Socioeconomic status affects the early outcome of total hip replacement

This prospective study assessed the effect of social deprivation on the Oxford hip score at one year after total hip replacement. An analysis of 1312 patients undergoing 1359 primary total hip replacements for symptomatic osteoarthritis was performed over a 35-month period. Social deprivation was assessed using the Carstairs index. Those patients who were most deprived underwent surgery at an earlier age (p = 0.04), had more comorbidities (p = 0.02), increased severity of symptoms at presentation (p = 0.001), and were not as satisfied with their outcome (p = 0.03) compared with more affluent patients. There was a significant improvement in Oxford scores at 12 months relative to pre-operative scores for all socioeconomic categories (p < 0.001). Social deprivation was a significant independent predictor of mean improvement in Oxford scores at 12 months, after adjusting for confounding variables (p = 0.001). Deprivation was also associated with an increased risk of dislocation (odds ratio 5.3, p < 0.001) and mortality at 90 days (odds ratio 3.2, p = 0.02).

Outcome, risk of dislocation and early mortality after a total hip replacement are affected by the socioeconomic status of the patient.

Patient-reported outcome measures (PROMs) are used to assess functional outcome after total hip replacement (THR). There are several standardised and validated assessment tools available, including the Oxford hip score. In April 2009 the routine collection of PROMs was introduced into the National Health Service (NHS) in the United Kingdom in order to assess outcome after THR. The recent White Paper Equity and excellence: liberating the NHS is committed to expanding the validity, collection and use of PROMs for audit purposes.

Townsend wrote that “people can be said to be deprived if they lack types of diet, clothing, housing, household facilities and fuel and environment, education, working and social conditions, activities and facilities which are customary, or at least widely encouraged, in societies to which they belong”. Deprivation is an aetiological factor in the development of osteoarthritis of the hip and is a determinant of access to joint replacement, with the most deprived patients being less likely to undergo THR. Jenkins et al demonstrated that deprived patients undergoing THR had greater comorbidity, a higher prevalence of smoking and reduced improvement in Short-form (SF-36) scores post-operatively than more affluent patients.

Using PROMs to compare different patient groups in clinical studies and audit, and potentially for financial recompense upon meeting performance targets, may need to be adjusted to acknowledge case-mix variables. Deprivation could potentially bias the outcome after THR. Unlike the SF-36, which is a general wellbeing score, the Oxford hip score is specific to the hip and is therefore widely used as a PROM. Our purpose in this prospective study was to assess the effect of deprivation on the results of THR using the Oxford hip score as the PROM and an assessment of early post-operative complications.

Patients and Methods
During a 35-month period from January 2006 to November 2008, patients undergoing THR at the study centre had prospectively compiled outcome data recorded. Only those with primary osteoarthritis of the hip were included. Patient demographics and comorbidity were recorded pre-operatively by an assessor (DM). Categories of comorbidity included heart disease, hypertension, lung disease, vascular disease, neurological problems, stomach ulcer, kidney disease, liver disease, anaemia,
depression, back pain, pain in other joints, and diabetes. Alcohol use and smoking were not included. These categories were used in conjunction with the patient notes to calculate the Charlson index of comorbidity.\textsuperscript{11} The pre-operative body mass index (BMI) was obtained from the pre-operative assessment charts. The Oxford hip score\textsuperscript{2} (scored from 12 to 60, with 60 as the worst score) and the SF-12 score\textsuperscript{12} were recorded pre-operatively and at 12 months post-operatively.

Patient satisfaction was assessed at one year using eight questions (Table I) and each had a graded response using a visual analogue scale, from 1 (most satisfied) to 6 (least satisfied). This tool has been used to assess satisfaction after total knee replacement.\textsuperscript{13}

The Carstairs score\textsuperscript{14} was used to measure the level of deprivation.\textsuperscript{14} This score has been used to measure social deprivation in the Scottish population since 1981. Each postcode sector (n = 1010) in Scotland is assigned a standardised deprivation score.\textsuperscript{15} The Carstairs score was derived from assessment of overcrowding, male unemployment, social class and car ownership using the 2001 census data. The distribution of scores is assigned a categorical variable called the deprivation category (DEPCAT). This ranges from 1, being the most affluent, to 7, which is the most deprived. Each patient was assigned a DEPCAT using the 2001 census data according to their postcode at the time of operation.\textsuperscript{15}

The study centre serves a population of approximately 780 000 people.\textsuperscript{16} During the study period the most commonly performed THR involved a cemented Exeter femoral component (Stryker, Newbury, United Kingdom) with a Contemporary polyethylene acetabular component (Stryker). All patients were pre-assessed. A standardised rehabilitation protocol was used for all patients. The length of stay was recorded. Patients were reviewed at six weeks, six months and 12 months post-operatively.

Post-operative complications, including the need for transfusion, myocardial infarction, deep-vein thrombosis (DVT) with a positive Doppler scan, pulmonary embolism with radiological evidence, deep infection and early dislocation (before one year) were obtained from the hospital’s electronic database and patient notes. A 90-day mortality rate was calculated for all patients, including those with and those without completed outcome measures at 12 months. Mortality figures were obtained from the General Register Office for Scotland.

\textbf{Statistical analysis.} Analysis was performed using Statistical Package for the Social Sciences version 17.0 (SPSS Inc., Chicago, Illinois). Non-parametric methods for univariate analyses and ordinal logistic regression analyses for multivariate data were used, as the distribution was skewed (Fig. 1). DEPCAT categories 6 and 7 were combined as the number of patients in each of these groups was low; this gave a comparable number of patients relative to the other groups for analysis. The pre-operative Oxford score was stratified into quintiles (12 to 34, 35 to 40, 41 to 45, 46 to 50 and 51 to 60) to allow for categorical analysis. A p-value < 0.05 was considered statistically significant.

\begin{table}[h]
\centering
\caption{The eight satisfaction questions, graded one to six}
\begin{tabular}{|l|l|l|l|l|l|}
\hline
Question & Very satisfied & Dissatisfied \\
\hline
Overall satisfaction & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline
Pain relief & & & & & & \\
Increased function & & & & & & \\
Work/sports & & & & & & \\
Expectations & & & & & & \\
Would you have the operation again? & & & & & & \\
Would you recommend your operation? & & & & & & \\
Hospital experience & & & & & & \\
\hline
\end{tabular}
\end{table}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{Fig1.png}
\caption{Bar chart showing the distribution of the Oxford hip score at 12 months post-operatively in 1312 patients (1359 hips).}
\end{figure}
Results

There were 1359 THRs performed in 1312 patients during the study period that had complete 12-month follow-up data. The mean age of the patients was 68.1 years (36 to 92) and the modal age range was 65 to 74 years, with 481 patients in this range. Table II demonstrates patient demographics, comorbidity and age-related Charlson scores, and body mass index (BMI) according to deprivation category (DEPCAT) group. A significant difference was observed between the groups for both age (univariate logistic regression, $p = 0.04$) and number of comorbidities (univariate logistic regression, $p = 0.02$), as more deprived patients were younger at the time of surgery and had more comorbidities. However, the mean Charlson index did not differ significantly between the groups (univariate logistic regression, $p = 0.09$). There was a greater proportion of women in DEPCAT 1 relative to all other categories, but this did not reach significance (chi-squared test, $p = 0.11$). No significant differences were observed between the DEPCAT categories for BMI or prevalence of THR (univariate logistic regression, $p = 0.5$ and $p = 0.36$, respectively).

There was a significant difference between the groups for pre-operative Oxford scores (Table III and Fig. 2), the most deprived patients having a higher score by a mean of 5.8 points than the most affluent group (univariate logistic regression, $p = 0.001$). The pre-operative Oxford score was found to be a highly significant predictor of mean improvement at 12 months (ordinal logistic regression, $p = 0.001$). Those patients with a high pre-operative Oxford score, quintile five, had a greater improvement in their post-operative score than those with a lower pre-operative score, quintile one (Fig. 3).

Table II. Patient demographics, comorbidity and age-related Charlson scores, and body mass index (BMI) according to deprivation category (DEPCAT) group

<table>
<thead>
<tr>
<th>DEPCAT group</th>
<th>Number of hips (per 1000 per yr)</th>
<th>Prevalence (per 1000 per yr)</th>
<th>Mean age (yrs) (range)</th>
<th>% female</th>
<th>Mean number of comorbidities</th>
<th>Mean Charlson index (range)</th>
<th>Mean BMI (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>113 (8.3)</td>
<td>0.55</td>
<td>67.1 (36 to 90)</td>
<td>65.5</td>
<td>1.6</td>
<td>2.2 (0 to 5)</td>
<td>28.7 (19 to 38)</td>
</tr>
<tr>
<td>2</td>
<td>260 (19.1)</td>
<td>0.71</td>
<td>69.6 (37 to 89)</td>
<td>58.5</td>
<td>1.6</td>
<td>2.1 (0 to 6)</td>
<td>27.8 (18 to 41)</td>
</tr>
<tr>
<td>3</td>
<td>250 (18.4)</td>
<td>0.55</td>
<td>68.0 (37 to 89)</td>
<td>56.8</td>
<td>1.8</td>
<td>2.3 (0 to 5)</td>
<td>27.5 (21 to 43)</td>
</tr>
<tr>
<td>4</td>
<td>445 (32.7)</td>
<td>0.65</td>
<td>68.6 (36 to 92)</td>
<td>55.5</td>
<td>2.1</td>
<td>3.0 (0 to 6)</td>
<td>28.5 (20 to 42)</td>
</tr>
<tr>
<td>5</td>
<td>196 (14.4)</td>
<td>0.51</td>
<td>67.5 (39 to 91)</td>
<td>58.2</td>
<td>2.0</td>
<td>2.8 (0 to 6)</td>
<td>27.9 (19 to 40)</td>
</tr>
<tr>
<td>6+7</td>
<td>95 (70)</td>
<td>0.60</td>
<td>64.5 (36 to 92)</td>
<td>58.9</td>
<td>2.1</td>
<td>2.9 (0 to 6)</td>
<td>28.9 (20 to 44)</td>
</tr>
<tr>
<td>Total</td>
<td>1359</td>
<td>0.60</td>
<td>68.1 (36 to 92)</td>
<td>57.8</td>
<td>1.9</td>
<td>2.8 (0 to 6)</td>
<td>28.2 (19 to 44)</td>
</tr>
</tbody>
</table>

Table III. Mean improvement in 12-month Oxford hip score according to deprivation category (DEPCAT) group and quintile of pre-operative Oxford score (SD)

<table>
<thead>
<tr>
<th>DEPCAT group</th>
<th>Mean pre-operative Oxford score</th>
<th>Quintiles of pre-operative Oxford score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quintiles 1</td>
</tr>
<tr>
<td>1</td>
<td>38.7</td>
<td>12.5 (75)</td>
</tr>
<tr>
<td>2</td>
<td>40.8</td>
<td>12.9 (61)</td>
</tr>
<tr>
<td>3</td>
<td>40.5</td>
<td>13.6 (68)</td>
</tr>
<tr>
<td>4</td>
<td>42.5</td>
<td>13.0 (67)</td>
</tr>
<tr>
<td>5</td>
<td>42.9</td>
<td>12.7 (64)</td>
</tr>
<tr>
<td>6+7</td>
<td>44.5</td>
<td>11.5 (50)</td>
</tr>
<tr>
<td>Total</td>
<td>41.7</td>
<td>13.0 (68)</td>
</tr>
</tbody>
</table>

Fig. 2
Bar chart showing the mean pre-operative Oxford hip score by deprivation category group.
DEPCAT according to the pre-operative Oxford score quintile. There was a significant variation within quintiles two to five between each of the DEPCAT groups (Table III): the most affluent patients had a greater improvement than the most deprived patients (ordinal logistic regression, \( p = 0.001 \)). This trend was not observed for quintile one, with no significant difference between the DEPCAT groups (ordinal logistic regression, \( p = 0.5 \)).

The mean improvement of the Oxford score at 12 months was predicted not only by deprivation and pre-operative Oxford scores, but also by comorbidity, length of stay, and physical and mental components of the SF-12 score. All these factors were significant independent predictors of change in Oxford score at 12 months, after adjusting for one another (ordinal logistic regression, \( p = 0.01 \)). The comorbidity with the strongest prediction of lack of improvement at 12 months was depression.

Table IV demonstrates the post-operative complications and 90-day mortality for each category. There was no significant difference in post-operative complications between the groups, except for dislocation (chi-squared test: transfusion, \( p = 0.70 \); pneumonia, \( p = 0.83 \); myocardial infarction, \( p = 0.40 \); DVT, \( p = 0.91 \); pulmonary embolism, \( p = 0.87 \); and infection, \( p = 0.79 \)). The most deprived groups (DEPCAT 6 and 7) were more likely to dislocate relative to all other categories (odds ratio 5.3, chi-squared test).
test, p < 0.001). There was also an increased mortality risk at 90 days for this deprived group relative to all other categories (odds ratio 3.2, chi-squared test, p = 0.02).

There was a significant variation in satisfaction between the DEPCAT groups (ordinal logistic regression, p = 0.03). The most affluent patients were more satisfied with their surgery than the most deprived patients (13.8 (8 to 29) vs 16.8 (8 to 35), respectively).

Discussion
This study has shown that two of the factors that affect the early outcome of THR, when assessed by the Oxford hip score, are the patients’ socioeconomic status and their pre-operative Oxford hip score. Those who are most socially deprived tend to undergo surgery at an earlier age, have more comorbidities, greater severity of symptoms, do not achieve as good an improvement of symptoms, and are not as satisfied as their less deprived counterparts. This poorer outcome is also associated with an increased risk of dislocation and mortality at 90 days.

The increased pain and poorer function exhibited by the most deprived quartile of the population would suggest that there was an increased requirement for THR in this group which is not reflected by a higher prevalence of arthroplasty surgery.\textsuperscript{7,17} The prevalence of arthroplasty across all categories of deprivation was similar for our cohort (Table II), supporting the evidence that the increased need for THR in the most deprived is not being met. An alternative explanation for this could be that additional factors prevent them from undergoing major surgery.\textsuperscript{18} We have shown that the most deprived have significantly more comorbidities, which may have provided contraindications to surgery because of the increased risks, although the increased number of comorbidities was not associated with a significantly increased risk of mortality according to the Charlson score.

We have shown that the inverse care law applies to THR. Many studies have found a higher need for THR in those with a lower socioeconomic status in the United Kingdom.\textsuperscript{6-8} The increased need for THR in the most deprived groups is reflected in our study by the younger age at which surgery is performed, some three to five years earlier than in the less deprived categories, which is an observation unique to this study. Furthermore, the severity of pain and disability is greater at the time of surgery in these deprived patients, as reflected by worse pre-operative Oxford scores. The increased severity of pre-operative Oxford hip scores in the most deprived groups is, as we have demonstrated, an independent and highly significant predictor of mean improvement at 12 months. This may reflect the fact that deprivation is an aetiological factor for the development of osteoarthritis of the hip,\textsuperscript{6-8} and hence these patients present at a younger age with more severe symptoms. In addition, these higher pre-operative scores may be due to delayed access to healthcare services, which has been described for the most deprived patients suffering from osteoarthritis.\textsuperscript{19} Ellis, Howard and Khaleel\textsuperscript{20} advocate not only improved access to healthcare but also improved patient education, addressing their expectations and perceptions of THR.

We have shown social deprivation to be an independent predictor of outcome assessed at 12 months using the Oxford hip score. This is the first study to demonstrate a difference between deprivation categories beyond six months after THR. Jenkins et al\textsuperscript{9} reported a difference at six months, but this was not significant beyond this time when using the Harris hip score. In addition, we also addressed confounding variables, of which we identified pre-operative Oxford scores, comorbidity, physical and mental components of the SF-12 score and length of stay to be independent predictors of outcome. If the NHS were to use the Oxford hip score to compare quality of surgery or the standard of service between Trusts after THR with differing case-mix variables, the aforementioned confounding factors should be addressed before comparisons are made and potential rewards or penalties decided.

After their THR the most deprived patients are not as satisfied as their less deprived counterparts. The reason(s) for their lack of satisfaction are not clear, as all patients improved relative to their pre-operative scores, although as we have demonstrated, the more deprived categories do not improve to the same extent as those from a less deprived category, and this may account for the difference in satisfaction. In part the reduced satisfaction might be the consequence of the increased risk of dislocation in the most deprived, which could be due to inadequate patient education.\textsuperscript{20} Several authors have reported increased rates of medical complications and infection after THR in the most socially deprived.\textsuperscript{20,21} Like Jenkins et al,\textsuperscript{9} we observed no significant increase in post-operative medical complications in this group. However, we did demonstrate an increased risk of mortality associated with deprivation, which is supported by data from the United States showing a higher risk of death at 90 days for patients with lower income.\textsuperscript{22}

Socioeconomic status is an independent variable affecting the early patient-assessed outcome, rate of dislocation and 90-day mortality after THR. The reason for this disparity is not clear. Further work should be undertaken to investigate this social discrepancy to establish whether there are factors that can and should be modified to improve the outcome of THR in deprived groups of society.

References


