

The Relationship Between Patient-Reported Outcome Measures (PROMs) in Patients Undergoing Hip and Knee Joint Replacement Surgery and Social Deprivation on the Wirral

B. GOMPELS, N. DONNACHIE

Wirral University Teaching Hospital NHS Trust, Upton, UK.

Correspondence at: Dr Benjamin Gompels, Wirral University Teaching Hospital NHS Trust, Arrowe Park Road, Upton CH495PE, UK.
Email: b.gompels@nhs.net

Objective: This study aimed to investigate the association between patient-reported outcome measures (PROMs), both pre- and post-operatively, and socio-economic deprivation among patients undergoing hip and knee replacement surgeries in the diverse socioeconomic region of Wirral.

Methods: A retrospective cohort study was conducted, involving 1666 adult patients who underwent hip or knee replacement procedures between 2012 and 2019. Socioeconomic deprivation was assessed using the Index of Multiple Deprivation (IMD). Pre- and post-operative outcomes were measured using the Oxford Hip and Knee scores.

Results: The mean scores for both pre- and post-operative assessments (Q1 and Q2) exhibited a strong positive correlation with PROM scores, regardless of gender, across both hip and knee replacements. However, the mean difference in scores between Q1 and Q2 showed no significant correlation with the IMD decile. Notably, patients residing in areas of higher socioeconomic deprivation demonstrated lower PROMs both before and after the surgery.

Conclusion: The Oxford Hip and Knee scores are widely employed for evaluating health status in patients. In our study, these scores were influenced by IMD decile, supporting the holistic assessment approach employed by the treating unit, which does not rely solely on PROM scores as a trigger for arthroplasty discussions. Furthermore, our findings align with the practice of NHS Digital, which publishes PROM scores based on changes in PROM scores pre- and post-operation rather than absolute PROM scores. This approach appears to be less influenced by deprivation in the catchment area, as the improvement or change in scores was poorly correlated with socioeconomic factors.

Keywords: arthroplasty, hip, knee, socioeconomic deprivation, PROMS.

INTRODUCTION

Wirral University Teaching Hospital, an NHS foundation trust, serves a diverse population of approximately 400,000 people residing in the Wirral Peninsula, Ellesmere Port Neston, and West Cheshire¹. The region exhibits a wide range of socioeconomic conditions, as reflected in the Indices of Multiple Deprivation (IMD), which assess relative deprivation based on various factors such as income, employment, education, health, crime, housing, and living environment². Despite this diversity, the majority of patients receive treatment from the same musculoskeletal service. The decision to proceed with hip/knee replacement is guided by clinical history, physical examination, and radiographic confirmation of degenerative joint disease. Joint replacement is considered when significant degenerative joint disease

is confirmed, and conservative measures have not effectively addressed the patient's considerable pain or disability. Notably, the Oxford Hip/Knee Score is not utilized as a sole threshold for decision-making.

It is well recognised that there are geographic disparities in the provision and outcomes of joint replacement surgeries. The mandatory National Joint Registry (NJR) and Public Health England (PHE) offer valuable information at the level of Primary Care Trust (PCT), Clinical Commissioning Group (CCG), and Hospital Trust. These registries amalgamate data on joint replacement surgeries from hospitals and local family doctors, and they also report on procedure volumes and implant survivorship.

The study conducted was a retrospective analysis of 1666 patients living on the Wirral who underwent hip or knee replacement surgeries between 2012 and 2019. The primary objective was to investigate the potential

relationship between postcode-based IMD and Patient Reported Outcome Measures (PROMs). PROM scores were collected both before and approximately 6-12 months after the operation. IMD data, based on postcode information, were evaluated in terms of decile and ranking within the country.

METHODS

Data

Data from Hospital Episode Statistics (HES) was integrated with information from the National PROM database for all patients who underwent primary joint replacement surgery between 2012 and 2019. The PROM dataset comprised two patient questionnaires: the Oxford Hip Score (OHS) and the Oxford Knee Score (OKS). Before surgery, patients completed a questionnaire to assess their pre-operative health and functional status of the joint^{3,4}. This questionnaire was then repeated between 6 to 12 months postoperatively, depending on the response time, and can be found in Appendix 1.

To ensure data quality, PROM entries were meticulously collated and screened, resulting in a total of 5863 complete entries, which included both hip and knee replacements. Subsequently, the anonymised PROM data was merged with HES data in Excel, and entries were excluded if they couldn't be matched with a hospital admission. Entries with missing critical data within the HES episode, such as sex, DOB, age at operation, Q1/Q2 scores, postcode, and procedure, were also excluded. Following this process, a final cohort of 1841 patients remained. Duplicate data accounted for 80 patients, which were removed, and an additional 95 patients were eliminated from the dataset if their postcode was not located on the Wirral peninsula. A flow chart outlining this process can be found in Figure 5.

The primary outcomes of interest were the Questionnaire 1 score (Q1), Questionnaire 2 score (Q2), and the Q1/Q2 score difference. The PROM score was calculated using either the Oxford Hip Score (OHS) or Oxford Knee Score (OKS) from the pre-operative (Q1) and 6-12-month post-operative (Q2) questionnaires. Both OHS and OKS consist of 12 questions each, scored out of a maximum of 5, detailing the patient's pain and functional status in daily activities. Higher scores indicate lower pain levels and better functional status. These clinical tools, OHS, and OKS, are widely recognised and are reliable measures for assessing functional status and pain in patients undergoing joint replacement surgery^{5,6}.

The Indices of Multiple Deprivation (IMD) is a tool used to assess relative deprivation at the local level based on seven domains: income, employment, education, health, crime, housing, and living environment. Since its inception in 2000, IMD has been utilised to measure deprivation locally². The combined information from each domain is weighted to calculate an overall relative measure, which, in turn, is used to determine a nationwide rank of deprivation for each postcode. For research purposes, IMD is often divided into deciles or quintiles. An IMD decile of 1 represents the most socioeconomically deprived group in the country, while an IMD decile of 10 represents the least deprived.

In the analysis, OKS and OHS were stratified by sex, considering that previous studies have shown a higher prevalence of hip and knee osteoarthritis in females compared to males, along with lower PROM scores pre-operatively. Furthermore, despite experiencing more severe symptoms and greater disability, females are less likely to undergo joint replacement surgery^{7,8}.

Statistical methods

In this study, we examined the relationship between local deprivation, as measured by the IMD decile, and patient-reported outcome measures (PROMs) for joint replacements. We first calculated the mean Q1 score for each IMD decile across all joint replacements and repeated this process to determine the mean Q2 score and mean Q1/Q2 difference for each IMD decile. These mean scores were further analysed based on the type of joint replacement (hip or knee) and the patient's sex.

Next, we plotted the mean Q1, Q2, and Q1/Q2 differences for each IMD decile on individual scatter graphs. We then calculated the correlation coefficient and added a linear trend line to assess the relationship between the IMD decile mean and PROM scores.

To determine statistical significance, we calculated the p-value for each dataset, using both the IMD decile's nationwide rank and the corresponding Q1, Q2, and Q1/Q2 differences. A correlation was considered statistically significant if the p-value was less than 0.05.

RESULTS

Association between Social Deprivation Index and Q1 Score

Table 1 presents the correlation coefficients between Q1, Q2, and IMD decile for males and females who underwent hip and knee replacement surgeries. Our

Table I. — Correlation Co-efficient and P value for Hip and Knee replacement surgery vs IMD Decile

	Hip Replacement			Knee Replacement		
	M	F	Combined	M	F	Combined
Correlation Co-efficient Q1/IMD decile	0.78	0.42	0.77	0.62	0.84	0.83
Correlation Co-efficient Q2/IMD decile	0.73	0.72	0.74	0.92	0.65	0.83
Correlation Co-efficient of Q Difference vs IMD	0.31	0.21	0.22	-0.23	0.16	0.03
P value Q1/IMD rank	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005
P value Q2/IMD rank	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
P value Q Difference/IMD rank	0.09	0.19	0.04	0.82	0.02	0.11

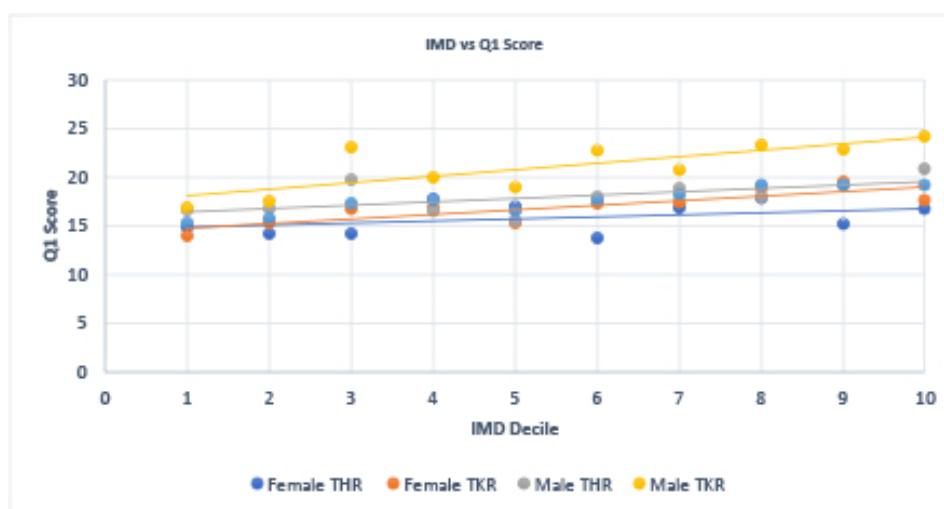


Figure 1. — Scatter graph of mean Q1 score vs IMD decile for male and female hip and knee replacement

analysis revealed a positive correlation between IMD decile and Q1 score, with a combined correlation coefficient of 0.83 ($p < 0.005$) for knee replacement surgery, and 0.77 ($p < 0.005$) for hip replacement surgery. Notably, the highest correlation coefficient was observed in female knee replacement surgery, reaching 0.84 ($p < 0.005$), while female hip replacement displayed the lowest correlation coefficient of 0.42, indicating a weaker association between deprivation and Q1 score.

In Figure 1, we present a scatter graph depicting the mean Q1 and Q2 values for each decile, with a trend line to visualise the strength of the correlation. The supplementary data includes the mean score for Q1/Q2 IMD decile for male and female hip and knee replacements, which were used to construct the scatter graph. This provides a clear representation of the relationship between deprivation and PROM scores for different joint replacements for both male and female patients.

Association between Social Deprivation Index and Q2 Score

The correlation coefficient between Q2 and IMD decile showed consistent results for knee replacement surgery, with a value of 0.83 ($p < 0.005$), mirroring that of the Q1 correlation. For hip replacement surgery, the correlation coefficient was slightly lower for Q2 at 0.74 ($p < 0.005$) compared to Q1 at 0.77 ($p < 0.005$). Among specific joint replacement categories, male knee replacements exhibited the highest correlation coefficient for Q2 at 0.92 ($p < 0.005$), while the lowest was observed in female knee replacements, registering 0.65 ($p < 0.005$). Detailed results are available in Table 1.

To visualise the relationship between Q2 and IMD decile, we plotted the mean Q2 scores for each IMD decile on a scatter graph (Figure 2). Notably, there is less observable variation between average Q2 scores for each IMD decile in male and female hip and knee

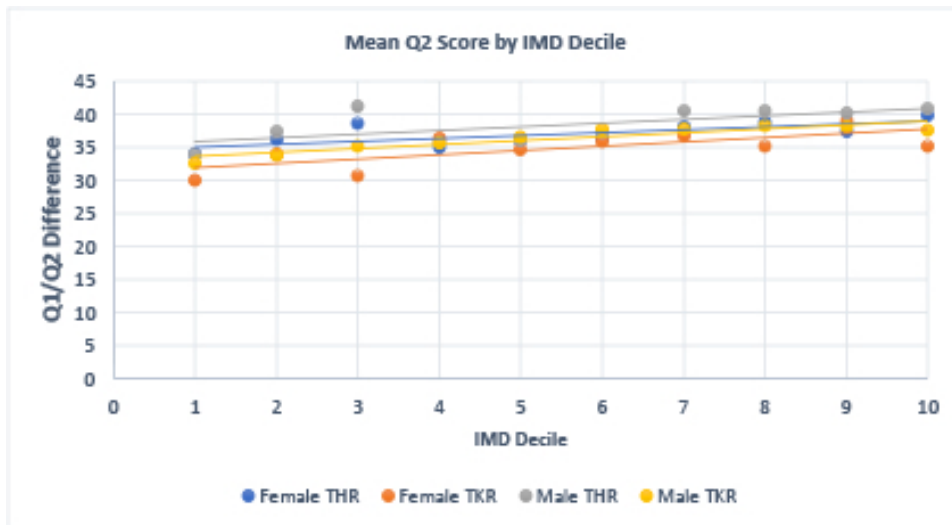


Figure 2. — Scatter graph of mean Q2 score vs IMD decile for male and female hip and knee replacement

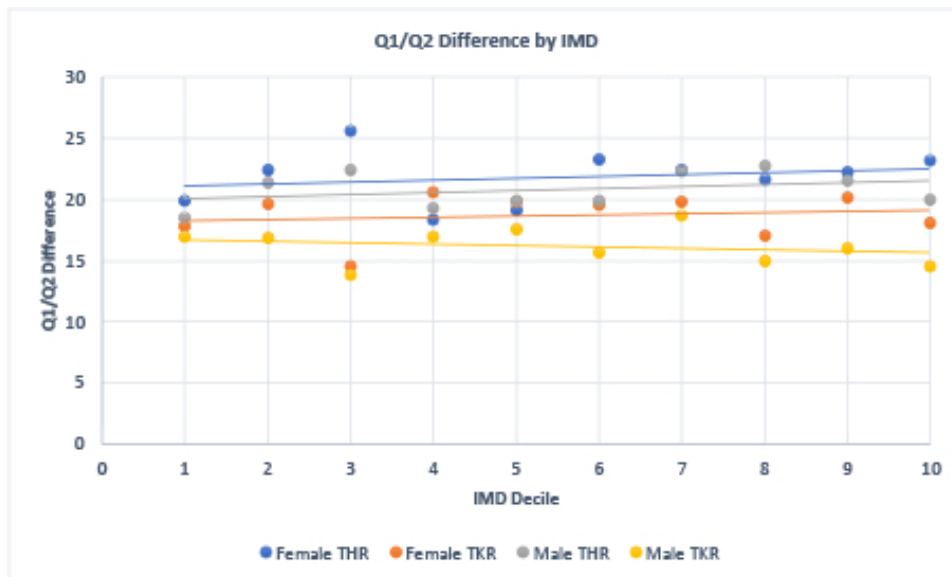


Figure 3. — Scatter graph of mean Q1/Q2 difference vs IMD decile for male and female hip and knee replacement

replacements compared to Q1. This observation is evident in the closer trend lines displayed in Figure 2 as compared to Figure 1. Supplementary data includes the mean Q2 score for each IMD decile, providing comprehensive insights into the correlation patterns between deprivation and PROM scores for different joint replacements and genders.

Association between the social deprivation index and Q difference

The correlation between IMD rank and the Q1/Q2 difference was limited, with the highest correlation

coefficient of 0.31 (p=0.9) observed in male hip replacements (Table 1). In contrast, male knee replacements exhibited a negative correlation of -0.23 (p=0.82) between Q1/Q2 and IMD. However, due to the lack of statistical significance, these results should be interpreted with caution.

To visualise the relationship further, we plotted the mean Q1/Q2 difference for each IMD decile on a scatter graph with a trendline (Figure 3). The flat trendline across both male and female knee and hip replacement surgeries suggests an absence of a positive correlation. The supplementary data includes the mean Q2 score

Table II. — Hip replacement surgery mean PROM score vs IMD Decile

IMD Decile	Patients	Q1 Mean	SD	Q2 Mean	SD	Q1/Q2 Difference	SD
1	150	15.1	7.7	31.0	10.6	17.5	11.9
2	83	16.2	7.0	33.9	10.6	18.5	11.0
3	63	19.3	8.5	32.6	11.2	14.2	12.0
4	88	18.0	8.0	36.2	9.1	19.2	10.3
5	66	16.8	6.2	35.5	9.6	18.9	10.7
6	96	19.8	7.4	36.8	9.1	17.8	9.5
7	107	18.6	7.7	37.1	9.2	19.4	11.7
8	96	20.5	8.0	36.4	8.5	16.3	9.5
9	102	20.9	7.4	38.8	6.8	18.5	8.4
10	59	20.3	8.5	36.3	8.8	16.7	10.9

DISCUSSION

The study revealed a statistically significant positive correlation between IMD decile and both Q1 and Q2 mean scores, indicating that higher levels of deprivation were associated with lower patient-reported health scores both before and after surgery.

Several factors could contribute to this association. PHE data showed a higher prevalence of musculoskeletal conditions in the most deprived areas, particularly among women. Social deprivation is also linked to higher rates of obesity and smoking, contributing to the development of osteoarthritis. Another recent study connected social deprivation with limitations in daily activities, which might impact Q1/Q2 scores^{9,10,11}.

However, the Q1/Q2 difference did not exhibit a statistically significant correlation with IMD decile for hip and knee replacements across both genders. This could be attributed to patients receiving the same treatment from the same musculoskeletal department, regardless of the level of deprivation. Furthermore, the variation in Q2 scores between 6 and 12 months postoperatively might also influence this lack of correlation. Studies have shown that there can be considerable variation in postoperative scores between 6 months and 12 months postoperatively for THR and TKR¹².

The study supports the use of Oxford Hip and Knee Scores as a valuable baseline for monitoring improvement or deterioration. However, using a finite score as a trigger for decision algorithms, as done in some Musculoskeletal Triage units, may disadvantage patients from higher IMD groups. The traditional approach of structured history, examination, and

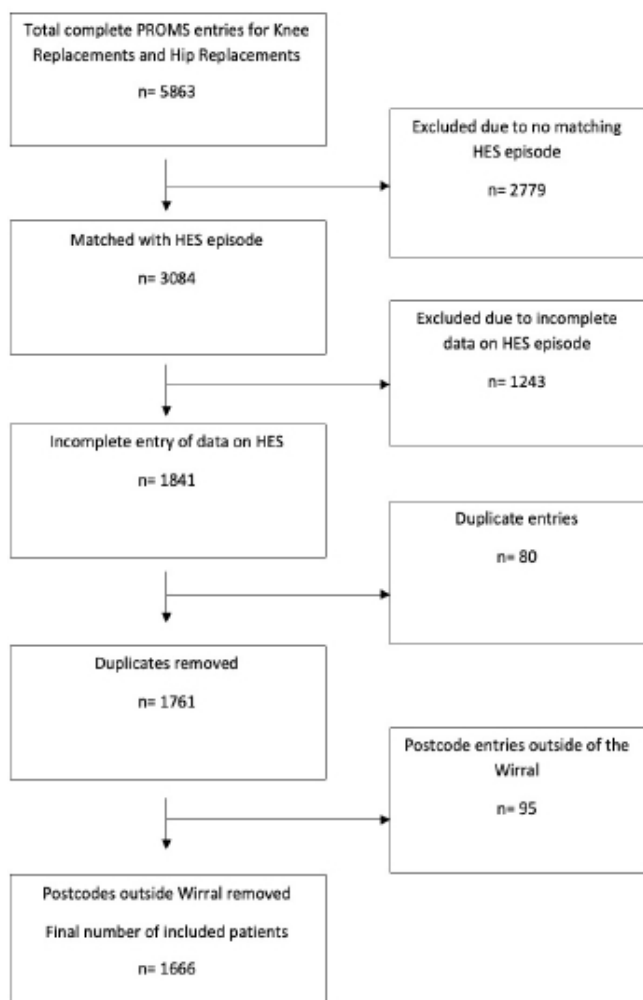


Figure 4. — Flow Chart for patient inclusion within study

for each IMD decile, which was used to construct this graph.

management discussion appears to be more appropriate. Understanding patient readiness and exploring coping strategies before and after the procedure is essential for achieving better patient satisfaction¹⁶. The NHS Digital PROMs publications focus on improvement/change in matched pre- and post-operative scores rather than absolute scores. This study supports this approach, indicating that using change is more beneficial than relying solely on an absolute score.

A strength of this study was its analysis of trends from a large cohort of 1666 patients over seven years. Additionally, the individual-level postcode analysis provided more detailed insights compared to previous studies at the CCG level¹³. Patients were all treated by the same musculoskeletal department, ensuring a relatively uniform standard of care among different patient groups. This paper is one of the first to investigate PROM data and IMD deprivation at a local level for knee and hip replacements managed at a single unit. However, the studies' limitations include its focus on a limited range of primary outcomes. Future work could explore broader primary outcomes, including patient-related factors, hospital factors, and multi-variant regression analysis to account for differences in healthcare between individual patients as seen in similar studies¹⁴.

Furthermore, incorporating quality-of-life data and qualitative research in future studies could provide a deeper understanding of the relationship between surgical outcomes, IMD, and patient experiences. Additional research is necessary to compare the Wirral peninsula with surrounding local CCGs and to examine if PROM scores are correlated with IMD decile to a similar extent. Regional variation in PROM scores has been observed in similar studies abroad¹⁵.

CONCLUSION

In conclusion, this study on the Wirral peninsula reveals a notable association between higher levels of socio-economic deprivation and lower PROM scores both before and after joint replacement surgery. However, despite this link, there is no statistically significant correlation between less social deprivation and overall improvement in PROM scores.

These findings highlight the impact of socio-economic deprivation on PROM scores, underscoring the need for comprehensive patient care strategies. They also provide valuable insights for outcome assessment and support the current approaches used in assessing and interpreting PROMs data. Future research could further explore the complex relationships between

socioeconomic factors, surgical outcomes, and patient experiences to improve healthcare practices in the context of joint replacement surgeries.

REFERENCES

1. Hospital WUT. Trust Structure | Wirral University Hospital NHS Foundation Trust. NHS 2021.
2. Communities, of Housing LGM. The English Indices of Deprivation 2019 Frequently Asked Questions. AssetsPublishingServiceGovUk 2021:3–4.
3. Dr Jill Dawson, Prof Ray Fitzpatrick. The Oxford Knee Score 2016.
4. The Oxford Hip Score 2016.
5. Bream E, Charman SC, Clift B, Murray D, Black N. Relationship between patients' and clinicians' assessments of health status before and after knee arthroplasty. *BMJ Quality & Safety* 2010;19. <https://doi.org/10.1136/qshc.2008.031310>.
6. Dawson J, Fitzpatrick R, Carr A, Murray D. QUESTIONNAIRE ON THE PERCEPTIONS OF PATIENTS ABOUT TOTAL HIP REPLACEMENT. *The Journal of Bone and Joint Surgery British Volume* 1996;78-B. <https://doi.org/10.1302/0301-620X.78B2.0780185>.
7. Mannion AF, Impellizzeri FM, Naal FD, Leunig M. Women Demonstrate More Pain and Worse Function Before THA but Comparable Results 12 Months After Surgery. *Clinical Orthopaedics & Related Research* 2015;473. <https://doi.org/10.1007/s11999-015-4479-3>.
8. Hawker GA, Wright JG, Coyte PC, Williams JI, Harvey B, Glazier R, et al. Differences between Men and Women in the Rate of Use of Hip and Knee Arthroplasty. *New England Journal of Medicine* 2000;342. <https://doi.org/10.1056/NEJM200004063421405>.
9. Office for Health Improvement and Disparities. Musculoskeletal health: trends, risk factors and disparities in England 2019.
10. Shaikh RA, Siahpush M, Singh GK, Tibbits M. Socioeconomic Status, Smoking, Alcohol use, Physical Activity, and Dietary Behavior as Determinants of Obesity and Body Mass Index in the United States: Findings from the National Health Interview Survey. *Int J MCH AIDS* 2015;4:22–34. <https://doi.org/10.21106/ijma.53>.
11. Kouraki A, Bast T, Ferguson E, Valdes AM. The association of socio-economic and psychological factors with limitations in day-to-day activity over 7 years in newly diagnosed osteoarthritis patients. *Sci Rep* 2022;12:943. <https://doi.org/10.1038/s41598-022-04781-3>.
12. Matharu GS, McBryde CW, Robb CA, Pynsent PB. An analysis of Oxford hip and knee scores following primary hip and knee replacement performed at a specialist centre. *The Bone & Joint Journal* 2014;96-B. <https://doi.org/10.1302/0301-620X.96B7.32479>.
13. Garriga C, Leal J, Sánchez-Santos MT, Arden N, Price A, Prieto-Alhambra D, et al. Geographical Variation in Outcomes of Primary Hip and Knee Replacement. *JAMA Network Open* 2019;2. <https://doi.org/10.1001/jamanetworkopen.2019.14325>.
14. Neuburger J, Hutchings A, Black N, van der Meulen JH. Socioeconomic differences in patient-reported outcomes after a hip or knee replacement in the English National Health Service. *Journal of Public Health* 2013;35. <https://doi.org/10.1093/pubmed/fds048>.
15. Oldsberg L, Garellick G, Friberg IO, Samulowitz A, Rolfson O, Nemes S. Geographical variations in patient-reported outcomes after total hip arthroplasty between 2008 - 2012. *BMC Health Services Research* 2019;19. <https://doi.org/10.1186/s12913-019-4171-5>.

16. Conner-Spady BL, Marshall DA, Hawker GA, Bohm E, Dunbar MJ, Frank C, et al. You'll know when you're ready: a qualitative study exploring how patients decide when the time

is right for joint replacement surgery. BMC Health Services Research 2014;14. <https://doi.org/10.1186/1472-6963-14-454>.

Supplementary Data

Table I. — Knee replacement surgery mean PROM score vs IMD Decile

IMD Decile	Patients	Q1 Mean	SD	Q2 Mean	SD	Q1/Q2 difference	SD
1	118	15.5	7.8	34.0	10.0	19.4	10.8
2	61	15.2	8.3	36.7	9.6	22.0	12.4
3	66	15.4	7.5	39.3	8.6	25.0	11.5
4	62	17.2	7.5	35.4	10.1	18.7	12.3
5	53	16.3	7.9	36.1	9.5	19.8	9.7
6	86	15.2	7.2	36.8	8.1	22.1	9.9
7	68	17.7	6.8	39.0	7.4	22.4	8.9
8	94	17.9	6.8	39.5	8.1	22.2	10.6
9	75	16.9	7.6	38.7	8.7	22.0	9.8