 0.04 |  |
| unable | 0.01 |  | 0.08 |  | 0.00 |  | 0.00 |  |
| Mobility |  |  |  |  |  |  |  |  |
| no problems | 0.06 |  | 0.06 |  | 0.78 |  | 0.79 |  |
| some problems | 0.93 |  | 0.94 |  | 0.22 |  | 0.21 |  |
| unable | 0.05 |  | 0.03 |  | 0.00 |  | 0.00 |  |
| Pain/Discomfort |  |  |  |  |  |  |  |  |
| no | 0.01 |  | 0.01 |  | 0.27 |  | 0.33 |  |
| moderate | 0.57 |  | 0.59 |  | 0.67 |  | 0.63 |  |
| extreme | 0.42 |  | 0.40 |  | 0.06 |  | 0.04 |  |
| Anxiety |  |  |  |  |  |  |  |  |
| no | 0.57 |  | 0.62 |  | 0.79 |  | 0.84 |  |
| moderate | 0.38 |  | 0.34 |  | 0.19 |  | 0.15 |  |
| extreme | 0.05 |  | 0.04 |  | 0.02 |  | 0.00 |  |
| Usual activity |  |  |  |  |  |  |  |  |
| no problems | 0.06 |  | 0.09 |  | 0.77 |  | 0.71 |  |
| some problems | 0.74 |  | 0.77 |  | 0.22 |  | 0.27 |  |
| unable | 0.2 |  | 0.14 |  | 0.01 |  | 0.02 |  |
| Waiting time variables |  |  |  |  |  |  |  |  |
| Wait b/n decision to admit and date of surgery (weeks) | 10.8 | 6.06 | 10.9 | 6.2 | 9.6 | 5.9 | 8.3 | 5.4 |
| Dependent variables |  |  |  |  |  |  |  |  |
| EQ-5D index (Q1) (-.594,1) | 0.35 | 0.32 | 0.4 | 0.31 | 0.77 | 0.21 | 0.79 | 0.2 |
| EQ-5D index (Q2) (-.594,1) | 0.76 | 0.26 | 0.7 | 0.27 | 0.86 | 0.2 | 0.87 | 0.19 |
| EQ-VAS (Q1) (0,100) | 66.14 | 21.01 | 68.69 | 19.21 | 80.23 | 15.67 | 80.24 | 14.76 |
| EQ-VAS (Q2) (0,100) | 75.16 | 18.27 | 71.86 | 18.68 | 79.74 | 16.2 | 79.18 | 15.97 |
| Oxford Hip Score (Q1) (0,48) | 18.09 | 8.36 |  |  |  |  |  |  |
| Oxford Hip Score (Q2) (0,48) | 37.84 | 9.46 |  |  |  |  |  |  |
| Oxford Knee Score (Q1) (0,48) |  |  | 18.77 | 7.76 |  |  |  |  |
| Oxford Knee Score (Q2) (0,48) |  |  | 33.53 | 10.15 |  |  |  |  |
| Aberdeen V.V. Score (Q1) (0,100) |  |  |  |  | 18.88 | 10.14 |  |  |
| Aberdeen V.V. Score (Q2) (0,100) |  |  |  |  | 10.95 | 9.92 |  |  |
| General Health (Q2) |  |  |  |  |  |  |  |  |
| Excellent | 0.08 |  | 0.05 |  | 0.14 |  | 0.11 |  |
| very good | 0.33 |  | 0.29 |  | 0.41 |  | 0.38 |  |
| Good | 0.39 |  | 0.43 |  | 0.35 |  | 0.37 |  |
| Fair | 0.17 |  | 0.2 |  | 0.09 |  | 0.12 |  |
| Poor | 0.03 |  | 0.03 |  | 0.02 |  | 0.02 |  |
| Overall, how are your hip problems now, compared to before your operation? |  |  |  |  |  |  |  |  |
| much better | 0.84 |  | 0.69 |  | 0.71 |  | 0.85 |  |
| a little better | 0.1 |  | 0.18 |  | 0.2 |  | 0.1 |  |
| about the same | 0.03 |  | 0.06 |  | 0.07 |  | 0.03 |  |
| a little worse | 0.02 |  | 0.04 |  | 0.02 |  | 0.02 |  |
| much worse | 0.01 |  | 0.03 |  | 0.01 |  | 0 |  |
| How would you describe the results of your operation? |  |  |  |  |  |  |  |  |
| Excellent | 0.37 |  | 0.22 |  | 0.22 |  | 0.34 |  |
| very good | 0.35 |  | 0.34 |  | 0.37 |  | 0.38 |  |
| Good | 0.19 |  | 0.26 |  | 0.27 |  | 0.2 |  |
| Fair | 0.07 |  | 0.13 |  | 0.1 |  | 0.06 |  |
| Poor | 0.02 |  | 0.04 |  | 0.04 |  | 0.02 |  |

**Table 2: Regression of waiting times on time-invariant and time-defined variables**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | Hip | Knee | VV | Hernia |
| Female | 0.0998 | 0.1445\* | 0.1843 | -0.1780 |
| Age | 0.2631\* | 0.0952 | -0.0139 | 0.0950 |
| Age2 | -0.0046\* | -0.0020 | 0.0009 | -0.0014 |
| Age3 | 0.0000\* | 0.0000 | -0.0000 | 0.0000 |
|  |  |  |  |  |
| Living arrangements |  |  |  |  |
| Alone | 0.1068 | -0.1222 | 0.5449\*\* | 0.1056 |
| Nursing home, hospital  | -0.2128 | 0.6366 | -0.6834 | 0.5968 |
| Other | 0.0157 | -0.6633 | -0.3449 | -0.7862 |
|  |  |  |  |  |
| Length of symptoms |  |  |  |  |
| 1–5 years | 0.9801\*\*\* | 0.8681\*\*\* | 0.4345 | 0.8773\*\*\* |
| 6-10 years | 1.1775\*\*\* | 0.9372\*\*\* | 0.4153 | - |
| >10 years | 1.5096\*\*\* | 0.9566\*\*\* | 0.4643 | - |
|  |  |  |  |  |
| Previous surgery | 0.2577 | 0.0567 | 0.4125\*\* | -0.4711\*\*\* |
| Heart disease | 0.1943 | 0.3845\*\*\* | 0.2241 | 0.3960\*\* |
| High blood pressure | 0.0576 | -0.0288 | 0.0607 | 0.1661\* |
| Stroke | 0.2043 | 0.5688\* | -0.0877 | -0.431 |
| Circulation | 0.0722 | 0.2388 | 0.0075 | 0.3229 |
| Lung disease | 0.3220\* | 0.2336 | 0.1482 | 0.2662 |
| Diabetes | 0.0409 | 0.0861 | -0.2521 | -0.2478 |
| Kidney disease | 0.0944 | 0.5398\* | 0.0779 | 0.0758 |
| Nervous system | -0.2970 | 0.4292 | -0.8330 | -0.6197 |
| Liver disease | 1.5669\* | -0.3542 | -0.0065 | 0.4842 |
| Cancer | -0.0884 | -0.1140 | 0.0354 | 0.0291 |
| Depression | -0.0942 | -0.3127\* | -0.4722 | -0.1458 |
| Arthritis | 0.1635\* | -0.0694 | -0.2723 | -0.0552 |
| No disability | 0.1808\* | -0.0018 | 0.2896 | -0.0418 |
|  |  |  |  |  |
| Income deprivation | 1.7469\* | 1.2099 | -1.0849 | -0.8851 |
| Education deprivation | -0.0065 | -0.0077 | -0.0034 | 0.0033 |
|   |  |  |  |  |
| N | 22687 | 24842 | 8525 | 21422 |
| Adjusted R2 | 0.2461 | 0.2415 | 0.1635 | 0.1874 |

Notes: \*\*\* p<0.001, \*\* p<0.01, \* p<0.05.

**Table 3: Coefficients on waiting times from the OLS regression of post-surgery health outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Hip Replacement | Knee Replacement | Varicose Veins | Hernia repair |
| EQ-5D index | -0.0620\*\* | -0.0587\*\* | 0.0247 | 0.0066 |
| EQ-VAS | -0.0488\* | -0.0646\*\* | -0.0074 | 0.0160 |
| Oxford Hip Score | -0.0951\*\*\* |  |  |  |
| Oxford Knee Score |  | -0.0385\*\*\* |  |  |
| Aberdeen Varicose Vein Score |  |  | 0.0195 |  |

Notes: \*\*\* p<0.001, \*\* p<0.01, \* p<0.05. To obtain coefficients on similar scales across measures, we have multiplied the EQ-5D index scores by 100 and rescaled the disease-specific scores to run from zero (worst state) to 100 (best state).

**Table 4: Coefficients on other covariates from the OLS regression of post-surgery health outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Hip | Knee | VV | Hernia |
|  | EQ-5D index | EQ-VAS | OHS | EQ-5D index | EQ-VAS | OKS | EQ-5D index | EQ-VAS | VV | EQ-5D index | EQ-VAS |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Female | -1.0790\*\*\* | -0.4004 | -1.8662\*\*\* | -0.0671 | -0.7093\*\* | -0.2795\* | -1.0980\*\*\* | -0.1128 | 1.3274\*\*\* | -0.6703\* | 0.2449 |
| Age | -0.4843 | -0.4222 | 0.1268 | -0.8070 | -2.0144\* | -0.1536 | -0.1661 | -0.1474 | -0.0332 | -0.7191\*\*\* | -0.3421\* |
| Age2 | 0.0113 | 0.0090 | 0.0011 | 0.0216 | 0.0392\*\* | 0.0071 | 0.0049 | 0.0033 | -0.0000 | 0.0147\*\*\* | 0.0067\* |
| Age3 | -0.0001\* | -0.0001 | -0.0000 | -0.0001\* | -0.0002\*\* | -0.0001 | -0.0000 | -0.0000 | 0.0000 | -0.0001\*\*\* | -0.0000\* |
| EQ-VAS |  | 0.0950\*\*\* |  |  | 0.1447\*\*\* |  | 0.2217\*\*\* |  | 0.2816\*\*\* |  |
| Oxford Hip Score  |  |  | 0.1807\*\*\* |  |  |  |  |  |  |  |  |
| Oxford Knee Score  |  |  |  |  |  | 0.2969\*\*\* |  |  |  |  |
| Aberdeen VV score  |  |  |  |  |  |  |  |  | 0.4870\*\*\* |  |
| General health | . | . | . |  |  |  |  |  |  |  |  |
| very good | -1.7047\*\*\* | -4.5459\*\*\* | -1.9914\*\*\* | -1.1656\* | -2.8331\*\*\* | -1.0581\*\* | -0.5559 | -3.9449\*\*\* | 0.8147\*\* | -1.0967\*\*\* | -4.3883\*\*\* |
| good | -3.6377\*\*\* | -9.2819\*\*\* | -4.7255\*\*\* | -3.0325\*\*\* | -8.0839\*\*\* | -2.3696\*\*\* | -1.9164\*\*\* | -9.7232\*\*\* | 1.4360\*\*\* | -2.6058\*\*\* | -9.3961\*\*\* |
| fair | -7.6658\*\*\* | -16.7913\*\*\* | -9.3636\*\*\* | -6.8585\*\*\* | -14.6396\*\*\* | -4.2612\*\*\* | -4.7753\*\*\* | -17.2299\*\*\* | 3.1715\*\*\* | -6.8305\*\*\* | -17.5233\*\*\* |
| poor | -11.2090\*\*\* | -20.8920\*\*\* | -11.5743\*\*\* | -11.4897\*\*\* | -20.5751\*\*\* | -6.0205\*\*\* | -7.3973\*\*\* | -21.9318\*\*\* | 4.1051\*\* | -13.8488\*\*\* | -24.6808\*\*\* |
| Self –care | . | . | . |  |  |  |  |  |  |  |  |
| some problems | -2.8991\*\*\* | -1.2410\*\*\* | -2.1828\*\*\* | -5.5492\*\*\* | -3.9094\*\*\* | -2.2372\*\*\* | -11.5141\*\*\* | -5.9064\*\*\* | 1.4455 | -8.5704\*\*\* | -3.0043\*\*\* |
| unable | -11.8124\*\*\* | -3.5864\* | -9.5033\*\*\* | -12.4958\*\*\* | -2.7844 | -2.3080\* | -18.8072 | -5.5422 | -1.1559 | -8.2578 | -1.0554 |
| Mobility | . | . | . | . | . | . | . | . | . | . | . |
| some problems | -0.0509 | -0.2474 | 1.4544\*\* | -0.2070 | 0.0672 | 0.6287\*\* | -3.8612\*\*\* | -1.7223\*\*\* | -0.0359 | -2.4967\*\*\* | -1.0969\*\*\* |
| unable | 0.6358 | 0.5046 | -0.3975 | -9.3029\*\* | -5.6524\* | -0.3554 | 2.8927 | 6.8707\* | 0.3750 | -2.1768 | -5.0428 |
| Pain/discomfort | . | . | . | . | . | . | . | . | . | . | . |
| moderate | -0.0527 | 2.4696\* | 0.8403 | -0.8047 | 2.2959\* | 0.8276 | -4.8668\*\*\* | 0.2425 | -0.2562 | -0.7998 | 0.0353 |
| extreme | -2.0830 | 1.1747 | 0.5962 | -4.5570\* | 0.9753 | 1.0966\* | -19.1383\*\*\* | -0.8965 | 2.0420\*\* | -1.9628 | -0.3405 |
| Anxiety/depression | . | . | . | . | . | . | . | . | . | . | . |
| moderate | -2.2654\*\*\* | -1.4132\*\*\* | -1.4509\*\*\* | -2.8156\*\*\* | -1.4610\*\*\* | -0.8812\*\*\* | -3.5697\*\*\* | -1.5956\*\*\* | 0.4315 | -1.9219\*\*\* | -1.1615\*\*\* |
| extreme | -5.7290\*\*\* | -2.1768\*\* | -3.7324\*\*\* | -7.4718\*\*\* | -3.1475\*\*\* | -2.4034\*\*\* | -11.5914\*\* | -2.9553 | -0.4369 | -5.3244\* | -2.4446 |
| Usual activity | . | . | . | . | . | . | . | . | . | . | . |
| some | -0.2599 | 0.0971 | 1.6382\*\* | -1.4717\*\*\* | -0.6914 | 0.2428 | -1.5877\*\* | 0.0684 | -0.4504 | -0.6823\* | 0.2168 |
| unable | -3.6047\*\*\* | -1.5463\* | -0.2624 | -5.9390\*\*\* | -3.4210\*\*\* | -0.6865\* | -9.0721\*\* | -0.2693 | -1.3554 | -1.8386 | 0.2434 |
| Living arrangements | . | . | . |  |  |  |  |  |  |  |  |
| alone | 0.2695 | 0.1425 | -0.2541 | -0.1432 | -0.2866 | -0.0929 | -1.5314\*\*\* | -0.9561\* | 0.8480\*\* | -0.8041\*\*\* | -0.9145\*\*\* |
| nursing home, hospital | -1.7616 | -4.5917 | -4.1824 | -5.8958 | -1.2162 | -2.5328 | -3.9739\* | -2.6378 | 6.0044\*\*\* | -1.3302 | -6.0960 |
| other | -1.9509 | -0.7780 | -1.6955 | -2.9014 | -1.5336 | -1.0979 | -1.1249 | -1.3953 | 0.5200 | 1.1698 | 1.6526 |
| Length of symptoms | . | . | . |  |  |  |  |  |  |  |  |
| 1–5 years | 0.2611 | 0.2081 | -0.2173 | -0.6751 | -0.2820 | -0.4308 | -0.7615 | 0.0425 | -1.3450 | 0.0120 | -0.2330 |
| 6-10 years | -1.6393 | -4.5116 | -3.8878 | -0.3031 | -0.1035 | 0.1295 | -1.0049 | 0.0959 | -1.2456 | . | . |
| >10 years | -0.9720 | -0.3562 | -1.3470 | -0.6071 | -0.5194 | -0.0766 | -1.8384\* | -0.4729 | -0.7383 | . | . |
| Previous surgery | -5.1801\*\*\* | -3.5853\*\*\* | -9.2586\*\*\* | -4.7056\*\*\* | -3.6072\*\*\* | -4.0602\*\*\* | -1.3014\*\*\* | -0.8161\* | 2.2459\*\*\* | 0.5619\* | 0.6512\* |
| Heart disease | -0.7627\* | -1.7502\*\*\* | -0.8444 | -0.9832\*\* | -2.0632\*\*\* | -0.3960 | 0.9241 | 0.2430 | -0.4865 | -0.3968 | -1.9350\*\*\* |
| High blood pressure | 0.5138\* | 0.0342 | 0.6560\* | 0.1304 | 0.1463 | 0.2941\* | -0.4286 | -0.6640 | 0.0797 | 0.1837 | 0.0802 |
| Stroke | -1.3142 | -1.7101 | -1.4793 | -1.6562 | -1.9591\* | -0.3362 | -4.1775 | 0.5439 | 0.5970 | 0.0580 | -0.3332 |
| Circulation | -2.5214\*\*\* | -2.4393\*\*\* | -4.6156\*\*\* | -2.1607\*\*\* | -1.7477\*\*\* | -2.1391\*\*\* | -1.2984\*\* | -1.6178\*\* | 1.1457\*\*\* | -2.4431\*\*\* | -1.5866\*\* |
| Lung disease | -0.4224 | -2.4676\*\*\* | -0.3402 | -0.4306 | -2.0936\*\*\* | -0.0056 | 0.2160 | -2.0730\* | 0.7421 | 0.7003\* | -1.9447\*\*\* |
| Diabetes | -1.0519\*\* | -1.4972\*\*\* | -1.5615\*\*\* | -0.5554 | -0.5281 | -0.7396\*\*\* | -0.6908 | 0.0570 | 0.2810 | 0.4909 | -0.9271\* |
| Kidney disease | -0.2341 | -0.7321 | 0.5737 | 1.8987\* | -0.8442 | 1.3903\*\* | -1.2518 | -3.6375 | -1.3452 | -0.9015 | 0.9835 |
| Nervous system | -2.1917 | -4.1839\*\* | -2.3885 | -4.5652\*\*\* | -7.3052\*\*\* | -0.9638 | 3.3122 | -1.8991 | 0.5892 | -3.0584\*\* | -3.9723\*\* |
| Liver disease | -4.5361\* | -4.3283\* | -4.3735 | -1.1691 | -2.7816 | -1.7162\* | 6.2649\*\* | 5.4478 | -0.1883 | 1.5406 | 1.2524 |
| Cancer | -0.2258 | -1.4442\* | 0.7376 | -0.1197 | -1.2961\* | -0.1559 | -2.0808\* | -1.4772 | 0.9915 | 0.2047 | -1.4811\*\* |
| Depression | -6.4887\*\*\* | -4.7375\*\*\* | -4.0938\*\*\* | -4.8615\*\*\* | -2.7926\*\*\* | -0.8871\*\*\* | -3.1017\*\*\* | -0.9850 | 0.3175 | -4.5456\*\*\* | -2.2052\*\*\* |
| Arthritis | -1.1247\*\*\* | -1.2533\*\*\* | -0.5938\* | -0.3423 | -0.3281 | 0.1667 | -1.8340\*\*\* | -1.7286\*\*\* | -0.6260\* | -2.5575\*\*\* | -1.4169\*\*\* |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Income deprivation | -6.1645\* | -5.4363 | -6.7787\* | -2.8592 | -4.0242 | -3.6618\*\* | -2.8272 | -5.4252 | 1.1884 | -5.6321\*\* | -6.3056\*\* |
| Education deprivation | -0.0209 | -0.0103 | -0.0498\*\* | -0.0363\*\* | -0.0139 | -0.0208\*\* | 0.0002 | 0.0156 | -0.0058 | 0.0115 | 0.0210 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| N | 18842 | 18719 | 19783 | 20504 | 20428 | 21260 | 7253 | 7332 | 7395 | 18413 | 18571 |
| Adjusted R2 | 0.2473 | 0.2710 | 0.2522 | 0.2742 | 0.3196 | 0.2727 | 0.3826 | 0.4068 | 0.3771 | 0.3440 | 0.4398 |

**Table 5 Marginal effects for waiting times variable from ordered probit regressions**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Hip | Knee | VV | Hernia |
|  |  |  |  |  |  |
| Overall, how are your hip problems now,  | Much better | -0.0012\*\* | -0.0013\* | -0.0028\*\*\* | -0.0001 |
| compared to before your operation? | A little better | 0.0006\*\* | 0.0005\* | 0.0014\*\*\* | 0.0000 |
|  | About the same | 0.0002\*\* | 0.0003\* | 0.0008\*\*\* | 0.0000 |
|  | A little worse | 0.0002\*\* | 0.0002\* | 0.0003\*\*\* | 0.0000 |
|  | Much worse | 0.0002\*\* | 0.0003\* | 0.0003\*\*\* | 0.0000 |
| How would you describe the results of your operation? | Excellent | -0.0015\*\* | -0.0007 | -0.0016\*\* | 0.0009 |
|  | Very good | 0.0002\*\* | -0.0002 | -0.0005\*\* | -0.0001 |
|  | Good | 0.0007\*\* | 0.0003 | 0.0009\*\* | -0.0005 |
|  | Fair | 0.0004\*\* | 0.0004 | 0.0008\*\* | -0.0002 |
|  | Poor | 0.0002\*\* | 0.0002 | 0.0004\*\* | -0.0001 |
| In general would you say your health is...? | Excellent | -0.0003 | -0.0002 | -0.0001 | 0.0005\* |
|  | Very good | -0.0005 | -0.0005 | -0.0001 | 0.0005\* |
|  | Good | 0.0002 | 0.0001 | 0.0001 | -0.0005\* |
|  | Fair | 0.0004 | 0.0004 | 0.0001 | -0.0004\* |
|  | Poor | 0.0001 | 0.0001 | 0.0000 | -0.0001\* |

Notes: \*\*\* p<0.001, \*\* p<0.01, \* p<0.05.