# Factors associated with the orthopaedic surgeon's decision to recommend total joint replacement in hip and knee osteoarthritis: an international cross-sectional study of 1905 patients

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## INTRODUCTION

With the global ageing and increasing obesity and sedentary lifestyle of the world's population, the prevalence of osteoarthritis (OA) is increasing along with its social and economic impacts [1,2]. Lower-extremity OA affects mainly the hip and the knee, which leads to pain and functional disability. In 2010, hip and knee OA were ranked as the 11th highest contributor condition to global disability worldwide and their disability burden keeps growing [2]. Total joint replacement (TJR) is the current treatment for moderate to severe knee and hip OA that has failed to respond to non-surgical management, including pharmacologic and non-pharmacologic modalities, and has the potential for significant improvement of pain, functional capacity and quality of life [3-5]. However, not all patients with OA will benefit from TJR. In the context of increasing burden of OA and consequent growing needs for this surgery, we need to better understand who receives an indication for TJR. This is linked to the ongoing studies on appropriateness criteria to consider TJR [6-12].

In studies exploring factors associated with TJR [13-19], some factors were key in the decision for TJR, such as levels of symptoms [5,13-18] and radiographic damage [13,14,17,18,20-22], whereas other factors were not linked to TJR, including patients' gender and body mass index [14-19]. For several factors, the association with TJR remained unclear, such as patients' age, comorbidities, and quality of life [15,18]. Furthermore, other previously unexplored factors may play a relevant role, like patients' social situation and surgeons' characteristics.

In 2010, a large international study was conducted under the auspices of the Osteoarthritis Research Society International (OARSI) and Outcome Measures in Rheumatology (OMERACT). The aim was to determine cut-offs for pain and

functional impairment related to the indication for TJR [23]. In the primary analyses, only pain and function were analysed: the main conclusions were that although both pain and function played a role in the surgeon's decision, because of substantial overlap no satisfactory cut-off values could be established to distinguish patients selected or not for TJR with an area under the receiver operating characteristic (ROC) curve greater than 0.64 [0.61;0,67] [23]. This dataset gave us the opportunity to explore more completely criteria involved in the indication of TJR, using the surgeon's opinion as the gold standard.

The objective of the present study was to determine the factors associated with the surgeon's recommendation to perform TJR in people with both knee and hip OA, in the context of a large, international, multi-site study.

## PATIENTS AND METHODS

### Study design

The study design has been described previously [23]. Briefly, this was a large international, observational, cross-sectional study with prospective inclusion, in the orthopaedic departments of secondary-care and tertiary-care centers in Europe (12 centers, one per country in Czech Republic, Italy, Spain, Sweden and the United Kingdom; two per country in France and the Netherlands; three in Germany), Canada (2 centers), the United States of America (2 centers), and Australia (2 centers). Ethical approval was obtained in all participating centers. All patients gave informed consent. The research forms were completed during a routine patient visit and no queries were sent to the investigators in case of missing data.

Study population

Consecutive outpatients with a clinical diagnosis of hip or knee OA (according to the orthopaedic surgeon and based on symptoms and radiographs) consulting an orthopaedic surgeon in one of the participating centers to discuss potential surgery were included for this analysis. Exclusion criteria were: prior TJR or prior osteotomy of the target joint, concomitant inflammatory joint disease, and patient inability to complete a questionnaire. Furthermore, among patients who had given data, only those with information on the surgeons' recommendations to perform TJR or not were included in the analysis.

Gold standard: Indication for TJR

The outcome analysed in the present study was the orthopaedic surgeon's indication regarding the requirement for TJR, i.e., the surgeon stating "surgery is recommended for the patient". This answer defined the 'indication for TJR', irrespective of whether the joint replacement surgery was performed or not.

Potential variables associated with surgeons' indication for TJR

Demographic data comprising age, gender, and body mass index (BMI, calculated based on height and weight, then analysed both as a continuous variable and categorised) were collected. Due to the high mean BMI in this population, the decision was taken to analyse BMI as above or below 35 kg/m2. Comorbidities were reported using a modified Charlson Comorbidity Index, and were analysed as the sum of the number of comorbidities (range, 0-14) [24]. Symptom severity was collected through the Western Ontario and McMaster Universities Osteoarthritis

(WOMAC) Index (total score; pain, function and stiffness subscales) [25]. WOMAC results were linearly transformed to a 0-100 score, where higher scores indicated worse status [23]. Patients' joint-related quality of life was evaluated by the Quality of Life subscale of the Hip disability and Osteoarthritis Outcome Score (HOOS) and Knee disability and Osteoarthritis Outcome Score (KOOS), as appropriate [26,27]. The HOOS/KOOS are two valid and reliable instruments with five individually calculated subscales that can be used for short-term and long-term follow-up of several types of hip/knee injury including OA. HOOS/KOOS scores are reported on a 0-100, worst to best, scale. Where radiographs of the target joint were available, the local investigator reported the OARSI joint space narrowing (JSN) radiological grade [28,29]. X-rays were taken in the context of usual care, according to local protocols. The score analyses JSN in categories from 0 to 4: (0) no narrowing, (1) < 25%, (2) 25-50%, (3) 50-75%, (4) > 75% of JSN [20,21]. The patients' social situation was collected by the physician as "living alone" (yes/no) and "being responsible for another person" (yes/no). Surgeons' characteristics such as gender and years of experience (year of certification as an orthopaedic surgeon) were collected.

Surgeon's reported reason(s) not to recommend TJR

If the surgeon selected "no indication for TJR", underlying reasons for not recommending surgery were collected from the surgeon as: symptoms not severe enough, patient declining surgery, comorbidity, main problem not being hip/knee OA, further investigations required, another treatment should be tried first.

Patients not recommended for TJR who were considered « not severe enough » were compared in terms of WOMAC total score with patients not recommended for other reasons.

Statistical analysis

Patient characteristics were described separately for knee and hip OA patients. To assess factors associated with indication for TJR, univariable analyses where OR with 95% confidence intervals have been calculated were performed in each patient population, evaluating each variable.

Forward multivariable logistic regressions were then performed, including variables with $p<0.20$ in univariable analyses and excluding colinear variables, eg WOMAC subscales (**online supplementary table 1**). Since OARSI JSN is a qualitative variable, radiographic severity was binarised as grade 1-2 versus 3-4. Surgeons' characteristics were analysed at the patient level rather than at the surgeon level.

There was no imputation of missing data. As there were many missing data for the radiographic grade and for surgeons' characteristics, a second multivariable logistic regression was performed excluding these variables, both for patients with knee and hip OA. All multivariable analyses were adjusted for country of residence as the objective was not to compare results between countries, given small sample sizes [23]. No formal testing was performed across countries.

All analyses were performed using R software, version 3.2.5.

## RESULTS

Patient characteristics

In all, 1974 patients were enrolled between June 2008 and December 2010. Among them, 1905 patients (96.5%) had data for TJR indication and were analysed: 1127 knee OA and 778 hip OA patients. Patients were from: Europe (N=1121), Australia (N=394), Canada (N=204) and the United States of America (N=186). Patient characteristics were typical of established OA cohorts (**Table 1**). Mean age was 66.5 [standard deviation (SD) 10.8] years, 1082/1866 (58.0%) were women, mean OA symptom duration was 6.3 (SD 8.4) years in knee OA patients and 3.3 (SD 3.4) years in hip OA patients. WOMAC subscale scores for pain and functional disability (0-100) were respectively 52.8 (SD 21.8) and 55.4 (SD 20.9) for knee OA; 56.5 (SD 21.6) and 59.5 (SD 20.9) for hip OA. In all, 516 patients had all data available (**online supplementary Table 2)**. Most patients for whom radiographic data were available had severe JSN: 351/512 (69.0%) knee OA patients and 311/403 (82.9%) hip OA patients had an OARSI JSN radiographic grade of 3 or 4.

Factors associated with TJR recommendation in univariable analysis

TJR was recommended in 561/1127 (49.8%) knee OA and 542/778 (69.7%) hip OA patients (**Table 1**).

*Knee OA:* In univariable analysis for knee OA (**Table 2**), the variables related to the decision to recommend total knee replacement (TKR) were older age (with more indications for TJR in the range 60 to 79 years old, **online supplementary table 3**), male gender, longer OA symptom duration, history of another TJR, patient living alone, patient being responsible for another person, higher WOMAC total score and subscale scores, lower KOOS Quality of life subscale score, more severe OARSI JSN radiographic grade, surgeon's male gender and years of experience. In contrast,

BMI (both continuous and categorized) and number of comorbidities were not associated with the indication of TKR.

*Hip OA:* In univariable analysis for hip OA (**Table 3**), factors associated with the decision to recommend total hip replacement (THR) were older age (again with most indications for TJR between 60 and 79 years of age, **online supplementary table 3**), longer OA symptom duration, patient living alone, higher WOMAC total score and all WOMAC subscales, lower HOOS Quality of life subscale score, more severe OARSI JSN radiographic grade and surgeon's male gender. Patients' gender, BMI (both continuous and categorized), history of another TJR, number of comorbidities, patient being responsible for another person and surgeon's experience were not associated with the indication for THR.

Factors associated with indication for TJR in multivariable analysis

A first multivariate analysis adjusted by country was performed in the 516 patients for whom all data, including radiographic assessment, were available (**Tables 4 and 5 and online supplementary table 1**). Independent factors associated with TJR in both knee and hip OA patients were OARSI JSN grade (assessed for an increase of one point) and higher (i.e. more symptoms, disability and stiffness) WOMAC total score. The corresponding results were respectively for knee OA, Odds Ratio, for a 1-point increase of OARSI JSN radiographic grade, OR: 2.90, 95% Confidence Interval [1.69;4.97] and OR for a 10-point increase of WOMAC total score: 1.65 [1.32;2.06]; and respectively for hip OA, OR: 3.30 [2.17;5.03] and OR: 1.38 [1.15;1.66]. The other demographic factors, including patient's social situation or surgeon characteristics, were not independently associated with a TJR indication.

As there were many missing data for the OARSI JSN radiographic grade and for surgeons' characteristics, a second multivariable logistic regression was performed excluding these variables, both for knee and hip OA (**Tables 4 and 5**). In these analyses, 1265 patients contributed (characteristics in **online supplementary table 2**). Here, higher (i.e. more symptoms, disability and stiffness) WOMAC total score (knee: OR 1.25 [1.14;1.37] and hip: OR 1.49 [1.33;1.68]) was a significant factor associated with indication for TJR in knee and hip OA. Patients' older age (knee: OR 1.03 [1.01;1.04]) was a significant factor in knee OA. No other factors were independently associated with a TJR indication.

Surgeons' reasons to not recommend TJR

For both knee and hip OA, almost half of patients for whom the surgeons did not recommend TJR were considered by the surgeon to be "not symptomatic enough" (N=224/491 (45.6%) and N=102/219 (46.5%), respectively) (**Table 6**). For these patients, symptom levels were indeed less severe at the group level: in knee and hip OA, WOMAC total score was 42.2 (SD 19.9) and 35.3 (SD 19.7) respectively, vs 51.5 (SD 20.3) and 55.6 (SD 19.9), in patients for whom surgery was not recommended because "symptoms were not severe enough" and those for whom TJR was not indicated for "other reasons", respectively (both $p<0.0001$). The second most frequent reason for the surgeon to not recommend TJR was because "another treatment should be tried first", in both knee and hip OA (**Table 6**).

## DISCUSSION

The present study brings relevant information on the reasons for orthopaedic surgeons recommending TJR. It confirmed the role of radiographic scores and symptoms as independent factors associated with surgeons' recommendation to perform TJR. It appeared, on the sample of patients with available radiographic scores, that the orthopaedic surgeon's decision to recommend a TJR was largely based on radiographic severity, i.e., a state of moderate-to-severe OA, in the present patients, who had pain and functional limitations. We also found that patient's age is an important factor in particular for knee OA. This study confirmed that some other factors were not associated with recommendation for TJR, such as patients' gender, BMI and comorbidities. Finally, previously unexplored factors, linked to patients' social situation or surgeons' characteristics that could be analysed, did not appear to be associated with surgeon's recommendation for TJR.

This study has strengths and limitations. The main limitation is the high rate of missing data, probably due to the large number of sites and the lack of queries sent to investigators for missing data. This led to a smaller analysed population in the multivariable logistic regressions. Nevertheless, to our knowledge, this is the only international study and among the largest, possibly explaining the difficulty to obtain information from all the involved participants (patients and practitioners). The factors that were most frequently missing were OARSI JSN radiographic grade and surgeons' characteristics. Missing data on radiographs could be explained by lack of availability of the radiograph, or a lack of standardised assessment. Surgeons' characteristics were given by orthopaedic surgeons themselves while filling case report forms during the visit but this page was often not completed. A second analysis

was therefore performed excluding these two factors. Of note, characteristics of the multivariable populations were similar compared to the initial 1905 included patients **(Online supplementary table 1)** which would be an argument in favour of random missing data. After excluding OARSI JSN radiographic grade and surgeons' characteristics, patient's age appeared to be a factor associated with indication for TJR, in knee OA: in this study population of a mean age of 69.0 years (SD 9.5), patients aged from 60 to 79 years were more likely to be recommended for TJR than younger patients (<60 years old) or older patients (>80 years old) **(Online supplementary table 3)**. It is possible that older patients had more radiographic JSN however this is not the only factor given the U shape of the relationship. Restrictions in recommendation of TJR in younger patients could also be explained by a higher revision rate (with subsequent poorer outcomes), as mentioned in Verra et al's study [30]. Other limitations include the incomplete nature of the data collection; for example, psychological distress, ethnicity and socioeconomic status were not collected although it has been suggested that they are predictors of patients being offered joint replacement. Finally, as variables from the univariable analysis were selected for entry into the multivariable model rather than all entered, we recognise some variables may have been missed. However, this method avoided colinearity between the variables.

In this group of patients with definite knee or hip OA, TJR was recommended in 49.8% and 69.7% respectively. These rates can be compared to prior studies which vary between 16% and 60% [13,14,17-19]. This indicates both the variability of surgery rates, and possibly differences between studies focused on surgery as the event, where rates were lower, and indication for surgery, where rates were

245 comparable to the ones found here. Better clarity on appropriateness criteria for TJR
246 would reduce inappropriate referrals and decisions [6-12].
247 In the present study, differences across countries were not analysed although
248 recommendations for TJR may vary by country [6-12], due to differences in clinical
249 practice and healthcare systems. Only a few centres participated in each country.
250 Therefore, results of this present study cannot be considered representative of
251 national practices. Furthermore, disparities among countries on pain and function
252 evaluation have been previously pointed out within this cohort [23]. To account for
253 national differences, results were adjusted by country.
254 The use of validated scores such as WOMAC and OARSI JSN radiographic scores,
255 not systematically used in prior studies [13,19] is a strength of this study, although the
256 use of the WOMAC total score is still in discussion [25].
257
258 The level of symptoms, in terms of pain and disability, and the radiographic severity,
259 were higher among patients for whom TJR was indicated by the surgeon, which is in
260 accordance with previous studies [14,17,18] and 4 national guidelines for assessing
261 need for total knee and hip replacement : (1) the US National Institute of Health
262 consensus guidelines, suggesting that knee and hip TJR should be considered in
263 patients with persistent pain, radiographic damage and limitation in daily activities
264 [35,36]; (2) Canadian criteria, listed by Hawker et al in 2000, considering that a total
265 WOMAC score ≥ 39, and clinical and radiographic evidences of OA should lead to
266 TJR [37]; (3) the French severity index for OA by Lequesne, composed of 3 criteria
267 (pain, maximum distance walked and activities of daily living) and suggesting knee or
268 hip TJR when ≥ 14 out of a possible 24 [38]; and (4) the New Zealand score,
269 considering that levels of pain, functional activity, movement and deformity, and other

factors such as multiple joint disease or ability to work could determine indication for knee or hip TJR [39]. These guidelines or consensus statements, although using pain and functional impairment criteria in majority, reveal some heterogeneity and difficulty in application in practice. This could explain in part why, to this day, no validated international guidelines exist. [6-12]. Of note, in the present study, JSN ( a qualitative score) wasanalysed as a binary variable, thus losing some granularity; however, radiographic severity is usually considered as present/absent when deciding on TJR. [36-39] The present study also confirmed the substantial overlap in symptoms and function between patients oriented or not towards TJR.[23]

Similarly to previous studies [19], the present study found that gender and BMI were not associated with indication for TJR. Of note, BMI was analysed using a cutoff of 35 kg/m2 but analyses with BMI as a continuous variable were similar. Factors which were doubtful or much less explored in previous studies appeared here not to be associated with indication for TJR, including comorbidities. Hawker et al also found no association with the number of comorbidities [15] although Maillefert et al concluded surgeons tended to indicate THR more often if patients had no severe cardiovascular comorbidity [18]. In the present study, each patient had around 3 comorbidities, but this factor was not associated with indication for TJR. This might reflect improvements in TJR and anesthesiology techniques, leading to a shorter surgical time and less risks for the patient, regardless of medical history. In terms of quality of life, the present study did not find a link with indication for TJR, unlike the studies performed by Hawker et al and Maillefert et al [8,10], perhaps due to the use of different scales. Furthermore, as joint-related quality of life is strongly related to pain and function, this variable was not entered in the multivariable analysis. Among

the new factors that this study was able to explore, related to patients' social situation and surgeons' characteristics, no significant links were found; though such findings would need to be further confirmed.

This cohort gave us the opportunity to explore indication for TJR rather than TJR itself, hence excluding a subset of confounding factors such as socio-economic criteria or patients' willingness, but also patients' expectations or psychological distress in order to determine factors that influence a surgeon's decision to recommend or not recommend TJR [31-34]. In this study, we collected the surgeon's reasons for not recommending TJR, when surgery was not recommended. For both knee and hip OA, almost half of patients for whom the surgeons did not decide on TJR were considered by them as "not symptomatic enough", and the second most frequent reason announced was "because another treatment should be tried first". These descriptive results suggest that patients might be referred perhaps too widely to orthopaedic surgeons. Other treatment options than surgery should be discussed first [40].

In summary, determining when to recommend TJR in knee and hip OA patients is difficult, but factors that help in such a decision are definitely the ones reflecting radiographic severity and higher levels of symptoms. Further studies are needed in particular to better define potential candidates for TJR, in the context of high and increasing world-wide burden of OA.

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## AUTHOR CONTRIBUTIONS

All the authors contributed to

(1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data

(2) drafting the article or revising it critically for important intellectual content

(3) final approval of the version to be submitted.

Laure Gossec (laure.gossec@aphp.fr) takes responsibility for the integrity of the work as a whole, from inception to finished article.

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The study sponsors played no role in the study design, in the collection, analysis and interpretation of data; in the writing of the manuscript; or in the decision to submit the manuscript for publication.

## CONFLICTS OF INTEREST

None relevant to the present work.

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## Table 2. Factors associated with indication for knee replacement in 1127 patients with knee OA: univariable analysis

| Variable | TKR recommended N= 561 | TKR not recommended N= 566 | OR [95% CI] | P value |
|---|---|---|---|---|
| Age, years, [N] mean (SD) | [447] 69.0 (9.5) | [434] 66.0 (11.0) | 1.03 [1.17-1.52] | <0.0001 |
| Gender, female, n/N (%) | 210/553 (38.0) | 249/560 (44.5) | 0.76 [0.60-0.97] | 0.03 |
| BMI, kg/m², [N] mean (SD) | [434] 30.9 (6.2) | [435] 31.0 (7.5) | 1.00 [0.98-1.02] | 0.81 |
| BMI > 35kg/m², n/N (%) | 98/434 (22.6) | 102/435 (23.4) | 0.95 [0.69-1.31] | 0.76 |
| OA symptom duration, years, [N] mean (SD) | [296] 7.1 (8.0) | [332] 5.6 (8.7) | 1.00 [1.00-1.01] | 0.03 |
| Comorbidities (KCS score), [N] mean (SD) | [474] 3.2 (1.7) | [358] 3.1 (1.7) | 1.03 [0.95-1.12] | 0.46 |
| History of another joint replacement (yes), n/N (%) | 122/542 (22.5) | 73/528 (13.8) | 1.81 [1.32-2.50] | <0.001 |
| Patient living alone, n/N (%) | 175/546 (32.1) | 135/530 (25.5) | 1.38 [1.06-1.80] | 0.02 |
| Patient being responsible for another person, n/N (%) | 120/543 (22.1) | 142/529 (26.8) | 0.77 [0.58-1.02] | 0.07 |
| Pain, WOMAC subscale (0-100), [N] mean (SD) | [540] 57.0 (20.5) | [520] 48.0(22.0) | 1.11 [1.07-1.14] | <0.001 |
| Function, WOMAC subscale (0-100), [N] mean (SD) | [479] 45.6 (14.5) | [480] 38.9 (16.2) | 1.03 [1.02-1.04] | <0.001 |
| Stiffness, WOMAC subscale (0-100), [N] mean (SD) | [536] 61.9 (25.0) | [507] 52.5 (25.2) | 1.20 [1.12-1.28] | <0.001 |
| WOMAC total score (0-100), [N] mean (SD) | [471] 57.0 (18.0) | [451] 48.7 (20.3) | 1.02 [1.02-1.03] | <0.001 |
| KOOS Quality of life subscale (0-100), [N] mean (SD)* | [518] 23.7 (19.6) | [536] 31.8 (16.8) | 0.98 [0.97-0.98] | <0.0001 |
| OARSI JSN radiographic grade (3-4), n/N (%) | 187/206 (90.8) | 164/306 (45.5) | 8.52 [5.17-14.77] | <0.0001 |
| Surgeon's gender, male, n/N (%)** | 268/288 (93.0) | 347/391 (88.7) | 1.70 [0.90-3.01] | 0.04 |
| Surgeon's experience, years, [N] mean (SD) | [284] 19.1 (9.3) | [375] 16.8 (8.7) | 1.03 [1.01-1.05] | 0.001 |

% are % of available data. N=number of patients with available data.
*Lower scales indicate worse status
**This line indicates that 93.0% of patients recommended for surgery had seen a male surgeon

## Table 3. Factors associated with indication for hip replacement in 778 patients with hip OA: univariable analysis

| Variable | THR recommended N= 542 | THR not recommended N= 236 | OR [95% CI] | P value |
|---|---|---|---|---|
| Age, years, [N] mean (SD) | [449] 65.8 (10.5) | [199] 63.1 (12.8) | 1.02 [1.01-1.04] | 0.004 |
| Gender, female, n/N (%) | 292/524 (55.7) | 133/229 (58.1) | 1.08 [0.79-1.47] | 0.65 |
| BMI, kg/m², [N] mean (SD) | [449] 28.3 (4.8) | [182] 28.3 (5.9) | 1.00 [0.97-1.04] | 0.92 |
| BMI > 35kg/m², n/N (%) | 42/446 (9.4) | 24/181 (13.2) | 0.68 [0.40-1.17] | 0.16 |
| OA symptom duration, years, [N] mean (SD) | [306] 3.7 (3.7) | [127] 2.3 (2.3) | 1.00 [1.00-1.01] | <0.0001 |
| Comorbidities (KCS score), [N] mean (SD) | [466] 3.1 (1.6) | [163] 2.9 (1.6) | 1.04 [0.93-1.17] | 0.51 |
| History of another joint replacement (yes), n/N (%) | 122/526 (23.2) | 42/218 (19.3) | 1.27 [0.65-1.13] | 0.24 |
| Patient living alone, n/N (%) | 147/526 (27.9) | 77/220 (35.0) | 0.72 [0.52-1.01] | 0.06 |
| Patient being responsible for another person, n/N (%) | 111/521 (21.3) | 49/218 (22.5) | 0.93 [0.64-1.37] | 0.72 |
| Pain, WOMAC subscale (0-100), [N] mean (SD) | [520] 60.4 (19.0) | [221] 47.5 (24.5) | 1.16 [1.11-1.21] | <0 .0001 |
| Function, WOMAC subscale (0-100), [N] mean (SD) | [475] 63.7 (18.1) | [202] 49.8 (23.4) | 1.05 [1.04-1.06] | <0 .0001 |
| Stiffness, WOMAC subscale (0-100), [N] mean (SD) | [517] 63.4 (22.6) | [214] 48.8 ( 25.6) | 1.36 [1.25-1.49] | <0 .0001 |
| WOMAC total score (0-100), [N] mean (SD) | [461] 62.6 (17.7) | [189] 48.5 (22.3) | 1.04 [1.03-1.05] | <0 .0001 |
| HOOS Quality of life subscale (0-100), [N] mean (SD)* | [500] 22.7 (16.3) | [215] 38.1 (22.0) | 0.96 [0.95-0.97] | <0 .0001 |
| OARSI JSN radiographic grade (3-4), n/N (%) | 232/246 (94.3) | 79/169 (61.2) | 10.49 [5.64-20.67] | <0 .0001 |
| Surgeon's gender, male, n/N (%)** | 287/307 (93.5) | 142/163 (87.1) | 2.12 [1.11-4.07] | 0.02 |
| Surgeon's experience, years, [N] mean (SD) | [299] 18.3 (9.7) | [161] 17.1 (8.8) | 1.01 [0.99- 1.03] | 0.21 |

% are % of available data. N=number of patients with available data.
*Lower scales indicate worse status
**This line indicates that 93.5% of patients being recommended for surgery had seen a male surgeon

**Table 4. Factors associated with indication for TKR : multivariate analysis adjusted on country**

| Variable | Complete model<br>OR [95% CI] | Second model<br>OR [95% CI] |
|---|---|---|
| OARSI JSN radiographic grade (3-4), for 1-point increase | **2.90 [1.69-4.97]** | Not analysed |
| WOMAC total score (0-100), for 10-point increase | **1.65 [1.32-2.06]** | **1.25 [1.14-1.37]** |
| Age, years | 1.01 [0.97-1.06] | **1.03 [1.01-1.04]** |
| Gender, female | 1.01 [0.47-2.12] | 0.90 [0.95-0.99] |
| Patient being responsible for another person | 1.21 [0.44-3.24] | 0.93 [0.61-1.43] |
| Surgeon's experience, years | 1.06 [0.99-1.13] | Not analysed |

The complete model included all variables but due to missing data only 243 patients contributed to the model
The second model was performed after excluding the variables with most missing data, radiographic OARSI grade and surgeon's experience. In this model 754 patients were analysed.
Significant results are presented in bold type.

**Table 5. Factors associated with indication for THR: multivariate analysis adjusted on country**

| Variable | Complete model<br>OR [95% CI] | Second model<br>OR [95% CI] |
|---|---|---|
| OARSI JSN radiographic grade (3-4), for 1-point increase | **3.30 [2.17-5.03]** | Not analysed |
| WOMAC total score (0-100), for 10-point increase | **1.38 [1.15-1.66]** | **1.49 [1.33-1.68]** |
| Age, years | 1.02 [0.98-1.04] | 1.02 [1.00-1.04] |
| BMI >35kg/m² | 1.32 [0.41-4.97] | 0.72 [0.37-1.48] |
| Patient living alone | 1.18 [0.55-2.62] | 0.60 [0.37-0.96] |
| Surgeon's gender, male | 1.04 [0.27-3.61] | Not analysed |

The complete model included all variables but due to missing data only 273 patients contributed to the model
The second model was performed after excluding the variables with most missing data, radiographic OARSI grade and surgeon's gender. In this model 511 patients were analysed.
Significant results are presented in bold type.

**Table 6. Surgeons' announced reasons for « non-indication for TJR »**

| Reasons | Knee, N=491<br>N (%) | Hip, N=219<br>N (%) |
|---|---|---|
| Symptoms were not severe enough | 224 (45.6) | 102 (46.5) |
| Another treatment should be tried first | 147 (29.9) | 50 (22.8) |
| Because of comorbidity | 36 (7.3) | 13 (5.9) |
| Patient declined surgery | 26 (5.3) | 17 (7.8) |
| Further investigations are required | 22 (4.5) | 20 (9.1) |
| Main problem was not hip/knee OA | 12 (2.4) | 9 (4.1) |
| Other causes | 24 (4.9) | 8 (3.7) |