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Predictors of Activity Limitation and Dependence on Walking Aids following Primary Total Hip Arthroplasty

Jasvinder A. Singh, MBBS, MPH[1,2,3,4] and **David G. Lewallen, MD**[2]

[1]Department of Health Sciences Research, Mayo Clinic School of Medicine, Rochester, MN

[2]Department of Orthopedic Surgery, Mayo Clinic School of Medicine, Rochester, MN

[3]Rheumatology Section, Medicine Service, VA Medical Center, Minneapolis, MN and Division of Rheumatology, Department of Medicine, University of Minnesota, Minneapolis, MN

[4]Birmingham VA Medical Center and University of Alabama, Birmingham, AL

Abstract

OBJECTIVES—To study function outcomes and their predictors after primary total hip arthroplasty (THA).

DESIGN—Prospective Cohort Study

SETTING—Single Institution

PARTICIPANTS—All patients who underwent primary THA at our institution between 1993 and 2005 and were alive at the time of follow-up.

MEASUREMENTS—Whether sex, age, body mass index (BMI), comorbidity, anxiety, and depression predict moderate to severe activity limitation (limitation in ≥3 activities) and complete dependence on waling aids 2 and 5 years after primary THA was examined. Multivariable logistic regression adjusted for operative diagnosis, American Society of Anesthesiologists score, implant type, and distance from medical center.

RESULTS—At 2 years, 30.3% of participants reported moderate to severe activity limitation; at 5 years, 35% of participants reported moderate to severe activity limitation. Significant predictors of moderate to severe activity limitations at 2-year follow-up were female sex (odds ratio (OR)=1.2, 95% confidence interval (CI)=1.1–1.4), aged 71 to 80 (OR=2.0, 95% CI=1.6–2.5), aged 80 and older (OR=4.5, 95% CI=3.4–6.0), depression (OR=2.1, 95% CI=1.6–2.7), and BMI greater than 30. At 5-year follow-up, significant predictors were aged 71 to 80 (OR=1.7, 95% CI=1.3–2.2), older than 80 (OR=4.3, 95% CI=2.8–6.6), depression (OR=2.3, 95% CI=1.6–3.4), and BMI greater than 30.Significant predictors of complete dependence on walking aids at 2 years were female sex (OR=2.0, 95% CI=1.4–2.7), aged 71 to 80 (OR=2.4, 95% CI=1.4–4.2), older than 80 (OR=11.4, 95% CI=6.0–21.9), higher Deyo-Charlson score (OR=1.5, 95% CI=(1.1–1.2) for 5-point increase, depression (OR=2.0, 95% CI=1.2–3.4), and BMI greater than 35. Each of these

Correspondence to: Jasvinder A. Singh, MBBS, MPH, Minneapolis VA Medical Center, Rheumatology (111R), One Veteran's Drive, Minneapolis, MN 55417. Phone: 612-467-4190; Fax: 612-725-2267; Jasvinder.Singh@gmail.com.

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factors also significantly predicted complete dependence on walking at 5-year follow-up, with similar odds ratios, except that BMI 30–34.9 was not significantly associated.

CONCLUSION—Higher BMI, depression, older age, and female sex predict activity limitation and complete dependence on walking aids 2 and 5 years after primary THA.

Keywords

Primary Total Hip Arthroplasty; THA; Predictors; Activity Limitation; Function; walking aids

INTRODUCTION

Primary Total Hip Arthroplasty (THA) is an extremely successful surgery associated with significant pain relief and improvement in function and quality of life. Patient-relevant outcomes, such as pain, activity limitation and quality of life are extremely important. It is important to understand factors that impact patient-reported outcomes after primary THA, since some of predictors may be modifiable.

A recent systematic review assessing prognostic factors for patient outcomes in THA studies up to 2001 reported that older age and female gender were associated with poorer function and female gender with less post-operative pain, after THA [1]. However, very few studies have assessed the impact of other important factors such as body mass index, medical comorbidity and depression, which may all be amenable to interventions. Very limited or no data exist regarding prevalence and predictors of dependence on walking aids after THA.

Due to an aging U.S. population, many of whom are likely to undergo a procedure such as primary THA, studies of functional and mobility outcomes following THA are needed. We hypothesized that in a cohort of patients who had undergone primary THA between 1993–2005, at 2- and 5-years post-THA: (1) higher body mass index and comorbidity will be associated with more activity limitation and dependence on walking aids; (2) depression and anxiety at baseline will be associated more activity limitation greater dependence on walking aids.

METHODS

We used the data collected prospectively in the Mayo Total Joint Registry, detailed in a previous study [2]. This registry includes patient demographics, date of last evaluation, whether the implant was in place or removed, reoperations, and complications; patients are asked to forward current radiographs [2]. Patients are scheduled for regular clinical evaluations including follow-ups at two, and five years following the arthroplasty and every five years thereafter. All elective and non-elective THA procedures are included in this registry. Starting in 1993, all patients who underwent hip arthroplasty at the Mayo Clinic received a hip questionnaire that includes questions regarding hip pain and function [3]. This validated questionnaire was administered at 2- and 5-years post-operatively by mail or in person at the clinical follow-up visit [4–5]. The validated questionnaire has face, content and construct validity as it has the 19 questions from the validated Harris Hip Score [6]; test-retest reliability and construct validity was shown in another study[4]. Patients who did not return the mailed survey and failed to return for follow-up clinic visits, had the questionnaire administered on the telephone by experienced registry staff. The study was approved by the Mayo Clinic Institutional Review Board. Patients were eligible for inclusion in this study if they had undergone a primary THA during 1993–2005 and were alive at the time of follow-up. The analyses were not limited to a specific diagnosis or age-group, since we wanted our results to be generalizable to all patients undergoing total hip arthroplasty.

Outcomes of Interest

The following function outcomes were assessed at 2- and 5-years post-primary THA:

(1) Moderate-severe activity limitation: responses to questions regarding limitations in 7 activities including walking, stair, shoes/socks, pick up objects from the floor, sitting, getting in/out of the car, rising from chair were categorized into 'no', 'mild', 'moderate' or 'severe' limitation for each activity- presence of ≥3 activities with moderate or severe limitation was classified as overall moderate-severe activity limitation (reference, all other categories)

(5) Dependence on walking aids: patients were queried regarding the use of walking aids: "Do you use any supports when you walk?", 'no aid', or 'cane occasionally' = no dependence; 'cane full time' = some dependence; 'crutch' '2 canes', '2 crutches', 'walker' or 'unable to walk' = complete dependence/unable – the reference category was no dependence.

Predictors of Interest

These included age and gender (unmodifiable) and BMI, comorbidity, depression and anxiety (modifiable) and were categorized as follows:

1. age- categorized, as previously [7] into ≤60, 61–70, 71–80 and >80
2. gender- female vs. male
3. BMI- categorized, as previously [8] into ≤25, 25.1–29.9, 30–34.9, 35–39.9 and ≥40
4. Comorbidity- continuous variable (5-point increase), measured by Deyo-Charlson score, a validated comorbidity measure [9], the most commonly used comorbidity measure consisting of a weighted scale of 17 comorbidities (including cardiac, pulmonary, renal, hepatic disease, diabetes, cancer, HIV etc.), expressed as a summative score [10–11]; higher score indicates more comorbidity load.
5. Depression and anxiety- presence or absence of International Classification of Diseases- ninth revision (ICD)-9 codes for depression and anxiety at or before THA

Statistical Analyses

Student's t-test and chi-square tests were used to compare baseline clinical and demographic characteristics of patients. Responder and non-responder characteristics were compared using logistic regression analyses. Univariate and multivariable-adjusted logistic regression analyses were performed for each outcome at 2- and 5-years. For these analyses, we used a Generalized Estimating Equations (GEE) approach to adjust for the correlation between observations on the same subject due to replacement of both hips. All pain and function assessments were only for time-points following primary THA; if a patient underwent revision THA, we excluded observations after the revision surgery. Age, gender, BMI, comorbidity, anxiety and depression were the primary predictors of interest. All logistic regression analyses were also adjusted for the following potential confounders: (1) operative diagnosis: (2) implant type- cemented, uncemented, hybrid; (3) ASA class: Class I or II vs. III/IV; and (4) distance from the medical center- <100, 100–500 and >500 miles/oversea. We present only the multivariable-adjusted estimates for the ease of understanding. Odds ratios and the 95% confidence intervals are presented. A p-value <0.05 was considered significant.

We examined gender*BMI and gender*Depression interactions in the above described models. In addition, we performed the above described analyses limited to patients with diagnosis of osteoarthritis.

Since patients with hip fracture undergo emergent THA as compared to non-hip fracture diagnosis and may have different characteristics and outcomes, we compared their characteristics and performed sensitivity analyses limited to non-hip fracture cohort.

RESULTS

Characteristics of the study population and the non-responders

Characteristics of patients are described in Table 1. Patients responding to survey 2-years post-primary THA had mean age of 65 years, 51% were female, 30% were 60 years or younger, 24% had BMI <25 kg/m^2, 38% were in ASA score class III-IV and 35% had an uncemented implant. Patients responding at 5-years had similar characteristics (Table 1). The underlying diagnosis was osteoarthritis in 87% in the two-year follow up group and 85% in the 5-year group.

The survey response rate was 62.3% (5,707/9,154) at 2- and 52.7% (3,289/6,243) at 5-years post-primary THA. Responders to the survey at 2-years post-primary THA were more likely to be older (age 61–70, 71–80 and >80 with odds ratios (OR), 1.4, 1.3 and 1.3, compared to ≤60 years) and less likely to have BMI ≥40 (OR, 0.7), ASA class III-IV (OR, 0.9) or live further from the medical center (distance >100–500 and >500 miles with OR 0.9 and 0.7). At 5-years, responders were more likely to be older (age 61–70, 71–80 with OR, 1.4 and 1.4), BMI 25–29.9 (OR, 1.2), and less likely to live further from the medical center (distance >100–500 and >500 miles with OR 0.9 and 0.6).

Patients with hip fracture as the underlying diagnosis (19/5,435 at 2-years and 11/3,130 at 5-years) had significantly higher prevalence of moderate-severe functional limitation at 2- and 5-years (74% vs. 30% at 2-years and 55% vs. 35% at 5-years; p<0.001 for both),complete dependence on walking aids (37% vs. 5% at 2-years and 18% vs 7% at 5-years; p<0.001 and p=0.27) and mortality (31% vs. 2% at 2-years and 41% vs. 6% at 5-years; p<0.001 for both) compared to those with underlying diagnoses other than hip fracture.

Prevalence of activity limitation and dependence on walking aids

Moderate-severe activity limitation was reported by 30.3% (1,649/5,435) at 2- years and 35% (1,095/3,130) at 5-years. Some dependence on walking aids was reported by 5.7% (278/4,883) at 2- years and 6% (180/2,982) at 5-years. Complete dependence on walking aids (or inability to walk) was reported by 5.5% (267/4,883) at 2- years and 7.2% (215/2,982) at 5-years.

Predictors of Activity limitation and dependence on walking aids after Primary THA

At 2-years post-primary THA, the overall moderate-severe activity limitation was significantly more common in: in older patients, 71–80 years with odds of 2.0 and >80 years, 4.5; women with odds of 1.2; those with higher BMI, 30–35 kg/m^2 with 1.9, 35–39.9 kg/m^2 with 3.3 and ≥40 kg/m^2 with 4.7; patients with ASA class III-IV, odds of 1.5; and in patients with depression, odds of 2.1 (Table 2).

At 5-years, patients in 71–80 and ≥80 year categories had odds ratio of 1.7 and 4.3 for overall moderate-severe activity limitation, patients with BMI 30–35, 35–39.9 and ≥40 kg/m^2 categories had odds of 2.3, 4.7 and 6.5, respectively (Table 2).

Limitation of analyses to patients with osteoarthritis only did not impact the significance of any of the associations noted above and altered odds ratio minimally (data not shown). In model with interaction terms, gender*depression term was not significant at either 2- or 5-year outcome. Gender*BMI interactions were also insignificant, except for the BMI category 25–29.9 at 5-years (p=0.003).

Predictors of dependence on walking aids after Primary THA

Two years after primary THA, patients 71–80 and >80 year old had odds of 2.6 and 12.5 and women had odds of 2.3 for complete dependence on walking aids. Respectively, those with BMI of 35–39.9 and ≥40 kg/m^2 had odds of 3.2 and 5.7, and depression, 2.2 times (Table 3). Similar associations with mild dependence on walking aids are described in Table 3.

Five years after primary THA, the odds of moderate/complete dependence on walking aids was higher in those aged 71–80 and >80 with odds of 2.4 and 11.4, women with odds of 2.0, BMI of 35–39.9 and ≥40 with odds of 2.4 and 4.0 times, ASA class III-IV with odds of 2.1 and in those with depression with odds of 2.0 (Table 3).

Limitation of analyses to patients with osteoarthritis only did not change the significance of any of the associations noted above (data not shown). In models with interaction terms, gender*depression term was not significant at either 2- or 5-year outcome. All gender*BMI interactions were also insignificant, except for the BMI category 25–29.9 for some dependence at 2-years (p=0.004) and for complete dependence at 5-years (p=0.03).

Sensitivity Analyses limited to patients with non-hip fracture underlying diagnoses

Sensitivity analyses were performed for patients without hip fracture as the underlying diagnosis (elective hip arthroplasties) and compared to estimates from the entire cohort (Appendix 1 and 2). When analyses were limited to the non-fracture group, no changes in significance were noted except one odds ratio – odds for some dependence on walking aids in >60–70 year age group at 5-years changed from 2.0 (1.1–3.8) for the overall cohort to 1.6 (0.9–2.9) for the non-fracture cohort (Appendix 1 and 2). The estimates changed minimally for this sensitivity analyses as well.

DISCUSSION

In this study, we found that older age, female gender, depression and higher BMI were each associated with higher odds of moderate/severe activity limitation and with moderate/complete dependence on walking aids 2-years post-primary THA. Similar associations were noted at 5-year follow-up, with minimal change in odds ratios or the level of significance. The frequent occurrence of moderate-severe functional limitation following primary THA indicates that evaluation and management of physical function and mobility is indicated in patients who report such deficits. In an aging U.S. population with increasing proportion of the elderly, a doubling of THA rate has been projected from 2005 to 2030 [12 12–13]. Further studies should examine modifiable underlying causes of functional limitation in these patients. Earlier interventions focused at addressing this problem in elderly patients undergoing primary THA could lead to improvement of quality of life and patient satisfaction. As expected, patients with hip fracture as the underlying diagnosis had poorer function and higher mortality at 2- and 5-years. Sensitivity analyses limited to patients without hip fracture as the underlying diagnosis showed minimal change in odds ratio estimates and no change in significance compared to analyses from the entire cohort, showing the robustness of our analyses.

Our cohort is similar to other THA cohorts, including a cohort from Switzerland with mean age of 68 years, 55% women [14] and a U.S. cohort with 53% women with median age of 66 years [15], and slightly younger than a Swedish THA cohort with mean age of 71 years [16].

Our study has many novel findings that add to the current knowledge. Firstly, older age was associated with higher odds of moderate-severe activity limitation, confirming similar findings [15, 17–18 19–21]. Our finding of higher odds of complete dependence on walking aids in older patients with primary THA adds to this earlier observation. This is intuitive, but had not been described in THA cohorts followed in the U.S. previously to our knowledge. In addition, this association showed a dose-response with the increase in odds of increasing dependence increased gradually with increasing age. In the elderly, patient-reported functional limitation predicts mortality [22], post-discharge medical services usage [23], and nursing home placement [24]. These functional limitations were seen in a third of all patients at 2- and 5-years after primary THA, which indicates a significant burden of disability in these elderly patients after primary THA. Further studies should investigate the underlying causes of worse functional outcomes in older patients undergoing primary THA with attention to those factors which may be modifiable.

We also showed that depression predicted all measured functional outcomes except moderate-severe activity limitation and dependence on walking aids at the 2-yearpost surgery interval. Previous studies in primary knee arthroplasty patients have reported that depression predicts pain at 1-year [25] and pain and function at 2-year [26] and 5-year follow-up [27]. Our findings suggest that screening for depression prior to surgery may help identify the elderly patients at-risk for poorer function outcomes. Optimization of treatment of depression may improve post-THA outcomes, a hypothesis that needs to be tested.

We found that increasing BMI showed a significant dose-relationship to the odds of moderate-severe activity limitation. This confirms similar findings of BMI association with functional outcomes in most previous studies of primary THA [14–15, 17, 19, 28–31], but is in contrast to one negative study in patients undergoing hip replacement [21]. Similar to depression, this is a modifiable factor. A weight reduction program or bariatric surgery prior to or following THA may improve the functional outcomes of patients following primary THA.

Our findings that age >70, female gender, BMI ≥35, higher Deyo-Charlson index and depression, each significant predicted the dependence on walking aids 2- and 5-years after primary THA, add to the current literature. To our knowledge, there are no published data regarding incidence of dependence on walking aids following primary THA and factors influencing this. Our study provides these estimates of dependence on walking aids and several predictors. The odds were twice or higher for most associations. This is an important clinically, since increasing mobility and decreasing dependence on walking aids is an important goal for majority of the patients undergoing primary THA, many of whom are elderly. Knowledge of the frequency of and the risk factors for dependence on gait aids may help inform patients regarding this outcome, and stimulate patient-physician discussions regarding interventions targeting important modifiable factors such as weight reduction and others. More research is needed to examine the impact of specific comorbidities, back problems, prior dependence on aids and severity of arthritis in other joints, on dependence on walking aids post-THA.

The association of female gender with every outcome except walking aids dependence at 5-years merits some discussion. Previous findings of THA function being negatively impacted by female gender [20–21, 29, 32] was confirmed in our study. Some of the effect may be age-related, as more elderly patients are female. But, based on these findings, an approach focused on intervention in obese women with pre-existing depression may be most cost-effective in improving outcomes in the elderly undergoing primary THA.

Our study has several strengths. Our ability to examine dependence on walking aids alongside activity limitation assessment is the most important contribution of this study. We were able to control for several important confounders and covariates, and provide robust estimates of association that changed minimally with multivariable adjustment and provide estimates for five year follow-up. We had a large study sample size and therefore negative findings are not due to underpowered analyses, but more likely due to absence of such associations.

Our study has several limitations. The response rate of 62% at 2-years and 53% at 5-years, is similar to the average response rate of 60% in large surveys of this size [33]. However, the five year estimates may not be as precise as the two year estimates. Non-response and referral bias may limit the ability to generalize to other populations. The estimates of association in this study are conservative, since non-responders were more likely to be younger, have ASA class III-IV and live >100 miles away from the medical center which are the same categories that also reported more pain and activity limitations. Another weakness is that depression and anxiety were based on clinical diagnosis pre-operatively and were assessed by presence of ICD-9 code. Therefore under-diagnosis of depression/anxiety and misclassification bias is likely. However, non-response and misclassification would both bias our findings towards null; therefore the actual associations may be of greater magnitude. In the absence of a National U.S. Joint Registry currently, analysis of systematically collected data from a large volume medical center (such as this) is the next best approach to examine these associations in a large cohort. We made an ‘a priori’ decision to combine moderate and severe categories based on our clinical judgment of what would be considered suboptimal by operating surgeons, but also to have enough events to analyze predictors of poor outcomes. Future studies from large national registries may allow examination of the predictors of moderate and severe categories separately with even larger samples. Current efforts by the United States orthopedic community to develop a U.S. national registry, if successful, would surmount many of these limitations. Residual confounding is possible in this cohort study due to our inability to control for pre-operative activity limitation in the main analyses, since this would have led to selection bias with only less than the half subjects eligible in each category. Although, we adjusted for surgery on the contralateral hip, we were unable to adjust for other lower extremity surgery including knee replacement, which may have confounded the results. We were unable to adjust for race or ethnicity, another limitation of this study.

In summary, in this study of patient-reported outcomes in a large cohort of patients with primary THA, moderate to severe activity limitation was reported by a third. A low prevalence of complete dependence on walking aids was noted. We observed important age- and gender-differences in functional outcomes. Several factors amenable to intervention such as BMI, depression and medical comorbidity were associated with functional outcomes. Further studies should examine if outcomes can be improved by targeting and modifying these factors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Santaguida PL, Hawker GA, Hudak PL, et al. Patient characteristics affecting the prognosis of total hip and knee joint arthroplasty: a systematic review. Can J Surg. 2008; 51:428–436. [PubMed: 19057730]
2. Rand JA, Trousdale RT, Ilstrup DM, Harmsen WS. Factors affecting the durability of primary total knee prostheses. J Bone Joint Surg Am. 2003; 85-A:259–265. [PubMed: 12571303]
3. Kavanagh BF, Fitzgerald RH Jr. Clinical and roentgenographic assessment of total hip arthroplasty. A new hip score. Clin Orthop Relat Res. 1985:133–140. [PubMed: 3971612]
4. McGrory BJ, Freiberg AA, Shinar AA, Harris WH. Correlation of measured range of hip motion following total hip arthroplasty and responses to a questionnaire. J Arthroplasty. 1996; 11:565–571. [PubMed: 8872577]
5. McGrory BJ, Morrey BF, Rand JA, Ilstrup DM. Correlation of patient questionnaire responses and physician history in grading clinical outcome following hip and knee arthroplasty. A prospective study of 201 joint arthroplasties. J Arthroplasty. 1996; 11:47–57. [PubMed: 8676118]
6. Andersson G. Hip assessment: a comparison of nine different methods. J Bone Joint Surg Br. 1972; 54:621–625. [PubMed: 4639438]
7. Singh JA, Gabriel S, Lewallen D. The impact of gender, age, and preoperative pain severity on pain after TKA. Clin Orthop Relat Res. 2008; 466:2717–2723. [PubMed: 18679762]
8. WHO. Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 2000.
9. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992; 45:613–619. [PubMed: 1607900]
10. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987; 40:373–383. [PubMed: 3558716]
11. Charlson ME, Sax FL, MacKenzie CR, Braham RL, Fields SD, Douglas RG Jr. Morbidity during hospitalization: can we predict it? J Chronic Dis. 1987; 40:705–712. [PubMed: 3110198]
12. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am. 2007; 89:780–785. [PubMed: 17403800]
13. Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M. Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. J Bone Joint Surg Am. 2005; 87:1487–1497. [PubMed: 15995115]
14. Lubbeke A, Katz JN, Perneger TV, Hoffmeyer P. Primary and revision hip arthroplasty: 5-year outcomes and influence of age and comorbidity. J Rheumatol. 2007; 34:394–400. [PubMed: 17143967]
15. Roder C, Parvizi J, Eggli S, Berry DJ, Muller ME, Busato A. Demographic factors affecting long-term outcome of total hip arthroplasty. Clin Orthop Relat Res. 2003:62–73. [PubMed: 14646703]
16. Nilsdotter AK, Lohmander LS. Patient relevant outcomes after total hip replacement. A comparison between different surgical techniques. Health Qual Life Outcomes. 2003; 1:21. [PubMed: 12816544]
17. Braeken AM, Lochhaas-Gerlach JA, Gollish JD, Myles JD, Mackenzie TA. Determinants of 6–12 month postoperative functional status and pain after elective total hip replacement. Int J Qual Health Care. 1997; 9:413–418. [PubMed: 9466176]
18. Nilsdotter AK, Lohmander LS. Age and waiting time as predictors of outcome after total hip replacement for osteoarthritis. Rheumatology (Oxford). 2002; 41:1261–1267. [PubMed: 12421998]
19. Nilsdotter AK, Lohmander LS. Patient Relevant Outcomes after total hip replacement. A comparison between different surgical techniques. Health Qual Life Outcomes. 2003; 1:21. [PubMed: 12816544]

20. Espehaug B, Havelin LI, Engesaeter LB, Langeland N, Vollset SE. Patient satisfaction and function after primary and revision total hip replacement. Clin Orthop Relat Res. 1998:135–148. [PubMed: 9646756]
21. Cushnaghan J, Coggon D, Reading I, et al. Long-term outcome following total hip arthroplasty: a controlled longitudinal study. Arthritis Rheum. 2007; 57:1375–1380. [PubMed: 18050176]
22. Carey EC, Walter LC, Lindquist K, Covinsky KE. Development and validation of a functional morbidity index to predict mortality in community-dwelling elders. J Gen Intern Med. 2004; 19:1027–1033. [PubMed: 15482555]
23. Fairchild DG, Hickey ML, Cook EF, et al. A prediction rule for the use of postdischarge medical services. J Gen Intern Med. 1998; 13:98–105. [PubMed: 9502369]
24. Steiner JF, Kramer AM, Eilertsen TB, Kowalsky JC. Development and validation of a clinical prediction rule for prolonged nursing home residence after hip fracture. J Am Geriatr Soc. 1997; 45:1510–1514. [PubMed: 9400563]
25. Brander VA, Stulberg SD, Adams AD, et al. Predicting total knee replacement pain: a prospective, observational study. Clin Orthop Relat Res. 2003:27–36. [PubMed: 14646737]
26. Lingard EA, Riddle DL. Impact of psychological distress on pain and function following knee arthroplasty. J Bone Joint Surg Am. 2007; 89:1161–1169. [PubMed: 17545417]
27. Brander V, Gondek S, Martin E, Stulberg SD. Pain and depression influence outcome 5 years after knee replacement surgery. Clin Orthop Relat Res. 2007; 464:21–26. [PubMed: 17603386]
28. Jones CA, Voaklander DC, Johnston DW, Suarez-Almazor ME. The effect of age on pain, function, and quality of life after total hip and knee arthroplasty. Arch Intern Med. 2001; 161:454–460. [PubMed: 11176772]
29. Busato A, Roder C, Herren S, Eggli S. Influence of high BMI on functional outcome after total hip arthroplasty. Obes Surg. 2008; 18:595–600. [PubMed: 18369684]
30. Bischoff-Ferrari HA, Lingard EA, Losina E, et al. Psychosocial and geriatric correlates of functional status after total hip replacement. Arthritis Rheum. 2004; 51:829–835. [PubMed: 15478156]
31. Lehman DE, Capello WN, Feinberg JR. Total hip arthroplasty without cement in obese patients. A minimum two-year clinical and radiographic follow-up study. J Bone Joint Surg Am. 1994; 76:854–862. [PubMed: 8200892]
32. Kennedy DM, Hanna SE, Stratford PW, Wessel J, Gollish JD. Preoperative function and gender predict pattern of functional recovery after hip and knee arthroplasty. J Arthroplasty. 2006; 21:559–566. [PubMed: 16781410]
33. Asch DA, Jedrziewski MK, Christakis NA. Response rates to mail surveys published in medical journals. J Clin Epidemiol. 1997; 50:1129–1136. [PubMed: 9368521]

Table 1

Characteristics of patients with primary THA and survey non-responders

	Responders		Non-responders	
	2-year (n = 5,707)	5-year (n = 3,289)	2-year (n = 3, 407)	5-year (n = 2,954)
Mean Age (±SD)	65.0 ± 13.3	64.7 ± 12.9	63.1 ± 14.9	**62.8 ± 14.8**
Men/Women (%)	49%/51%	47%/53%	48%/52%	**48%/52%**
Age groups n (%)				
≤60 yrs	30%	30%	37%	**37%**
>60–70 yrs	31%	32%	27%	**28%**
>70–80 yrs	30%	31%	29%	**27%**
>80 yrs	9%	6%	8%	**8%**
Body Mass index (in kg/m^2)				
≤24.9	24%	24%	24%	**26%**
25–29.9	39%	40%	36%	**37%**
30–34.9	24%	23%	25%	**24%**
35–39.9	8%	8%	9%	**8%**
≥40	4%	4%	6%	**4%**
Missing	1%	1%	0.5%	**0.2%**
ASA Score				
Class I–II	62%	64%	60%	**63%**
Class III–IV	38%	36%	40%	**37%**
Missing	1%	1%	0.2%	**0.4%**
Cemented				
Yes	11%	14%	14%	**14%**
Hybrid	54%	59%	48%	**53%**
Uncemented	35%	27%	38%	**32%**
Underlying Diagnoses				
Rheumatoid Arthritis/ Other Inflammatory arthritis conditions	3%	3%	3%	**4%**
Osteoarthritis	87%	85%	84%	**82%**
Avascular Necrosis	7%	8%	8%	**9%**
Other [a]	4%	4%	5%	**5%**
Deyo-Charlson Index	1.1 ± 1.9	1.1 ± 1.9	1.0 ± 1.8	**1.0 ± 1.9**
Depression	7%	6%	9%	**7%**
Anxiety	5%	4%	5%	**4%**
Outcomes				
Moderate-severe activity limitation	30.3%	35.0%	N/A	**N/A**
Some dependence on walking aids	5.7%	6.0%	N/A	**N/A**
Complete dependence/unable to walk	5.5%	7.2%	N/A	**N/A**

[a]Other category includes congenital dislocated hip, neoplasm, fracture, Legg Parthe's etc.

ASA, American Society of Anesthesiologists; N/A, Not available

Deyo-Charlson score, a validated comorbidity measure, consists of a weighted scale of 17 comorbidities (including cardiac, pulmonary, renal, hepatic disease, diabetes, cancer, HIV etc.), expressed as a summative score; higher score indicates more comorbidity load.

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Table 2

Multivariable* Predictors of Moderate-severe Activity limitation

	Multivariable-adjusted 2-year			Multivariable-adjusted 5-year		
	Odds Ratio	(95% Confidence Interval)	p-value	Odds Ratio	(95% Confidence Interval)	p-value
Female Gender (Ref- Male)	**1.2**	**(1.1–1.4)**	**<0.01**	1.1	(0.9–1.4)	0.16
Age (Ref- ≤60 yrs)						
>60–70 yrs	1.2	(1.0–1.5)	0.06	0.9	(0.7–1.2)	0.65
>70–80 yrs	**2.0**	**(1.6–2.5)**	**<0.01**	**1.7**	**(1.3–2.2)**	**<0.01**
>80 yrs	**4.5**	**(3.4–6.0)**	**<0.01**	**4.3**	**(2.8–6.6)**	**<0.01**
BMI (Ref- <25 kg/m^2)						
25–29.9	1.1	(0.9–1.3)	0.20	1.2	(1.0–1.5)	0.11
30–34.9	**1.9**	**(1.5–2.3)**	**<0.01**	**2.3**	**(1.7–2.9)**	**<0.01**
35–39.9	**3.3**	**(2.6–4.3)**	**<0.01**	**4.7**	**(3.3–6.7)**	**<0.01**
≥40	**4.7**	**(3.4–6.6)**	**<0.01**	**6.5**	**(4.1–10.2)**	**<0.01**
Deyo-Charlson index (5-point change)	1.1	(0.9–1.3)	0.20	1.1	(0.8–1.4)	0.68
Anxiety (**Ref**- no)	0.8	(0.6–1.1)	0.26	0.7	(0.5–1.2)	0.24
Depression (**Ref**- no)	**2.1**	**(1.6–2.7)**	**<0.01**	**2.3**	**(1.6–3.4)**	**<0.01**

*Adjusted for ASA score, distance from the medical center, implant type and the operative diagnosis, in addition to the above variables

Regression: n/N = 1,577/5,200 at 2-yr FU; n/N = 1,030/2,931 at 5-yr FU; BMI, Body Mass Index

Higher score on Deyo-Charlson indicates higher comorbidity; **Numbers in Bold indicate significant Odds ratios and p-values**

Table 3

Multivariable* Predictors of dependence on Walking aids

	Severity of Dependence	Multivariable-adjusted 2-year			Multivariable-adjusted 5-year		
		OR	**(95% CI)**	**p-value**	**OR**	**(95% CI)**	**p-value**
Female Gender (Ref- Male)	Some	1.0	(0.8–1.4)	0.77	0.9	(0.6–1.3)	0.53
	Complete dependence/unable	**2.3**	**(1.7–3.2)**	**<0.01**	**2.0**	**(1.4–2.7)**	**<0.01**
Age (Ref- ≤60 yrs)							
>60–70 yrs	Some	1.1	(0.7–1.8)	0.66	**2.0**	**(1.1–3.8)**	**0.03**
>70–80 yrs	Some	**2.8**	**(1.7–4.4)**	**<0.01**	**5.4**	**(2.8–10.2)**	**<0.01**
>80 yrs	Some	**9.9**	**(5.8–16.8)**	**<0.01**	**16.2**	**(7.5–35.2)**	**<0.01**
>60–70 yrs	Complete dependence/unable	1.2	(0.7–1.9)	0.57	1.3	(0.7–2.2)	0.37
>70–80 yrs	Complete dependence/unable	**2.6**	**(1.6–4.3)**	**<0.01**	**2.4**	**(1.4–4.2)**	**<0.01**
>80 yrs	Complete dependence/unable	**12.5**	**(7.3–21.6)**	**<0.01**	**11.4**	**(6.0–21.9)**	**<0.01**
BMI (Ref- <25 kg/m^2)							
25–29.9	Some	1.0	(0.7–1.5)	0.98	1.1	(0.7–1.9)	0.59
30–34.9	Some	**1.9**	**(1.3–2.8)**	**<0.01**	**3.0**	**(1.8–4.9)**	**<0.01**
35–39.9	Some	**3.2**	**(2.0–5.1)**	**<0.01**	**3.3**	**(1.7–6.4)**	**<0.01**
≥40	Some	**5.7**	**(3.2–10.1)**	**<0.01**	**7.5**	**(3.5–15.8)**	**<0.01**
25–29.9	Complete dependence/unable	1.1	(0.8–1.6)	0.52	1.1	(0.7–1.7)	0.55
30–34.9	Complete dependence/unable	1.4	(1.0–2.2)	0.08	1.6	(1.0–2.5)	0.06
35–39.9	Complete dependence/unable	**3.3**	**(2.0–5.3)**	**<0.01**	**2.4**	**(1.3–4.3)**	**<0.01**
≥40	Complete dependence/unable	**5.7**	**(3.2–10.3)**	**<0.01**	**4.0**	**(2.0–8.2)**	**<0.01**
Deyo-Charlson index (5-point change; higher=worse)	Some	**1.6**	**(1.2–2.1)**	**<0.01**	**1.5**	**(1.1–2.2)**	**0.02**
	Complete dependence/unable	1.2	(0.9–1.7)	0.20	1.1	(0.8–1.7)	0.53
Anxiety (Ref- no)	Some	1.2	(0.7–2.0)	0.57	0.9	(0.4–2.1)	0.77
	Complete dependence/unable	1.0	(0.6–1.7)	0.98	1.0	(0.5–2.1)	0.91
Depression (Ref- no)	Some	1.5	(0.9–2.3)	0.12	1.1	(0.5–2.2)	0.81
	Complete dependence/unable	**2.2**	**(1.4–3.4)**	**<0.01**	**2.0**	**(1.2–3.4)**	**0.01**

*Adjusted for ASA score, distance from the medical center, implant type and the operative diagnosis, in addition to the above variables

Regression: n/N = 264/4,658, mild dependence and 253/4,658, complete dependence at 2-yr FU; n/N = 167/2,701, mild dependence and 200/2,701, complete dependence at 5-yr FU

Higher score on Deyo-Charlson indicates higher comorbidity

Numbers in Bold indicate significant Odds ratios and p-values

OR, Odds Ratio; CI, Confidence Interval; BMI, Body Mass Index