Patient characteristics affecting the prognosis of total hip and knee joint arthroplasty: a systematic review

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Background: Total joint arthroplasty is a highly efficacious and cost-effective procedure for moderate to severe arthritis in the hip and knee. Although patient characteristics are considered to be important determinants of who receives total joint arthroplasty, no systematic review has addressed how they affect the outcomes of total joint arthroplasty. This study addresses how patient characteristics influence the outcomes of hip and knee arthroplasty in patients with osteoarthritis. **Methods:** We searched 4 bibliographic databases (MEDLINE 1980–2001, CINAHL 1982–2001, EMBASE 1980–2001, HealthStar 1998–1999) for studies involving more than 500 patients with osteoarthritis and 1 or more of the following outcomes after total joint arthroplasty: pain, physical function, postoperative complications (short- and long-term) and time to revision. Prognostic patient characteristics of interest included age, sex, race, body weight, socioeconomic status and work status. **Results:** Sixty-four of 14 276 studies were eligible for inclusion and had extractable data. Younger age (variably defined) and male sex increased the risk of revision 3-fold to 5-fold for hip and knee arthroplasty. The influence of weight on the risk of revision was contradictory. Mortality was greatest in the oldest age group and among men. Function for older patients was worse after hip arthroplasty (particularly in women). Function after knee arthroplasty was worse for obese patients. **Conclusion:** Although further research is required, our findings suggest that, after total joint arthroplasty, younger age and male sex are associated with increased risk of revision, older age and male sex are associated with increased risk of mortality, older age is related to worse function (particularly among women), and age and sex do not influence the outcome of pain. Despite these findings, all subgroups derived benefit from total joint arthroplasty, suggesting that surgeons should not restrict access to these procedures based on patient characteristics. In addition, future research needs to provide standardized measures of outcomes.

Contexte : L'arthroplastie totale est une intervention très efficace et rentable pour soulager l'arthrite modérée ou grave à la hanche ou au genou. Bien que les caractéristiques du patient soient considérées comme des facteurs importants pour choisir les récipiendaires d'une arthroplastie totale, aucune synthèse systématique ne fait état de leur incidence sur les résultats. La présente étude traite de l'incidence des caractéristiques des patients atteints d'arthrose sur les résultats d'une arthroplastie de la hanche ou du genou. **Méthodes** : Nous avons consulté 4 bases de données bibliographiques (MEDLINE 1980–2001, CINAHL 1982–2001, EMBASE 1980–2001 et HealthStar 1998–1999) pour trouver des études sur plus de 500 patients atteints d'arthrose et ayant présenté un ou plusieurs des résultats suivants après une arthroplastie totale : douleur, fonction physique, complications postopératoires (à court et à long terme) et attente d'une révision. Les caractéristiques pronostiques retenues comprenaient l'âge, le sexe, la race, le poids corporel, la situation socioéconomique et l'état relatif à l'emploi. **Résultats** : Des 14 276 études, 64 pouvaient être incluses et contenaient des données extractibles. On a constaté un risque de révision de 3 à 5 fois plus élevé pour les arthroplasties de la hanche ou du genou réalisées dans les groupes plus jeunes (définis de façon variable) et chez les hommes. L'influence du poids

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sur le risque de révision s'est révélée contradictoire. La mortalité était plus élevée dans les groupes plus âgés et chez les hommes. La fonction physique s'était détériorée chez les patients plus âgés après une arthroplastie de la hanche (plus particulièrement chez les femmes), ainsi que chez les patients obèses après une arthroplastie du genou. **Conclusion** : Bien qu'une recherche plus approfondie s'impose, nos conclusions indiquent que, après une arthroplastie totale, le risque de révision augmente dans les groupes plus jeunes et chez les hommes, alors que le risque de mortalité s'accroît dans les groupes plus âgés et chez les hommes. De plus, une détérioration de la fonction a été observée dans les groupes plus âgés (plus particulièrement chez les femmes), mais l'âge et le sexe ne semblent pas influer sur la douleur. Malgré ces conclusions, tous les sous-groupes ont tiré profit d'une arthroplastie totale, ce qui incite à penser que les chirurgiens ne devraient pas restreindre l'accès à cette intervention en fonction des caractéristiques des patients. Il importera cependant que la recherche future fournisse des mesures normalisées des résultats.

Total joint arthroplasty of the hip and knee result in substantive and sustained improvement in quality of life for individuals with moderate to severe osteoarthritis.[1,2] Total joint arthroplasty is highly cost-effective and may even be cost-saving in the management of disability related to arthritis.[3] However, previous population-based research has shown that many patients who are appropriate for, and willing to consider, total joint arthroplasty have not had the procedure.[4] Although physicians agree about the value of arthroplasty, they show little agreement on how patient characteristics affect their decisions to perform or refer patients for total joint arthroplasty.[5,6] This variation in opinion has been linked to area variation in care delivery.[7]

Young and colleagues[8] reported that the best functional outcomes and prosthesis survival rates after hip arthroplasty were reported among patients between 45 and 75 years of age who weighed less than 70 kg, and had strong social support, a higher level of education, better preoperative functional status and no comorbid diseases. However, this was not a systematic review. Callahan and colleagues[9,10] performed a review of the outcomes of total knee arthroplasty but did not identify the effect of patient characteristics on outcomes. Thus a systematic review of the literature evaluating the effect of patient characteristics on the outcomes of joint arthroplasty is lacking.

The purpose of our systematic review was to determine how patient characteristics affect the outcomes of hip and knee arthroplasty. Establishing how patient characteristics influence the outcome of total joint arthroplasty would assist in patient selection and provide patients with better information about the risks and benefits of the procedure. An evidence-based systematic review of the literature has the potential to improve consensus among physicians and patients and thereby improve access and quality of care.[11]

Methods

Search strategy

We searched 4 bibliographic databases (MEDLINE 1980–2001, EMBASE 1980–2001, CINAHL 1982–2001 and HealthStar 1998–1999). We selected the Medical Subject Headings (MeSH) and keywords detailed in Box 1 with the assistance of an experienced research librarian.[12]

Study selection

We imported all citations into a bibliographic management program (Reference Manager 9.5, RSI Research Software Inc.). We used a modified approach based on the *Cochrane Reviewers Handbook*[13] to systematically select citations in 2 stages: identification and selection. Raters were not blinded to citation identifiers (e.g., author, institution, year of publication) because unblinding has been shown to have minimal potential for selection bias.[14] Two pairs of trained raters evaluated all English-language citations, and a single native speaker evaluated all non-English citations.

Eligibility criteria

In the identification phase, we reviewed abstracts to identify studies with sample sizes of 500 or more; we chose this sample size to have sufficient statistical power to evaluate the effect of multiple factors on rare outcomes of total joint arthroplasty such as death or revision. We identified citations in 19 languages other than English. We decided a priori not to review studies that constituted less than 10% of the total number of non-English citations retrieved. Of the 441 non-English studies that we reviewed, those in French (26.1%), German (22.5%), Scandinavian (14.1%, Danish, Finnish, Norwegian, and Swedish) and Italian (10.0%) accounted for 73%.

In the selection phase, we evaluated the full text of all studies with 500 or more participants against the

Box 1. Search terms used to retrieve citations from the MEDLINE bibliographic database*

Set 1
"Arthroplasty, replacement knee," for knee prosthesis and "arthroplasty, replacement hip" for hip prosthesis
Set 2
(Prognosis +, survival analysis, morbidity, mortality +)
OR
(Postoperative complications +, reoperation, revision, arthroplasty, risk factor)
OR
(Cohort studies +, case-control studies +, clinical trials +)
Set 3
Set 1 AND Set 2

*Terms varied with the database searched, but the same strategy was used.
+The term was exploded to include subheadings.

eligibility criteria outlined in Box 2. We considered only patients with osteoarthritis because most patients undergoing total joint arthroplasty have this diagnosis. We evaluated the following outcomes of total joint arthroplasty: function, pain, revision, mortality and complications. We defined revision as surgery that necessitated the replacement of any component except later resurfacing of the patellas in knee arthroplasty. The study also had to be adjusted or stratified for 1 or more of the following prognostic factors: age, sex, race, anthropometry (body mass index, height, weight), socioeconomic status, work status and high physical demands in relation to one of the outcomes of interest.

Validity assessment

We evaluated study validity using published validity criteria,[15] which we modified in 2 ways: we assessed the adequacy of follow-up, not simply the duration, and we added a criterion related to data quality for database studies (Box 3).

Results

General study characteristics

Our search returned 14 276 citations, of which 3211 met the eligibility criteria for the identification phase. Of the 3211 studies, 87 met the eligibility criteria in the selection phase, and 64 had data that could be extracted and were subsequently evaluated for study validity. Table 1 details the years of publication for the abstracted studies. Of the 64 studies, 23 focussed on knee arthroplasty, 38 focussed on hip arthroplasty and 3 studies evaluated both procedures. The year of publication ranged from 1989 to 2002; 60% of eligible studies were published between 1997 and 2001. Some studies were based on data from arthroplasty registries ($n = 19$), administrative (e.g., Medicare) or state-discharge databases ($n = 4$) or large urban hospitals ($n = 4$).

Box 2. Eligibility criteria for the selection phase of the systematic review. Raters were asked to determine if the criteria were present, absent or "unsure"

Outcomes

At least 1 of the following main outcomes was included:

- *Function and health*
  Health status (disease-specific or generic), health utility, work status measures
- *Pain (≥ 6 wk postoperatively)*
  Rating on visual analog scale(s), pain behaviour scale(s)
- *Revision*
  Rates, time to revision (up to 2 yr OR > 10 yr after primary surgery) or survival analyses
- *Postoperative complications*
  Arthroplasty complications a) periprosthetic fracture complications (fracture occurs following the arthroplasty and occurs in any bone around the prosthesis, including the patella), b) dislocation (for the hip, dislocation of the ball and socket prosthesis, and for the knee, dislocation of the patella) and c) patellar failure requiring revision (failure due to disruption of extensor mechanism or due to loosening)
  Surgical complications a) nerve complications resulting in a motor-control deficit, b) reflex sympathetic dystrophy, c) deep infection (of the prosthesis) where the management of the complication required surgical intervention (excluding those infections treated with oral antibiotics alone), d) thromboembolitic complications within the first 30 d postoperatively (deep vein thrombosis and pulmonary emboli), e) pneumonia diagnosed within the first 30 d postoperatively and f) mortality (all causes) within the subsequent 3 mo (reflecting the probability that mortality within this time frame was associated with the arthroplasty)
  Other complications a) economic measures and health care use (such as cost of care, cost of treatment, other associated costs, cost benefit, cost-effectiveness, cost minimization, cost utility), b) psychological and social measures (for such domains as anxiety level, depression, social support, patient performance and experience of health care, i.e., perception of rating of health care, experience of consumer–professional interactions, feelings of control and self-esteem related to health care use) and c) satisfaction
- *Mortality*

Stratification / adjustment

- *Prognostic factors*
  Age, sex, race, height, weight (or body mass index), socioeconomic status, work status, high physical demands

  Stratified in the analysis for prognostic factors, which are patient characteristics (listed above) that are relative to an outcome of interest

  OR

  Adjusted (or controlled) for the effects of patient characteristics in a multivariate model using linear or logistic regression analyses

Percent lost to follow-up

- Maximum of 30% lost for mean follow-up time of 10 yr
- No maximum % for mean follow-up time > 10 yr

Sample size

- ≥ 500 participants

  OR

- ≥ 500 joints or cases

Population

- *Inclusions*
  - Humans with knee or hip joint arthroplasty (unicompartmental, bicompartmental, tricompartmental of the knee or acetabular or femoral components of the hip)
  - 90% of study participants with osteoarthritis diagnosis

    OR

  - The % of osteoarthritis patients is less than 90% but there was a minimum of 500 patients and the subsequent analyses were stratified with respect to this diagnosis
- *Exclusions*
  - Patients who have had surgical procedures other than joint arthroplasty such as a) osteotomies, b) synovectomies, c) débridements, d) patellar resurfacing only and are usually followed prospectively
  - Patients who have had a joint arthroplasty as a result of a hip fracture only
  - Patients who have had a joint arthroplasty owing to cancer
  - The participants were surgeons/physicians and not patients
  - The prosthesis characteristics (removed from the body) are the factor of interest being evaluated in the study (i.e., wear patterns on the prosthesis or the presence of infection, etc.)

Six of the 64 studies were prospective (including 1 multicentre randomized trial); the rest were retrospective. The duration of follow-up ranged from 7 days to 10 years postoperatively for knee arthroplasty and from 6 weeks to 20 years postoperatively for hip arthroplasty. Sample sizes varied from 657 to more than 20 000 patients for knee arthroplasty and from 555 to 96 675 patients for hip arthroplasty. Although most studies collected multiple outcomes across different domains, typically only 1 outcome was presented in a stratified form with respect to one of the identified prognostic factors of interest.

For clarity, we grouped results according to the 5 main outcomes of interest: revision, mortality, function, pain and postoperative complications. The inconsistency of reporting methods and lack of independence among the studies (from the same total joint arthroplasty registries) precluded combination of results from multiple studies.

Box 3: Validity criteria and scoring categories used for studies selected in this systematic review

1. **Case definition**
   - 2 = Operational definition of cases/controls including exclusion criteria
   - 1 = Operational definition of cases/controls but no exclusion criteria
   - 0 = No explicit definition of cases or can't tell
2. **Patient selection**
   - 2 = Inception cohort, defined in relation to time of primary joint replacement or revision
   - 1 = Mixed cohort, including a subset of the sample followed from time of primary joint replacement or revision
   - 0 = Mixed cohort, unable to define subsets within the cohort or can't tell
3. **Follow-up**
   - 2 = Complete follow-up; > 90% of all participants accounted for
   - 1 = < 90% follow-up with description provided of participants lost to follow-up
   - 0 = < 90% follow-up with no description of those lost to follow-up
4. **Outcome**
   - 2 = Blinded outcome appropriate to the research question with potential for replicability of at least 1 outcome or valid/reliable self-report measure
   - 1 = Outcome appropriate to the research question with description of how outcome was assessed
   - 0 = Outcome appropriate to the research question but no description of how outcome was assessed
5. **Analysis**
   - 3 = Adjusted proportions provided (e.g., by use of Mantel–Haenzel) or appropriate multivariate techniques used to adjust for any prognostic factor
   - 2 = Crude proportions but data stratified or presented in a manner that would allow for analysis of subsets
   - 1 = Crude proportions for at least 1 outcome
   - 0 = Description of sample only, unclear about statistical methods used or can't tell
6. **Database (for database studies only)**
   - 2 = Any attempt to assess data quality (i.e., double data entry, some reabstraction of primary data, or other quality checks)
   - 1 = No attempt to assess data quality
7. **Total score**
   - _____/ 11 (question 6 omitted)
   - _____/ 13 (question 6 included)

Table 1

Distribution of the publication date of eligible studies

	Year of publication; no. of studies							
Subject	1989–90	1991–92	1993–94	1995–96	1997–98	1999–2000	2001	Total
Knee	7	0	2	0	3	4	7	23
Hip	5	2	5	3	11	8	4	38
Mixed	—	—	—	1	—	—	2	3
Total	12	2	7	4	14	12	13	64

Revision

Revision (all causes) was reported in 28 studies and of these, 22 (14 hip and 8 knee) reported data stratified by age, sex and obesity (Table 2 and Table 3). All Swedish registry studies and 2 other studies (1 each from the Norwegian registry and an urban US hospital) reported revision due to aseptic loosening of the hip; the remaining Norwegian studies and 1 US study considered all causes for revision as the primary outcome. For knee arthroplasty, revision was reported as all causes.

For hip arthroplasty, age and sex were the most consistently evaluated prognostic factors (Table 2). Although the classification of younger and older patients varied across studies, when age was shown to be a significant factor, younger patients were consistently shown to be at greater risk for revision at intervals ranging from 2 to 20 years postoperatively. The influence of age on hip revision varied as a result of the femoral and acetabular components. For the acetabular component, Havelin and colleagues[23] found that the middle age group (70–79 yr) had the highest failure rate ratio; it was 4.5 (95% confidence interval [CI] 0.9–33.5) times greater than that of the oldest age group (> 79 yr). The failure rate ratio for the femoral component for the oldest age group was 2.1 (95% CI 0.9–4.5). We were not able to compare other age groups directly, but our results suggest lower rates of failure for the femoral component in all age categories (see Appendix 1, available online at www.cma.ca/cjs). However, Johnsson and colleagues[24] reported no difference between acetabular and femoral component survival (Appendix 1).

Men were generally found to be at greatest risk of revision in 9 of 10 studies, ranging from a 3-fold to 5-fold increase. In particular, younger men had the greatest risk for revision.

For knee arthroplasty, the definition of younger and older patients again varied. In most studies, younger age was associated with greater risk for revision ranging from 2 to 10 years postoperatively (Table 3). However, Scuderi and colleagues[39] showed that this age trend reversed for 1 of the 3 types of prostheses that they compared; for patients having the total condylar prosthesis with metal backing (TCPM), there was a slight increase in the risk of revision for older patients. One study showed that age influenced the 10-year survival[36] for tricompartmental replacements only. The magnitude of the influence of age for revision was estimated with an odds ratio of 0.82[38] to a risk ratio of 0.97.[43] Male sex was associated with an 8%–23% higher risk of knee revision[38,39,43] (Table 3).

For the knee, Spicer and colleagues[42] reported that obesity was not a significant prognostic factor for all-cause revision because the survival rates did not significantly differ from those in the nonobese group (Table 3). However, Scuderi and colleagues[39] reported that patients at less than 110% of ideal body weight had a slightly increased risk of revision at the 10-year survival interval for both the total condylar prosthesis (TCP1) and total condylar prosthesis with polyethylene backing (TCPP). For the TCPM type, patients at more than 110% of their ideal body weight had a slightly increased risk for revision.

Mortality

Of the 16 studies in which mortality was evaluated, 5 had extractable data. Mortality intervals reported for hip arthroplasty were 30 days, 60 days, 90 days and 1 year (Table 2). Older age at the time of surgery was associated with increased postoperative mortality. Male sex was also associated with higher mortality rates in all but 1 study. No study provided information on predictors of mortality after knee arthroplasty.

Functional outcomes

Of the 17 studies that reported functional outcomes, data was extractable for only 7 studies (Table 2 and Table 3). For hip arthroplasty, older individuals and women had poorer function and less improvement relative to baseline function.

For knee arthroplasty, 1 study reported that age was not a predictor of postoperative function, as determined

Table 2

Summary of the main findings related to outcome prognostic factors for hip joint replacement

Outcome prognostic factor	Revision	All-cause mortality	Function	Postoperative pain
Age	+/–	+/+	+/+	Not evaluated
	Age not significant for 3 mo–3 yr or 1–3 yr (n = 6)[16–21] Younger patients at greater risk for uncemented revision only up to 4.5 yr postoperatively (n = 1)[22] Younger patients at greater risk for revision at 8–15 yr postoperatively (n = 9)[16,17,19–21,23–27]	Age ≥ 80 yr at greater risk for death in 30–60 d (n = 2)[28,29] Increasing age is a predictor of death in 90 d – 1 yr (n = 1)[18] Rates increased at age > 70 yr (n = 1)[30]	Older age (> 70 yr) was associated with poorer function, except in WOMAC scores (n = 1)[31] Less improvement in function with increasing age (n = 1)[32]	
Sex	+/–	+/+	+/+	+
	Men at greater risk (n = 8)[16,17,19–24,26] Sex not significant at 3 mo or 1 yr postoperatively (n = 1)[18]	Men younger than 80 yr had increased mortality rates 30–60 d postoperatively (n = 1)[29] Men older than 80 yr were at greatest risk of death in 30–60 d postoperatively (n = 1)[28] Men at increased risk of death in 90 d – 1 yr postoperatively (n = 3)[18,30,33]	Women had poorer function than men for all outcomes (n = 1)[31] Women showed less improvement in function than men (n = 1)[32]	Women experienced less postoperative pain than men (n = 1)[34]
Weight	Not evaluated	Not evaluated	+	Not evaluated
			BMI was negatively correlated with function (n = 1)[35]	

BMI = body mass index; WOMAC = Western Ontario and McMaster Universities index.
+/– Contradictory findings.
+/+ Multiple positive studies.
+ Single positive study.

by Western Ontario and McMaster Universities index (WOMAC) scores.[31] Sex did not affect function. Stickles and colleagues[35] found that higher body mass index was associated with difficulty ascending and descending stairs postoperatively.

Postoperative pain

Although pain relief is a primary reason for undergoing arthroplasty, this outcome was seldom reported separately. Visuri and colleagues[34] reported that women experienced less postoperative pain than men after total hip arthroplasty. Whiteside[44] reported that, among patients having knee arthroplasty, older women (> 65 yr) fared best with respect to being pain free at both 1 and 2 years postoperatively. In contrast, Hawker and colleagues[41] found that women reported more pain and took more pain medications than men after knee arthroplasty.

Satisfaction

Stickles and colleagues[35] found that satisfaction did not differ for obese patients after both hip and knee arthroplasty. Similarly, Esephaug and colleagues[32] found that age and sex did not affect the satisfaction level of patients undergoing primary hip arthroplasty. However, women and older patients undergoing revision were reported to be less satisfied.[32] Hawker and colleagues[41] found that greater body mass at 2–7 years after knee arthroplasty was associated with a lower level of satisfaction among patients who had knee arthroplasty.

Arthroplasty complications

We encountered 2 barriers when we attempted to evaluate the influence of prognostic factors on risk for postoperative complications. First, complications tended to be reported as frequencies and were not stratified with respect to the prognostic factors of interest. Second, the exact nature of the complication often could not be adequately determined. For example, we defined a deep infection as one that involved the prosthesis and where the management of the

Table 3

Summary of the main findings related to outcome prognostic factors for knee joint replacement

Outcome prognostic factor	Revision	All-cause mortality	Function	Postoperative pain
Age	+/– Older patients at greater risk (n = 3)[6,36,37] Risk decreases with age (n = 1)[38] Age < 55 yr at greater risk for revision with TCP1 at 2-, 5- and 10-yr intervals (n = 1)[39] Age < 65 yr at greater risk for revision (n = 2)[36,37] Age marginally significant (n = 1)[40]	Not evaluated	+ Age did not affect function (n = 1)[41]	+ Older women (> 65 yr) had less pain at 1 and 2 yr postoperatively with Ortholoc I cementless prosthesis (not Ortholoc II) (n = 1)
Sex	+/– Women less likely in the short term (2 yr) to undergo revision; males more likely in the long term (4 yr) to undergo revision (n = 1)[38] Men at greater risk (n = 1)[37] for tricompartmental only (n = 1)[36] No difference between sexes (n = 2)[6,40]	Not evaluated	+ No difference in global health based on SF36 (n = 1)[41]	+/– Women had less postoperative pain than men with Ortholoc I cemenetless prosthesis (not with Ortholoc II) (n = 1) Women had more preoperative pain and took more pain medications than men (n = 1)[41]
Weight	+ Rates did not differ between obese and nonobese patients at 10-yr postoperative follow-up (n = 1)[42]	Not evaluated	+/– Preoperative Knee Society scores lower in obese patients than nonobese patients, but no differences postoperatively (n = 1)[42] BMI negatively correlated with Physical Component score of the SF36 (n = 1)[35]	Not evaluated

BMI = body mass index; SF36 = short form 36-item questionnaire.
+/– Contradictory findings.
+ Single positive study.

complication necessitated surgical intervention (excluding those infections treated with oral antibiotics alone). However, numerous studies defined infection only in the most general sense, and few studies identified the manner in which infections were managed. For these reasons, no conclusive results can be reported with respect to the influence of prognostic factors on postoperative and arthroplasty complications.

Discussion

Treatment is proposed for patients based on the assumption that patients will, on balance, have more benefit than harm. Prognostic factors influence the probability of response, remission, recurrence and duration of disease under clinical care.[15] Determining prognostic factors that affect treatment effectiveness is essential to clinicians and important to patients in their decision-making. Physicians report that patient characteristics *do* affect their decisions either to refer patients for or recommend knee arthroplasty; yet, *how* patient characteristics influence their recommendations varies substantially.[5,7] Despite variation in physician opinion, our systematic review found little consistent evidence on the nature and magnitude of the influence of patient characteristics on the outcomes of pain, revision, function and mortality after total joint arthroplasty. Furthermore, even if certain subgroups fare less well after total joint arthroplasty, this does not mean that, on average, these patients did not receive benefit from the procedure. The major finding of our review suggests that, despite the impressions of referring physicians and surgeons,[5,7] patients should in general not be restricted access to total joint arthroplasty based on their characteristics.

On the other hand, decision-making requires discussion of the risks and benefits of treatment tailored to the patient and his or her circumstances. The results of this study suggest that certain factors, even in the context of low risk and overall improvement in quality of life, do affect outcome. Older patients, particularly men, need to know that, although the absolute differences are small, their risks of revision and mortality for both hip and knee arthroplasty are higher. Although they vary by study, most results seem to suggest higher revision rates for both femoral and acetabular components. Older age was also associated with poorer functional outcome relative to younger patients. The exact age at which this relative decrease in improvement occurs was not adequately described, because the ages described as "younger" ranged from younger than 50 to younger than 75. Furthermore, and more importantly, functional improvement relative to baseline occurred in all age groups. Thus although older patients may realize less benefit compared with younger patients, they are still candidates for arthroplasty and can expect, on average, an improvement in quality of life. Women who had hip arthroplasty had worse functional outcomes. However, this may have been due to their surgeries occuring at a more advanced stage of disease. Although lower function and satisfaction scores were reported among obese patients, obesity, which is generally assumed to adversely affect prosthesis longevity, did not increase revision rates in these studies. These findings are important in view of the many appropriate candidates who consider themselves to be "too old, too fat or too sick" for the procedure.

There is increasing recognition that the systematic reviews of clinical studies evaluating prognosis are not as straightforward as randomized controlled trials.[45] Nevertheless, great strides in the methodologies for evaluating quality and combining data from prognostic studies have been developed.[45] Numerous factors, however, prevented us from summarizing studies in order to provide aggregated point estimates. These issues would likely be relevant to prognostic studies of most surgical conditions and therapies. First, many studies were derived from the same national registries (e.g., several studies used data from overlapping years), and thus we were unable to combine results among studies. Second, there was inconsistency with respect to the definition of various prognostic factors and outcomes. For example, the categorization of young or old varied by up to 20 years and on several occasions varied within studies based on the same registry data.[16,17] Third, we observed that most studies assumed a linear relation between prognostic factor and patient outcome because regression analyses were almost always used. However, not all relations may be linear. Fourth, many studies did not take into account all important variables such as the extent of obesity, work status, physical activity, preoperative function or health status. Fifth, studies lacked consistent definition of key outcomes such as "joint failure" and the definition and verification of important postoperative adverse events or arthroplasty complications. Sixth, there are no subject terms specifically available to capture "prognosis" studies. The MeSH terms are imprecise in those bibliographic databases that use them (MEDLINE, CINAHL), but subject terms are very broad in EMBASE, which does not use MeSH terms. Finally, many of the studies identified in this systematic review were based on databases and registry data. These studies seldom reported the methods employed to minimize entry of false or incorrect data. Only a few studies reported use of double data entry, retrospective audits of hospital medical files or comparison to a national discharge registry. More often, we observed that there was discussion of the software and training of the entry personnel but not necessarily quality checks for the data collection.

Recognizing the limitations of

prior research, an important question is whether future meta-analyses should or should not use the older studies such as those identified in this article. The updating of systematic reviews does not always add to the precision of pooled estimates or change the clinical interpretation.[46,47] For example, some areas of research are more prolific than others, and thus time alone would not be sufficient criteria for updating a review.[48] The quality of the literature is an important factor to consider. A review by Kane and colleagues[49] did not find age, sex and obesity to be significantly correlated with knee arthroplasty outcomes; they too noted that few studies used any analysis to evaluate the relation between patient characteristics and functional outcomes. Ethgen and colleagues[50] also conducted a systematic review to evaluate health-related quality of life in patients who had knee arthroplasties. They determined that age and weight did not affect improvement in functional outcomes. Although they suggested that men benefitted more from arthroplasty than women, the evidence to support this finding is not substantive. The qualitative summaries in both these reviews depict much variation in the influence of the patient characteristics. Despite the varied eligibility criteria in these other reviews, as in our systematic review, the studies do not show an unequivocal relation between the patient characteristics and outcomes. As identified in our review, the methodologic quality of all these studies is limited. The inclusion criteria for study patients were not always clearly specified, and they likely reflected the selection biases of surgeons. In addition, the operational definitions of some important outcomes such as pain were nonstandardized. Thus we believe future reviews or meta-analyses should not include studies from an older chronological period because this typically magnifies methodologic limitations.

Our study has several specific limitations. First, we limited our review to patients with osteoarthritis; therefore, extension of the findings to other diagnoses such as rheumatoid arthritis may be limited. Second, our review included only studies with a sample size of 500 or more patients. Because our initial search yielded more than 14 000 citations, we considered such a restriction to be necessary to yield a manageable number of studies. This may have resulted in the exclusion of some studies that might have provided useful information. However, given the limitations of the literature noted above, we do not believe these studies would dramatically affect our conclusions. Third, we did not perform manual searches of relevant journals or contact organizations to identify additional studies or unpublished work meeting our eligibility criteria.

In conclusion, the results of this study suggest that subgroups of patients, particularly men and older patients, are at higher risk of death and revision following total joint arthroplasty. The risks were higher in some subgroups than others, but overall risks for all groups remained very small. Thus in no specific subgroup of patients did total joint arthroplasty appear contraindicated. This is relevant to decision-making since many physicians often advise the patients they are too old or obese to receive total joint arthroplasty. Future studies are needed to address the methodologic limitations identified in this study to more clearly advise patients and doctors on how patient characteristics affect the outcome of total joint arthroplasty.

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