The rate of joint replacement in osteoarthritis depends on the patient's socioeconomic status

A cohort study of 71,380 patients

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Background and purpose — Assessment of potential disparities in access to care is a vital part of achieving equity in health and healthcare. We have therefore studied the effect of socioeconomic status (SES) on the rates of knee and hip replacement due to osteoarthritis.

Methods — This was a cohort study in Skåne, Sweden. We included all residents aged ≥ 35 years with consultations between 2004 and 2013 for hip or knee osteoarthritis. We retrieved individual information on income, education, and occupation and evaluated the rates of knee and hip replacement according to SES, with adjustment for age and sex. Professionals, legislators, senior officials, and managers, and individuals with the longest education, served as the reference group.

Results — We followed 50,498 knee osteoarthritis patients (59% women) and 20,882 hip osteoarthritis patients (58% women). The mutually adjusted rate of knee replacement was lower in those with an elementary occupation (hazard ratio (HR) = 0.81, 95% CI: 0.72–0.92), in craft workers and those with related trades (HR = 0.88, CI: 0.79–0.98), and in skilled agricultural/fishery workers (HR = 0.83, CI: 0.72–0.96), but higher in the 2 least educated groups (HR = 1.2 in both). The rate of hip replacement was lower in those with an elementary occupation (HR = 0.77, 95% CI: 0.68–0.87), in plant and machine operators/assemblers (HR = 0.83, CI: 0.75–0.93), and service workers/shop assistants (HR = 0.88, CI: 0.80–0.96). The rate of hip replacement was higher in the highest income group (HR = 1.1, 95% CI: 1.0–1.2).

Interpretation — There was a lower rate of joint replacement in osteoarthritis patients working in professions often associated with lower socioeconomic status, suggesting inequity in access to care. However, the results are not unanimous, as the rate of knee replacement was higher in the least educated groups.

There is a well-known gradient of health related to socioeconomic status (SES), so that people of lower social class have a higher incidence of most diseases and a shorter lifespan (Wilkinson and Marmot 2003). This gradient also exists for osteoarthritis; people with lower SES have both a higher incidence of OA and an associated higher level of disability (Thumboo et al. 2002, Callahan et al. 2010). In addition to inequity in health itself, there are also disparities in the use of healthcare that are linked to SES. Even in countries with tax-based healthcare systems where the financial barrier to seeking care should be small, people of lower SES are less likely to seek medical care (Agerholm et al. 2013). Specialist care in particular is more accessible to people with higher income, and this tendency is more prominent in healthcare settings with private options (van Doorslaer et al. 2006). In Sweden, women, lower income groups, and less educated people refrain from seeking medical care to a greater extent than men, higher income groups, and people with a higher education, respectively (Gerdtham and Sundberg 1998, Westin et al. 2004).

For nonoperative therapy (self-management education, primary care, specialist care, physiotherapy, and pain medication), there is some evidence of inequity in arthritis care and there is strong evidence that a lower income and less education are associated with disparities in access to hip replacement and knee replacement (Ackerman and Busija 2012). Previous research suggested disparities in the use of joint replacement due to SES in countries such as Canada (Rahman et al. 2011), the USA (Hawkins et al. 2011), and the UK (Steel et al. 2006). However, these studies were all based on group-level measures of SES or survey data. In Sweden, population-based registries provide comprehensive individual-level data on SES—includ-

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ing level of education, occupation, and income—which were used in the present study. Furthermore, inequity in the use of joint replacement has not been studied in Sweden, a country with a long tradition of a publicly funded healthcare. Thus, we investigated whether there might be an association between individual-level SES and the use of joint replacement in knee and hip OA patients in Sweden.

Methods

Study design

The investigation was set in Skåne, the most southerly region of Sweden with 1,274,069 inhabitants (in 2013). We conducted 2 separate cohort studies (knee OA and hip OA) using prospectively obtained registry data. We included all patients aged 35 years or more, living in the Skåne region, with doctor-diagnosed OA of the knee or hip between 2004 and 2013. Any patient who had both knee OA and hip OA registered was included in both cohorts.

The Skåne Healthcare Register

The Swedish healthcare system is financed through the tax system, with both public and private healthcare. In order to receive reimbursement, healthcare providers register the inpatient and outpatient doctor visits with diagnostic codes according to the ICD-10 system. Each visit is registered with up to 8 diagnostic codes, date, healthcare provider, and specialty. In the Skåne region, these data is stored in the Skåne Healthcare Register (SHR). All surgical procedures are registered using codes according to a hierarchal system, the classification of healthcare procedures (KVÅ by Swedish acronym), which caregivers are obliged to report to the National Board of Health and Welfare. These data are also stored in the SHR.

The Swedish population register

All Swedish citizens are registered in the population register with a unique personal identification number, which is used in all healthcare contacts. It provides information on date of birth and sex. This allows linkage of data between different databases. The population register also contains information on marital status, place of residence, and death.

Individual information on socioeconomic status

We retrieved individual-level data on income, level of education, and occupation from the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA by Swedish acronym), provided by Statistics Sweden. The subjects were divided into quartiles of income. Statistics Sweden classifies educational background on a scale from 1 to 7 according to the Swedish Educational Terminology. For this study, we converted this scale into 4 categories (0–9, 10–12, 13–14 and ≥ 15 years of education) and divided the cohorts into these groups according to highest level of education reached. The Standard of Swedish Classification of Occupations from 1996 (SSYK 96 by Swedish acronym) divides occupations into 10 groups. This is the Swedish version of the International Standard Classification of Occupations from 1988, created by the International Labour Organization. Occupations are classified by SSYK 96 according to the type of work, its tasks, and the skill required. In this study, we merged the group of legislators, senior officials, and managers with the most similar group (professionals), and the group of technicians and associate professionals was merged with the similar group of clerks, in order to create groups with sizes that were more comparable. We excluded armed forces from the analysis due to the small number of patients (115 knee OA patients and 39 hip OA patients). This resulted in 7 occupational groups for analysis.

Outcome

The outcome studied was the first total or partial replacement surgery of the knee or hip, with a concurrent main diagnosis of OA. Censoring events included relocation out of the Skåne region, undergoing knee or hip replacement with a main diagnosis other than OA, or death.

Statistics

We linked data from the SHR to data from Statistics Sweden on an individual basis using the patient's personal identification number. Data on age, sex, marital status, occupation, income, and education were collected at the date of the first known OA diagnosis in the time period studied. The first occurrence of a registered OA diagnosis of the hip or knee during the study period was considered the index date, from which we calculated person time to outcome or a censoring event. We used person time from index date until outcome to calculate incidence rates of knee replacement and hip replacement—stratified according to income, occupation, and education.

The effect of each SES variable on incidence rates of hip replacement and knee replacement was evaluated by using Cox's proportional hazards regression to calculate age- and sex-adjusted hazard ratios (HRs) with 95% confidence intervals (CIs). We also had a model with additional adjustment for the other SES variables. As part of a sensitivity analysis, we evaluated the effect of additional adjustment for marital status in another model. Each person was included only once in the analysis and the proportional hazards assumption was verified using plots of the Schoenfeld residuals. SPSS Statistics version 22 was used to perform the analyses, and we considered any 2-tailed p-value of less than 0.05 to be statistically significant.

Ethics

The study was approved by the regional ethical review board of Lund University (Dnr 2011-432) and by Region Skåne.

Table 1. Characteristics of the knee OA cohort, stratified according to different measures of socioeconomic status

	Women %	Married %	Age, years mean (SD)	Follow-up, years mean (SD)	Outcome, knee replacement %	Crude incidence rate of knee replacement per 10,000 person years
Income, quartiles						
Lowest	79	68	72 (11)	4.4 (3)	19	429
2nd and 3rd	61	52	67 (12)	4.3 (3)	19	443
Highest	35	64	61 (11)	4.4 (3)	17	392
Total	49	59	67 (12)	4.3 (3)	18	426
Educational level, years						
15+	60	57	71 (11)	4.3 (3)	19	447
13–14	57	59	64 (12)	4.3 (3)	19	430
10–12	59	63	62 (11)	4.3 (3)	17	384
0–9	59	65	64 (11)	4.3 (3)	18	407
Total	59	59	67 (12)	4.3 (3)	19	430
Occupational group						
Legislators/ senior officials/ managers/ professionals	51	68	63 (10)	4.3 (3)	19	442
Technicians/ associated professionals/ clerks	61	65	64 (11)	4.2 (3)	20	473
Service workers and shop assistants	87	60	62 (11)	4.2 (3)	21	501
Skilled agricultural and fishery workers	30	71	71 (10)	4.2 (3)	22	525
Craft workers and those with related trades	6	66	62 (11)	4.5 (3)	18	408
Plant and machine operators and assemblers	26	61	62 (11)	4.4 (3)	20	456
Elementary occupations	73	58	63 (10)	4.4 (3)	17	386
Total	55	64	63 (11)	4.3 (3)	20	458

Results

Osteoarthritis of the knee

Study cohort

We identified 50,498 individuals (59% of them women) with knee OA, with a mean age of 67 (SD13) years at the time of their first known diagnosis of OA in the study period. Those with a higher income and more education were typically younger at the time of the first known OA diagnosis. The group of skilled agricultural and fishery workers stood out as being older than the other occupational groups at the time of their first known OA diagnosis. The proportion of married patients was greater in the group with the lowest income, in the group with the highest education, and in the group of skilled agricultural and fishery workers. 18% of the patients in the knee OA cohort underwent knee replacement during the follow-up period. In crude incidence rates, knee replacement was most common in patients with medium income, in those with the shortest education, and in the group of skilled agricultural and fishery workers. Knee replacement was least common in the highest income group, in the group with 13–14 years of education, and the group with elementary occupations (Table 1).

Rates of knee replacement

When we adjusted for age and sex, there was a statistically significantly lower hazard ratio (HR) for knee replacement in

Table 2. Adjusted HRs for undergoing knee replacement, stratified according to different measures of socioeconomic status

	HR [a] (95% CI)	HR [b] (95% CI)
Income, quartiles		
Lowest	0.92 (0.9–1.0)	0.96 (0.9–1.0)
2nd and 3rd	1.00 [c]	1.00 [c]
Highest	0.96 (0.9–1.0)	0.97 (0.9–1.0)
Educational level, years		
15+	1.00 [c]	1.00 [c]
13–14	0.97 (0.9–1.1)	1.01 (0.9–1.1)
10–12	1.07 (1.0–1.2)	1.15 (1.0–1.3)
0–9	1.01 (0.9–1.1)	1.15 (1.0–1.3)
Occupational group		
Legislators/senior officials/ managers/ professionals	1.00 [c]	1.00 [c]
Technicians/associated professionals/clerks	1.05 (1.0–1.1)	0.99 (0.9–1.1)
Service workers and shop assistants	1.16 (1.1–1.3)	1.06 (1.0–1.1)
Skilled agricultural and fishery workers	0.91 (0.8–1.0)	0.83 (0.7–1.0)
Craft workers and those with related trades	0.97 (0.9–1.1)	0.88 (0.8–1.0)
Plant and machine operators and assemblers	1.09 (1.0–1.2)	0.99 (0.9–1.1)
Elementary occupations	0.89 (0.8–1.0)	0.81 (0.7–0.9)

HR: hazard ratio; 95% CI: 95% confidence interval.
[a] adjusted for age and sex.
[b] adjusted for age, sex, and socioeconomic factors.
[c] reference

Table 3. Characteristics of the hip OA cohort, stratified according to different measures of socioeconomic status

	Women %	Married %	Age, years mean (SD)	Follow-up, years mean (SD)	Outcome, knee replacement %	Crude incidence rate of knee replacement per 10,000 person years
Income, quartiles						
Lowest	78	68	75 (10)	3.0 (3)	39	1,289
2nd and 3rd	59	50	71 (12)	3.0 (3)	41	1,340
Highest	36	64	64 (11)	2.7 (3)	47	1,755
Total	58	58	70 (12)	3.0 (3)	42	1,421
Educational level, years						
15+	58	64	67 (11)	2.7 (3)	48	1,817
13–14	60	61	66 (11)	2.8 (3)	45	1,577
10–12	57	58	68 (12)	3.0 (3)	42	1,453
0–9	58	55	74 (10)	3.0 (3)	40	1,344
Total	58	58	70 (12)	3.0 (3)	42	1,433
Occupational group						
Legislators/ senior officials/ managers/ professionals	52	68	66 (10)	2.6 (3)	50	1,935
Technicians/ associated professionals/ clerks	62	64	67 (10)	2.8 (3)	47	1,701
Service workers and shop assistants	88	58	66 (10)	2.9 (3)	45	1,551
Skilled agricultural and fishery workers	25	71	73 (9)	2.8 (3)	49	1,764
Craft workers and those with related trades	6	68	67 (10)	3.0 (3)	47	1,575
Plant and machine operators and assemblers	26	60	66 (10)	3.0 (3)	43	1,407
Elementary occupations	73	57	67 (9)	3.1 (3)	41	1,324
Total	54	64	67 (10)	2.8 (3)	46	1,649

the lowest income quartile compared to the middle quartiles (HR = 0.92, CI: 0.88–0.97). However, when we also adjusted for occupation and level of education, no statistically significant differences remained (Table 2).

Using the most educated group (with ≥ 15 years of education) as reference, there were statistically significantly higher HRs for knee replacement in the least educated groups (HR = 1.15 for 0–9 years of education and HR = 1.15 for 10–12 years of education) when we adjusted for age, sex, education, and occupation (Table 2).

The group of elementary occupations—including, for example, laborers in manufacturing and agriculture—had the largest difference in HR for knee replacement compared to the reference group of legislators, senior officials, managers, and professionals (age- and sex-adjusted HR = 0.89 (CI: 0.80–0.99)); also adjusted for income and education, the HR was 0.81 (CI: 0.72–0.92). The group of craft workers and those with related trades and the group of skilled agricultural and fishery workers also had statistically significantly lower adjusted HRs for knee replacement (Table 2).

After adjusting for age, income, education, and occupation, there was no significant difference in knee replacement rates between men and women with OA. (Using women as the reference category, the HR for knee replacement in men was 1.0 (CI: 0.94–1.06)).

The incidence rate of knee replacement increased by 3% per year of older age. The results remained essentially the same with additional adjustment for marital status. The only additional result that reached statistical significance after this adjustment was the lowest income group being less likely to undergo knee replacement (HR = 0.92, CI: 0.86–0.99).

Osteoarthritis of the hip

Study cohort

We identified 24,882 individuals (58% of them women) with hip OA, with a mean age of 70 (SD 12) years at the time of their first known diagnosis of OA. Those with a higher income and more education were generally younger at the time of their first known diagnosis of hip OA. The group of skilled agricultural and fishery workers stood out as being older than the other occupational groups at the time of the first known diagnosis of hip OA. The proportion of married patients was greater in the group with the lowest income, in the group with the highest education, and in the group of skilled agricultural and fishery workers. 42% of the hip OA patients underwent hip replacement during the follow-up period. In terms of crude incidence rates, hip replacement was most common in the highest income group, the most educated group, and the group of legislators, senior officials, managers, and professionals. Hip replacement was least common in the groups with the

Table 4. Adjusted HRs for undergoing hip replacement, stratified according to different measures of socioeconomic status

	HR [a] (95% CI)	HR [b] (95% CI)
Income, quartiles		
Lowest	0.98 (0.9–1.0)	1.04 (1.0–1.1)
2nd and 3rd	1.00 [c]	1.00 [c]
Highest	1.17 (1.1–1.2)	1.08 (1.0–1.2)
Educational level, years		
15+	1.00 [c]	1.00 [c]
13–14	0.88 (0.8–1.0)	0.93 (0.9–1.0)
10–12	0.83 (0.8–0.9)	0.96 (0.9–1.0)
0–9	0.83 (0.8–0.9)	1.00 (0.9–1.1)
Occupational group		
Legislators/senior officials/ managers/ professionals	1.00 [c]	1.00 [c]
Technicians/associated professionals/clerks	0.91 (0.9–1.0)	0.94 (0.9–1.0)
Service workers and shop assistants	0.84 (0.8–0.9)	0.88 (0.8–1.0)
Skilled agricultural and fishery workers	0.96 (0.9–1.1)	0.98 (0.9–1.1)
Craft workers and those with related trades	0.90 (0.8–1.0)	0.93 (0.8–1.0)
Plant and machine operators and assemblers	0.82 (0.7–0.9)	0.83 (0.8–0.9)
Elementary occupations	0.75 (0.7–0.8)	0.77 (0.7–0.9)

HR: hazard ratio; 95% CI: 95% confidence interval.
[a] adjusted for age and sex.
[b] adjusted for age, sex, and socioeconomic factors.
[c] reference

lowest income, in those with the least education, and in those with elementary occupations (Table 3).

Rates of hip replacement

When we adjusted for age and sex, there was a statistically significantly higher HR for hip replacement in the highest income quartile compared to the middle quartiles (HR = 1.2, CI: 1.11–1.22). When we also adjusted for occupation and level of education, the higher HR for hip replacement in the highest income group was still statistically significant, although the difference was smaller (Table 4).

Using the most educated group with ≥ 15 years of education as a reference, the HRs for hip replacement in the less educated groups were all statistically significantly lower when we only adjusted for age and sex. These differences were, however, not statistically significant when we also adjusted for other measures of SES (Table 4).

The group of elementary occupations—including, for example, laborers in manufacturing and agriculture—had the largest difference compared to the reference group (age-, sex-, and SES-adjusted HR = 0.77 (CI: 0.68–0.87)). The group of plant machine operators and assemblers and the group of service workers and shop assistants also had statistically significantly lower HRs for hip replacement (Table 4).

After adjusting for age, income, education, and occupation, there was no statistically significant difference in hip replacement rates between men and women with OA. (Using women as the reference group, the HR for hip replacement in men was 0.96 (CI: 0.91–1.0)).

There was no statistically significant change in incidence rates for hip replacement with each year older in age. The results remained essentially the same with additional adjustment for marital status.

Discussion

In this study, using individual-based information on SES, we investigated how education, income, and occupation influenced the rates of hip and knee replacement in Swedish patients with physician-diagnosed OA.

We found higher rates of knee replacement in the less educated groups of OA patients, which may be due to lower educational attainment being associated with worse symptoms (Cleveland et al. 2013). Also, these patients may be more likely to have physically demanding occupations, which has been considered to be a risk factor for knee OA and its progression (Anderson and Felson 1988). The risk of hip replacement, by contrast, was lower in the less educated groups when we only adjusted for age and sex, but not when we also adjusted for income and education. Lower presence of pain and better functional status in hip OA patients with higher education has been reported in a Finnish population (Juhakoski et al. 2013). This should lead to a lower need for—and therefore a lower rate of—hip replacement in this group, which we did not find in this study of a probably similar Swedish population. This indicates that there may be a disparity in the form of a possibly greater unmet need for hip replacement in less educated individuals. Previous research has also suggested that there may be a greater need for knee replacement and hip replacement in patients with lower income (Yong et al. 2004). We found a higher rate of hip replacement in the highest income group, whereas the rate of knee replacement was similar in all income groups. Considering the possible differences in need, this could indicate under-utilization of joint replacement in lower income groups.

Patients with higher education and income were generally younger at the time of the first known OA diagnosis in both cohorts. This suggests that they may seek care at an earlier stage of the disease, which is in line with what has previously been reported on SES and health-seeking behavior in Sweden (Gerdtham and Sundberg 1998, Westin et al. 2004). Using a classification consisting of 7 occupational groups, we found evidence of the 5 lowest-skilled groups all having lower rates of knee and/or hip replacement. The lowest rates of both knee and hip replacement were found in the group with elementary occupations, which includes potentially physically demanding occupations such as cleaning, garbage collecting, and working as an agricultural laborer. Physically demanding occupations have been reported to increase the risk of both hip OA and knee OA (Jarvholm et al. 2008). Thus, there may be a

greater need for knee and hip replacement in individuals with elementary occupations, and the relatively low rate of surgery that we found in this group may indicate inequity in the use of joint replacement. However, according to the "healthy worker effect" phenomenon, the lower rate of joint replacement in patients employed in heavier occupations may be attributable to the healthiest individuals being more likely to stay in physically demanding occupations (Shah 2009).

We found similar rates of knee replacement and hip replacement in OA patients of both sexes. As female sex is a well-established risk factor for worse pain and disability in OA patients (Busija et al. 2010), this could reflect an under-utilization of joint replacement in women.

Obesity is another well-established risk factor for OA (Anderson and Felson 1988, Jarvholm et al. 2005, Lohmander et al. 2009). We could not, however, include BMI or any other measures of obesity in our analysis. The inverse correlation between SES and obesity has been seen previously in Sweden (Norberg et al. 2010). Thus, there may be a greater need for joint replacement due to obesity in people of lower SES. Obesity as a confounding factor could possibly explain the higher rate of knee replacement in patients with poorer education found in this study.

Other comorbidities could possibly confound our results, as higher levels of comorbidity in individuals with lower SES (Wilkinson and Marmot 2003) could mean that these patients would be less eligible for surgery.

Another limitation of our study is that information on income, education, and occupation was collected and registered only once—at the time of each subject's first known OA diagnosis during the study period. Variations in subjects' occupations and incomes before and after the index date were not included in the analysis.

A large proportion of subjects with OA symptoms refrain from seeking physician care at all; these would of course have been missed in our analysis (Turkiewicz et al. 2014). Furthermore, there is under-utilization of diagnostic codes, especially in primary care, causing false negatives (Harrold et al. 2000). There should, however, have been few false positives included in our analysis, as the positive predictive value of a knee OA diagnosis in the SHR is high (88%) (Turkiewicz et al. 2014). Also, previous studies that have performed validations of the SHR have found that for rheumatic diseases, the quality of the disease classification is high (Englund et al. 2010, Lofvendahl et al. 2014).

The data from Statistics Sweden on income and education were comprehensive, with little missing. However, 33% of the knee cohort and 36% of the hip cohort had no occupation registered. Not having a registered occupation could be due to not having been employed for many years because of long-term sick-leave or unemployment, or to being self-employed or being an immigrant.

Our findings for knee and hip OA are not fully in line, but most of the significant results indicate that there was a lower rate of undergoing joint replacement in patients of lower SES. Previous studies using group-level SES data in the USA, Canada, and the UK also found that people of higher SES were more likely to undergo joint replacement (Steel et al. 2006, Hawkins et al. 2011, Rahman et al. 2011). Our results, derived from a large population in southern Sweden with both rural and urban areas, can most likely be generalized to the rest of Sweden, while differences in healthcare systems make their generalizability to other countries more difficult to assess.

In summary, we found that lower SES is associated with a lower likelihood of joint replacement. This may indicate inequity regarding access to joint replacement, possibly due to differences in health-seeking behavior, the tendency of general practitioners to refer patients for surgery, or orthopedic surgeons' inclination to perform joint replacement. Some confounding factors were not adjusted for in this study, such as obesity, and it is possible that differences in the likelihood of undergoing knee or hip replacement can be partially explained by these factors. Further studies on the association between SES and joint replacement in Sweden are warranted, including assessment of the need for surgery and adjustment for obesity.

MW interpreted the results and drafted the manuscript. ME conceived and designed the study, interpreted the results, and revised the manuscript. AT designed the study, acquired and analyzed the data, interpreted the results, and revised the manuscript. JH and KS interpreted the results and revised the manuscript.

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