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No influence of immigrant background on the outcome of total hip arthroplasty

140,299 patients born in Sweden and 11,539 immigrants in the Swedish Hip Arthroplasty Register

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Background and purpose Total Hip Replacement (THA) is one of the most successful and cost-effective operations. Despite its benefits, marked ethnic differences in the utilization of THA are well documented. However, very little has been published on the influence of ethnicity on outcome. We investigate whether the outcome—in terms of reoperation within 2 years or revision up to 14 years after the primary operation—varies depending on ethnic background.

Methods Records of total hip arthroplasties performed between 1992 and 2007 were retrieved from the Swedish Hip Arthroplasty Registry and integrated with data on ethnicity of patients from 2 demographical databases (i.e. Patient Register and Statistics Sweden). The first operated side in patients with THA recorded in the Swedish Hip Arthroplasty Register (SHAR) between 1992 and 2007 were generally included. We excluded patients with 1 Swedish and 1 non-Swedish parent and patients born abroad with 2 Swedish parents. After these exclusions 151,838 patients were left for analysis. There were 11,539 Swedish patients born outside Sweden. We used a Cox regression model including age, sex, diagnosis, type of fixation, whether or not there was comorbidity according to Elixhauser or not, marital status and educational level.

Results The mean age was lowest in the group of patient coming from outside Europe including the former Soviet Union (61 years), and highest in the Swedish population (70 years). Before adjustment, for covariates, patients born in Europe outside the Nordic countries showed a lower risk to undergo early reoperation (HR = 0.73, 95% CI: 0.56–0.97), which increased after adjustment to (HR = 0.76, 95% CI: 0.58–1.01). Before adjustment, patients born in the Nordic countries outside Sweden and those born outside Europe (including the former Soviet Union) showed

a higher risk to undergo revision than patients born in Sweden (HR = 1.14, 95% CI: 1.02–1.27; HR = 1.49, 95% CI: 1.2–1.9), but this difference disappeared after adjustment for covariates.

Conclusion We did not find any certain differences in reoperation within 2 years, or revision within 14 years, between patients born in Sweden and immigrants. Further studies are needed to determine whether our observations are biased by the attitude of health providers regarding performance of these procedures, or by a reluctance of certain patient groups to seek medical attention should any complications requiring reoperation or revision occur.

Despite the fact that THA is one of the most successful and cost-effective orthopedic interventions, marked ethnic differences in its utilization are well documented which are not explained by differences in prevalence. Over the past 2 decades numerous studies have showed that African Americans receive THA less often than whites Americans (Baron et al. 1996, Katz et al. 1996, Mahomed et al. 2003, Skinner et al. 2003, DCD 2009, Ibrahim 2010). There are probably many reasons for these reported differences in use— including patient-level factors (e.g. beliefs about health), system-level factors (e.g. access to specialist care), and provider-level factors (e.g. physician biases) (Ibrahim et al. 2002, Hawker 2004, Suarez-Almazor et al. 2005). Associations between outcome of hip arthroplasty and racial and ethnic minorities are less evident. However, racial and ethnic minority groups appear to have a higher risk for early complications and a higher risk of mortality after total hip replacement (Nwchukwu et al.

2010). Very little has been published on the influence of ethnicity or race on the risk of a repeated surgical intervention related to the inserted THR. To perform such a study, larger series have to be reviewed.

In Sweden almost 16 000 total hip replacements (THR) are performed yearly. The revision rate in Sweden is among the lowest in the world (3–5% at 10 years). The incidence of revisions is not only related to the performance of the implant, but also to the surgeons attitude or opinion concerning when to revise, the general medical condition of the patient, the patient's willingness to undergo a revision and how these matters are communicated between the patient and the health providers. Finally, the priority of the individual patient to seek medical attention, should any symptoms from the operated hip appear, is also of importance for the length of the time period between the initial operation and any subsequent revision.

We hypothesized that certain immigrant groups in Sweden, operated with a primary total hip replacement might more frequently undergo reoperation within 2 years and/or revision in the longer time. This could be caused by a number of factors related to the patient—such as a different profile of hip diseases, lower age at operation, the attitude of the patient to Swedish healthcare, and the attitude of the healthcare providers. After adjustment for possible confounders available, we expected any such differences in reoperation or revision rate to decrease or disappear. Data from the Swedish Hip Arthroplasty Register were used and cross-matched with Statistics Sweden and the National Patient Register to obtain information about ethnicity, cohabitation, educational level and comorbidity.

Patients and methods

All THA recorded in the Swedish Hip Arthroplasty Register (SHAR) between 1992 and 2007 were included. Tumor cases and the second hip operation in bilateral cases were excluded. We also excluded patient with 1 Swedish and 1 non-Swedish parent, and patients born abroad with 2 Swedish parents. After these exclusions 151,838 patients were left for analysis.

Sources of data

Since 1992, all patients receiving a primary THR are reported by the operating unit using a personal identification number. All units performing THR in Sweden report to the Swedish Hip Arthroplasty Register, and the completeness on an individual basis is at present about 99% for primary THR (Swedish Hip Arthroplasty Register 2010). The personal identification number enables cross-matching with other official Swedish registers. In this study, cross-matching was done with Statistics Sweden and The Patient Register. After cross-matching, all further analyses were done using de-identified data. The matching of SHAR data with data from Statistics Sweden and The Patient Register was approved by the Regional Ethics Committee (no. 328-08).

Study population

Statistics. In the survival analyses the endpoint was defined either as reoperation within 2 years or revision within 14 years, death or December 31, 2007, whichever came first. In the analyses of revisions a time limit of 14 years was used to ensure a sufficient number of observations in each patient group at the end of the study period. At this time point there were 77 observations left in the smallest group (born outside Europe including the former Soviet Union).

The hazard ratios (HR) and 95% confidence intervals (CI) for the 3 immigrant groups were first computed without adjustment for possible confounders and with use of patients born in Sweden as reference. Thereafter, after adjusting for confounders, the HRs was calculated using a Cox proportional hazard regression model. In this analysis age was classified into 5 groups (< 50, 50–59, 60–69, 70–79, 80 years and above) using the group with most observations as reference (70–79 years). Diagnosis was also classified into 6 groups (primary osteoarthritis, inflammatory arthritis, hip fracture or sequele after hip fracture, sequele after pediatric hip disease, idiopathic femoral head necrosis and other) using the first diagnosis as reference. In the group “other” the majority had Mb Paget (73%), followed by secondary osteoarthritis after acetabular fracture (16%) and hip dislocation (7%). Data from Statistics Sweden and The National Patient Register concerning ethnicity, educational level, whether or not there was cohabitation and comorbidity were classified according to the description above (Table 1).

The relative hazard assumption was tested by plotting the HRs, log-minus-log plots, and the computation of Schoenfeld residuals for the chosen covariates. The level of significance was set at $p \leq 0.05$. SPSS version 19.0 and 20.0 and R software version 2.15.1 were used.

Results

Demographics

Mean age was lowest in the group of patient coming from outside Europe and former Soviet Union (61 years) and highest in the Swedish population (70 years). There were more female (64%) than males (36 %) patients. This was a consistent pattern in the 4 ethnical groups, being most pronounced in the Nordic countries outside Sweden (68% females) and least pronounced in Sweden (60% females).

Primary osteoarthritis was the most common preoperative diagnosis in all ethnic groups. In the population from Europe outside the Nordic countries it amounted to 80%, followed by Sweden and the Nordic Countries outside Sweden (78% and 77%). In patients born outside Europe and former Soviet this diagnosis constituted only 65 %. This group also had a high share of pediatric hip diseases (11% vs. 1.6–3.6% in the 3 other groups).

Table 1. Patient data based on ethnicity

Variables	Born in Sweden n (%)	Born in the Nordic countries excl. Sweden n (%)	Born in Europe excl. the Nordic countries and the former Soviet Union n (%)	Born outside Europe including the former Soviet Union n (%)
Sex				
M	56,480 (40.3)	2,029 (31.7)	1,416 (35.3)	417 (36.9)
F	83,818 (59.7)	4,367 (68.3)	2,597 (64.7)	713 (63.1)
Age ^a	69.7 (69.7–69.8)	67.8 (67.6–68.1)	67.1 (66.8–67.5)	61.4 (60.5–62.4)
< 50	5,864 (4.2)	298 (4.7)	288 (7.2)	298 (26.4)
50–59	17,798 (12.7)	955 (14.9)	593 (14.8)	168 (14.9)
60–69	38,468 (27.4)	2,102 (32.9)	1,250 (31.1)	225 (19.9)
70–79	52,690 (37.6)	2,355 (26.8)	1,424 (35.5)	304 (26.9)
≥ 80	25,479 (18.2)	686 (10.7)	458 (11.4)	135 (11.9)
Diagnoses				
Primary OA	108,966 (77.7)	4,925 (77.0)	3,221 (80.3)	732 (64.8)
Inflammatory disease	5,275 (3.8)	283 (4.4)	131 (3.3)	51 (4.5)
Fracture	18,032 (12.9)	817 (12.8)	363 (9.0)	125 (11.1)
Pediatric hip disease	2,212 (1.6)	121 (1.9)	146 (3.6)	126 (11.2)
Idiopathic femoral head necrosis	4,297 (3.1)	201 (3.1)	116 (2.9)	73 (6.5)
Others without tumor	1,517 (1.1)	49 (0.8)	36 (0.9)	23 (2.0)
Cohabiting				
Yes	81,319 (58.0)	3,439 (53.8)	2,267 (56.5)	621 (55.0)
No	58,980 (42.0)	2,957 (46.2)	1,746 (43.5)	509 (45.0)
Education (ISCED 97)				
Low	94,331 (67.2)	4,188 (65.5)	2,126 (53.0)	667 (59.0)
Middle	32,188 (22.9)	1,688 (26.4)	1,264 (31.5)	272 (24.1)
High	13,780 (9.8)	520 (8.1)	623 (15.5)	191 (16.9)
Comorbidity ^b				
Elixhauser 0	100,065 (71.5)	4,385 (68.8)	2,864 (71.5)	817 (72.6)
Elixhauser ≥1	39,808 (28.5)	1,984 (31.2)	1,139 (28.5)	309 (27.4)
Type of fixation				
Cemented	124,502 (89.0)	5,538 (86.8)	3,370 (84.3)	777 (69.2)
Uncemented	6,120 (4.4)	380 (6.0)	292 (7.3)	182 (16.2)
Hybrid	5,557 (4.0)	269 (4.2)	186 (4.7)	68 (6.1)
Inverse hybrid	3,004 (2.1)	179 (2.8)	122 (3.1)	80 (7.1)
Hip resurfacing	761 (0.5)	15 (0.2)	29 (0.7)	16 (1.4)

^a mean (95% CI).^b no comorbidity (0) or 1 or more comorbidities according to Elixhauser.

Cemented designs were the most frequently used in all 4 groups (relative share: 69–89%). There was, however a trend to choose uncemented components more frequently—either as an all-uncemented, hybrid or reversed hybrid arthroplasty—the farther away from Sweden the patient was born. Thus, all-uncemented components were used in 4.4% in the Swedish population, 6% in patients born in the other Nordic countries, 7.3% in patients born in the remaining part of Europe and, 16.2% in patients born outside Europe. A similar trend was observed for hybrids and inverse hybrids.

Most of the patients in the 4 groups were classified as having a low educational level (53–67%). The highest proportions of intermediate educational level were observed in the groups born in the Nordic countries (26%) and Europe outside the Nordic countries (32%), whereas patients from the last-mentioned region and patients born outside Europe had the highest proportions of high educational level (16% and 17%). Between 42 and 46% were living alone, and in the 4 groups 69–73% had no comorbidity registered.

Survival and revisions

Reoperation up to 2 years. 2,654 hips (1.7%) had been reoperated within 2 years, most often due to dislocation (38%) followed by infection (24%). The unadjusted frequency of reoperation varied between 1.3% (Europe outside the Nordic countries) and 2.0% (Outside Europe and the former Soviet Union). The unadjusted 2- year survival based on reoperation within 2 years varied between 97.9% (95% CI: –4 to 4) (outside Europe and the former Soviet Union) to 98.7% (95% CI: –2 to 2) (Europe outside the Nordic countries). Before adjustment, patients born in Europe excluding the Nordic countries showed a lower risk to undergo early reoperation (HR = 0.73, CI: 0.56–0.97, $p = 0.03$), which increased after adjustment to HR = 0.76 (CI: 0.58–1.01, $p = 0.05$). Patients born in the Nordic countries and outside Europe had a risk ratio closer to that of the population born in Sweden ($p \geq 0.6$), which showed minor changes after adjustment ($p \geq 0.4$). In the regression analysis, male sex and all 5 groups of secondary OA showed a higher risk than their corresponding reference groups. All

uncemented, inverse hybrids and resurfacing replacements were associated with increased risk for early reoperation compared to all-cemented components. Patients living alone and those with any comorbidity according to Elixhauser showed an increased risk for early reoperation (HR = 1.15, CI: 1.06–1.25; and HR = 1.41, CI: 1.30–1.52, respectively) (Table 2).

Revision up to 14 years. There were 7,358 revisions up to 14 years (4.8%), most often due to aseptic loosening (56%) followed by infection (24 %). The unadjusted frequency of revision varied between 4.9% (Europe outside the Nordic countries) and 6.5% (Outside Europe and the former Soviet Union). The unadjusted 14-year survival varied between 82.5% (CI: –3 to 3) outside Europe and the former Soviet Union) to 87.5% (CI: –3 to 3) for Europe excluding the Nordic countries. Before adjustment, patients born in the Nordic countries and outside Europe including the former Soviet Union showed a higher risk to undergo revision than patients born in Sweden (HR=1.14, CI: 1.02–1.3; $p=0.03$ as opposed to HR = 1.5, CI: 1.2–1.9 $p = 0.001$), but this difference disappeared after adjustment (HR = 1.1, CI: 1.0–1.2; $p = 1.0$ as opposed to HR = 1.04, CI: 0.82–1.3; $p = 0.77$). Patients born in Europe outside the Nordic countries showed an unadjusted risk ratio close to that of the reference group (HR = 1.08, CI: 0.9–1.2), which approached 1 after adjustment for confounders HR = 1.01, CI: 0.88–1.16). After exclusion of type of prosthetic fixation from the analysis, the risk ratios for the groups with different geographical origin remained almost unchanged.

In the complete regression analysis decreasing age, male sex, all groups of secondary OA except inflammatory arthritis, and use of uncemented components on the acetabular, femoral or both sides were associated with a statistically significantly increased risk of revision. Patients without any type of comorbidity according to Elixhauser had a decreased risk of revision, whereas whether or not the patients was cohabiting and educational level had no certain influence (Table 3).

Discussion

This is the largest and first nationwide study of the influence of ethnicity on the outcome of hip arthroplasty. We used 2 outcome parameters. Revision is the standard outcome reported from National Registers. Reoperation within 2 years is exclusively reported by the Swedish Register. This is dominated by surgical procedures caused by dislocation and infections- reasons for repeated surgery that can be related to the quality of the surgical process. This outcome is therefore reported by the Swedish Hip Arthroplasty Register as an indicator of surgical quality.

Previous studies have indicated that variable use of osteoarthritis treatment may be related to differences in perception of the usefulness of treatment with arthroplasty (Ang et al. 2002). Ibrahim et al. (2002) studied the willingness of African American and White patients to undergo arthroplasty or non operative arthritis care. African Americans were less

Table 2. Reoperation within 2 years. Hazard ratios according to regression analysis

Variables	HR	95% CI	p-value
Countries of birth (unadjusted)			
Born in Sweden ^a	1		
Born in the Nordic countries ^b	1.07	0.89–1.29	0.5
Born in Europe ^c	0.73	0.56–0.97	0.03
Born outside Europe ^d	1.16	0.77–1.75	0.5
Countries of birth (adjusted)			
Born in Sweden ^a	1		
Born in the Nordic countries ^b	1.09	0.91–1.31	0.4
Born in Europe ^c	0.76	0.58–1.01	0.05
Born outside Europe ^d	1.00	0.66–1.53	1.0
Sex			
M	1.42	1.31–1.54	< 0.001
F	1		
Age, years			
< 50	0.84	0.67–1.05	0.1
50–59	1.04	0.90–1.19	0.6
60–69	0.95	0.85–1.06	0.4
70–79	1		
≥ 80	1.02	0.91–1.13	0.8
Diagnosis			
Primary OA ^a	1		
Inflammatory disease	1.30	1.05–1.57	0.01
Fracture	2.72	2.47–2.99	< 0.001
Pediatric hip disease	1.56	1.19–2.06	< 0.001
Idiopathic femoral head necrosis	2.03	1.69–2.43	< 0.001
Others without tumor	2.12	1.58–2.84	< 0.001
Cohabiting			
Yes	1.15	1.06–1.25	0.001
No ^a	1		
Educational level (ISCED 97)			
Low ^a	1		
Middle	1.07	0.92–1.24	0.4
High	1.03	0.88–1.20	0.7
Comorbidities			
Elixhauser 0 ^a	1		
Elixhauser ≥ 1	1.41	1.30–1.52	< 0.001
Type of fixation			
Cemented ^a	1		
Uncemented	1.56	1.29–1.87	< 0.001
Hybrid	1.19	0.97–1.46	0.09
Inverse hybrid	2.06	1.67–2.53	< 0.001
Hip resurfacing	2.82	1.92–4.14	< 0.001

^a reference group.

^b excluding Sweden.

^c excluding the Nordic countries and the former Soviet Union.

^d including the former Soviet Union.

likely to undergo arthroplasty, but after adjustment for patient expectations this difference became insignificant.

Choice of treatment may vary regionally. Havelin et al. (2009) compared 3 national hip arthroplasty registers (Norway, Sweden and Denmark) in the Nordic Arthroplasty Database (NARA). They found differences in treatment concerning choice of fixation technique and incision. In Sweden and Norway, most of the THRs were all-cemented (89% and 79 %, respectively), whereas the all-cemented hip replacement in Denmark only accounted for 46%. The posterior approach was chosen more often in Denmark than in Sweden, and even more so than in Norway.

Table 3. Revision within 14 years. Hazard ratios according to regression analysis

Variables	HR	95% CI	p-value
Countries of birth (unadjusted)			
Born in Sweden ^a	1		
Born in the Nordic countries ^b	1.14	1.02–1.27	0.03
Born in Europe ^c	1.08	0.94–1.24	0.3
Born outside Europe ^d	1.49	1.18–1.88	0.001
Countries of birth (unadjusted)			
Born in Sweden ^a	1		
Born in the Nordic countries ^b	1.09	0.98–1.23	1.0
Born in Europe ^c	1.01	0.88–1.16	0.9
Born outside Europe ^d	1.04	0.82–1.31	0.8
Sex			
M	1.42	1.35–1.49	< 0.001
F ^a	1		
Age, years			
< 50	2.20	1.99–2.44	< 0.001
50–59	1.72	1.59–1.86	< 0.001
60–69	1.32	1.24–1.41	< 0.001
70–79	1		
≥ 80	0.83	0.75–0.91	< 0.001
Diagnosis			
Primary OA ^a	1		
Inflammatory disease	1.11	0.99–1.24	0.6
Fracture	1.80	1.67–1.94	< 0.001
Pediatric hip disease	1.49	1.31–1.70	< 0.001
Idiopathic femoral head necrosis	1.47	1.30–1.67	< 0.001
Others without tumor	1.38	1.15–1.65	< 0.001
Cohabiting			
Yes ^a	1		
No	0.98	0.93–1.03	0.5
Educational level (ISCED 97)			
Low ^a	1		
Middle	0.94	0.87–1.01	0.1
High	0.96	0.89–1.04	0.4
Comorbidities			
Elixhauser 0 ^a	1		
Elixhauser ≥ 1	1.14	1.06–1.20	< 0.001
Type of fixation			
Cemented ^a	1		
Uncemented	1.42	1.29–1.56	< 0.001
Hybrid	1.40	1.29–1.53	< 0.001
Inverse hybrid	1.29	1.08–1.54	0.004
Hip resurfacing	1.66	1.20–2.30	0.002

^a reference group.^b excluding Sweden.^c excluding the Nordic countries and the former Soviet Union.^d including the former Soviet Union.

There have only been a few studies that compared the outcome of joint arthroplasty between groups of different ethnicity. Nwachukwu et al. (2010) performed a review of 9 studies: 4 examined total knee replacement, 3 examined total hip replacement and 2 studies examined both. 2 of 4 studies found an increased mortality for blacks after either total hip or knee replacement. 3 of 4 found increased risk for infectious complications after total knee replacement in blacks and Hispanics and 4 of 4 found an increased risk of aseptic complications in blacks after the same procedure.

SooHoo et al. (2010) examined the rate of complications during the first 90 days postoperatively for patients undergo-

ing total hip replacement. They found that a variety of patient related factors were associated with increased risk of complications such as diabetes, rheumatoid arthritis, age, male sex and black race. Hispanics and Asian patients had lower risks of complications in this study. On the other hand, Ibrahim et al. (2005) found more complications in Hispanics and also in black patients, but after total knee replacement. Specifically, after total knee replacement, it appears that racial and ethnic minorities tend to have more postoperative complications (Collins et al. 1999, Weaver et al. 2003, Nwachukwu et al. 2010, SooHoo et al. 2010).

We found that male sex and all 5 groups of secondary OA showed a higher risk of reoperation and revision of total hip replacement than their corresponding reference groups. All uncemented, inverse hybrids and resurfacing replacements were associated with increased risk for early reoperation and revision compared to all cemented implants. Our findings are only to a certain extent similar to those reported by Katz et al. (2001) and SooHoo et al. (2010) who reported that age, sex, comorbidity, race and income had an effect on the risk of complications in the Medicare population.

Our immigrant patients were too few to be selected from a specific country of emigration, and no details were known about their cultural background, which makes comparison with previous studies uncertain. These studies examined increased risk of both ethnicity and race on total hip/knee replacement (Collins et al. 1999, Weaver et al. 2003, Nwachukwu et al. 2010, SooHoo et al. 2010), whereas we only partially could evaluate the specific influence of ethnicity for 2 patient groups from Europe, both with a comparatively wide definition-corresponding to the Nordic countries excluding Sweden and the remaining part of Europe excluding the former Soviet Union. Patients coming from countries outside Europe represented a number of different cultures. Probably most of our immigrant patients also had a different background than those groups evaluated in previous studies. Most of them-and especially those born outside Europe-tended to be younger and to have a higher level of education than the reference group. Our immigrant patients coming from countries outside Europe more often received uncemented implants. We believe that this was mainly the decision of the surgeon, based on their lower age and high prevalence of secondary osteoarthritis often associated with anatomical variations, which were judged to be more adequately addressed with uncemented fixation. They also more often suffered from secondary osteoarthritis and more frequently received uncemented implants, which have a different profile of complications than cemented prostheses. Before adjustment for these and other confounders, the risk of reoperation within 2 years was slightly reduced in Europeans born outside the Nordic countries, whereas the risk for revision was elevated in patients born in the Nordic Countries and still more so in those born outside Europe. These differences in outcome became insignificant after adjustment for confounders.

Thus, our study cannot be compared to previous studies of the influence of ethnicity without consideration of these factors. The influence of ethnicity will also most probably vary depending on factors unique to the culture in the specific country to which a person emigrates. The influence of ethnicity can also be expected to vary over time and between different generations of immigrants.

Provided that the indications for reoperation and revision were the same in the 4 groups studied by us, the failure rate turned to be about the same and independent on the origin of the patient. The outcomes studied by us are, however, only one aspect of the quality of THR. In a previous study, we compared the patient-reported outcome in terms of EQ-5D, VAS pain and VAS satisfaction in patients born in Sweden and in immigrants, all of whom received a THR. 1 year after the operation and after adjustment for confounders, patients born outside Sweden reported lower scores for self-care and usual activities in the EQ-5D form and more pain on a visual analogue scale (Krupic et al. 2012).

Most of the patients in the present study had a low educational level. The immigrant groups tended to have a higher proportion of patients with a medium or high educational level. This is in accordance with our previous study, where we studied patient-reported outcomes before and 1 year after THR in the Gothenburg region (Krupic et al. 2012). Patients born outside Sweden generally had a higher educational, but despite this they generally declared lower income than those born in Sweden. Even though they were well-educated, some of these patients may have difficulties in becoming employed because of language problems, suggesting that educational level and socio-economic status are not always correlated—especially not in immigrants.

Whether or not the patient was living alone could probably be regarded as a rather poor surrogate variable for social network. In most countries this information is not generally available, which probably explains why its influence on the outcome of medical interventions is rarely reported. Edit et al. (2012) studied the effect of psychosocial factors and comorbidities on the health status of patients with chronic nonspecific low back pain and patients with surgical intervention because of disk herniation. The authors measured quality of life and presence and degree of depression using validated instruments. They failed to show any correlation between the depression and variables such as marital status, education, and comorbidities and, suggested that depression runs parallel with the number of surgical procedures. In the present study, patients living alone showed an increased risk of early reoperation but not of revision during the entire period, whereas the presence of any comorbidity according to Elixhauser turned out to be a risk factor for both of these outcomes.

The present study had some limitations. The current literature usually differentiates between races, whereas our study focussed on geographical origin based on region of birth. This type of differentiation was done partly because no infor-

mation of race was available. We also think that the grouping performed by us is more relevant to the immigrant groups in Scandinavian countries and Northern Europe. Another limitation was that there were only 77 revisions in the smallest group, suggesting that some analyses are underpowered. However, combined registry data (e.g. Scandinavian countries) would provide more power for future studies on particular issues.

In conclusion, after adjustment for confounders we found no certain differences in revision within 14 years between patients born in Sweden and immigrants. Our finding that Europeans born outside the Nordic countries showed reduced risk of early reoperation was unexpected. Since these operations are mainly caused by dislocation and infection, it seems unlikely that these patients return to their previous habitat should any early complication occur. Before adjustment, 2 of the patient groups born outside Sweden showed an increased risk for revision, most probably reflecting differences in demography. The present study does not account for the beliefs of the patient and the attitudes of the health providers concerning disadvantages and benefits of total hip arthroplasty. Based on our findings, we have no reason to believe that there are any substantial differences regarding these factors in the treatment of a failed THA between patients born in Sweden and immigrants. Further studies are, however, needed to determine whether our observations have been biased by a reluctance of immigrants to seek medical attention should any complications occur.

FK and JK initiated and planned the study, prepared the database, performed statistical calculations, and wrote the manuscript. GG coordinated database compilation and edited the manuscript. MG and ThE prepared the database and computed comorbidity index. TE helped prepare the manuscript.

No competing interests declared.

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