

# Disparities in Outcomes for Blacks versus Whites Undergoing Total Hip Arthroplasty: A Systematic Literature Review

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**ABSTRACT. Objective.** Total hip replacement (THA) surgery is a successful procedure, yet blacks in the United States undergo THA less often and reflect poorer outcomes than whites. The purpose of this study is to systematically review the literature on health-related quality of life after THA, comparing blacks and whites.

**Methods.** A librarian-assisted search was performed in Medline through PubMed, Embase, and Cochrane Library on February 27, 2017. Original cohort studies examining pain, function, and satisfaction in blacks and whites 1 year after elective THA were included. Using the Patient/Population–Intervention–Comparison/Comparator–Outcome (PICO) process format, our population of interest was US black adults, our intervention was elective THA, our comparator was white adults, and our outcomes of interest were pain, function, and satisfaction after elective THA. The protocol was registered under the PROSPERO international register, and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines were followed.

**Results.** Of the articles, 4739 were screened by title, 180 by abstract, 25 by full text, and 4 remained for analysis. The studies represented 1588 THA patients, of whom 240 (15%) were black. All studies noted more pain and worse function for blacks; although differences were statistically significant, they were not clinically significant. One study sought and identified less satisfaction for blacks after THA, and 1 study showed worse fear and anxiety scores in blacks.

**Conclusion.** When measured, there are small differences in THA outcomes between blacks and whites, but most studies do not analyze/collect race. Future studies should address the effect of race and socioeconomic factors on healthcare disparities. (First Release February 1 2018; J Rheumatol 2018;45:717–22; doi:10.3899/jrheum.170855)

## Key Indexing Terms:

ARTHROPLASTY

HIP

OUTCOMES

QUALITY OF LIFE

Total hip replacement (THA) surgery is one of the most successful procedures and has been referred to as the “operation of the century,” in light of its predictable results and limited morbidity<sup>1,2</sup>. Use of THA has continued to rise for the treatment of pain and to restore function caused by endstage arthritis<sup>3</sup>. Nonetheless, despite an equivalent prevalence of hip osteoarthritis (OA) in blacks and whites, lower use of THA for blacks in the United States has persisted over decades<sup>4,5</sup>.

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The reason for the disparities in THA use is unclear. Physician bias in recommendations for surgery does not seem to play a major role, because black and white patients are equally likely to be referred for arthroplasty, and when differences in recommendations are noted, they appear to be determined by patient preference<sup>6,7</sup>. Expectations for arthroplasty outcomes are lower for blacks, and blacks prefer nontraditional interventions such as prayer or massage over arthroplasty, possibly contributing to the disparity between whites and blacks in THA use<sup>8,9</sup>. Complications, including risk of revision, are higher in blacks undergoing total knee arthroplasty (TKA)<sup>10</sup>, and while noninfectious- and infection-related 30-day complications are higher after TKA for blacks, no difference in complications was observed after THA<sup>11</sup>. However, blacks are more likely to receive arthroplasty in low-volume hospitals<sup>12,13</sup> where the outcomes for common procedures such as arthroplasty are not as consistent as the outcomes in high-volume hospitals<sup>14,15</sup>. For blacks undergoing TKA, poorer health-related quality of life (HRQOL) outcomes have been reported, although literature on the difference in outcomes was sparse<sup>16,17</sup>. This suggests that

poorer outcomes for blacks may in part mediate their decreased arthroplasty use. The purpose of our study was to systematically review the literature to compare pain, function, and satisfaction for US blacks versus whites undergoing THA.

MATERIALS AND METHODS

We performed a systematic literature review using guidelines contained in the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement to determine whether there are differences in pain, function, or satisfaction after THA between US blacks and whites. We registered the systematic review protocol under PROSPERO international register ([www.crd.york.ac.uk/PROSPERO/display\\_record.asp?ID=CRD420170643](http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD420170643) 20). As per institutional policy for research without human subjects or their unique information, this study did not require institutional review board approval and otherwise followed appropriate ethical standards. Using the Patient/Population–Intervention–Comparison/Comparator–Outcome (PICO) format, our Population of interest was US black adults, our Intervention was THA, our Comparator was white adults, and our Outcomes of interest were pain, function, and satisfaction after elective THA measured by validated instruments. We restricted our search to US cohorts given the differences in access to healthcare and differences in the involvement of race in different countries; we also restricted our search to studies published after 2000 to reflect recent protocols in surgery. We excluded studies that specifically selected patients with inflammatory arthritis, revisions, fractures, hemophilia, or studied a specific surgical technique or implant materials. We excluded expert-opinion review articles, systematic reviews, abstracts, duplicate articles, case series, and case reports. The minimal acceptable followup postoperative was 1 year, and our search was limited to humans and English-language literature. The included papers were assessed for quality and sources of bias using the GRADE system (Grading of Recommendations Assessment, Development, and Evaluation).

*Search strategy.* A librarian-assisted search was performed in Medline through PubMed, Embase, and Cochrane Library (including Cochrane Central Register of Controlled Trials, Health Technology Assessment Database, Cochrane Methodology Register and NHS Economic Evaluation Database) on February 27, 2017. We also reviewed journals not in these databases that focus on healthcare disparities by hand-searching the individual journals (grey literature). The PubMed search strategy is detailed in Table 1.

A sensitive search strategy was applied to identify all relevant data related to race. The included studies used instruments validated for use after THA, for example, The Western Ontario and McMaster Universities Arthritis Index (WOMAC), Hip Injury and Osteoarthritis Outcome Score, Oxford Hip

Score, and Harris Hip Score (HHS). The screening was performed by 2 authors (SG, BM) who independently screened 4739 articles by titles and abstracts, and identified articles for further review. If there was a conflict, the 2 reviewers discussed the paper and reached an agreement. We confirmed with the same author of 3 of the studies that they were performed in separate cohorts of patients.

RESULTS

We identified 6991 articles (3372 Medline through PubMed + 554 Cochrane + 3065 Embase). Duplicates were removed, leaving 4739 articles screened by title. One hundred eighty papers were selected for abstract review. We excluded 63 abstracts that reported on non-US cohorts, 45 that failed to analyze/report race, 21 that were on a wrong topic/procedure, 17 that reported outcomes not of interest, and 9 that were review articles. The remaining 25 studies underwent full-text review. Twenty-one studies were eliminated because of inadequate analysis of the outcomes of interest by race or wrong outcome (Figure 1). Four studies were included in the final analysis after consensus of the 2 reviewing authors. Two studies were prospective in design and 2 were retrospective analysis of prospectively acquired data. The studies included 1588 THA patients, including 240 (15%) blacks (Table 2)<sup>18,19,20,21</sup>.

Lavernia, *et al*<sup>18</sup> performed a prospective study in which 331 patients with endstage OA underwent primary or revision hip or knee arthroplasty between October 2000 to March 2002. All had patient data collected at baseline and were followed for a minimum of 3 years (average 5 yrs; range 3–8 yrs). All surgeries were performed by 3 surgeons and used a cemented technique. Regardless of time, blacks scored worse than whites for all measures except for the Medical Outcomes Study Short Form-36 physical function and general health scores. Blacks had worse WOMAC scores (scale 1–100, higher worse) for physical function, pain, and total scores. Total scores of blacks were higher ( $44.31 \pm 2.06$ ) compared to whites ( $34.51 \pm 0.87$ ). Using the Quality of Well-being index as well as the Pain Anxiety Symptom Scale (PASS) in the study, blacks presented at the time of surgery

Table 1. Electronic search strategy.

Database	Medline through PubMed
Date	21/04/2017
Strategy	#1 AND #2 AND #3
#1	(“Arthroplasty, Replacement, Hip”[Majr] OR (total[Title/Abstract] AND Hip[Title/Abstract] AND (arthroplasty[Title/Abstract] OR replacement[Title/Abstract])))
#2	((“pain measurement” [MeSH Terms] OR (“pain”[All Fields] AND “measurement”[All Fields]) OR “pain measurement”[All Fields]) OR (“recovery of function”[MeSH Terms] OR (“recovery”[All Fields] AND “function”[All Fields]) OR “recovery of function”[All Fields]) OR (“quality of life”[MeSH Terms] OR (“quality”[All Fields] AND “life”[All Fields]) OR “quality of life”[All Fields]) OR Koots[All Fields] OR WOMAC[All Fields] OR (“patient satisfaction”[MeSH Terms] OR (“patient”[All Fields] AND “satisfaction”[All Fields]) OR “patient satisfaction”[All Fields]))
#3	(“2000/01/01”[PDAT]: “3000/12/31”[PDAT])

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

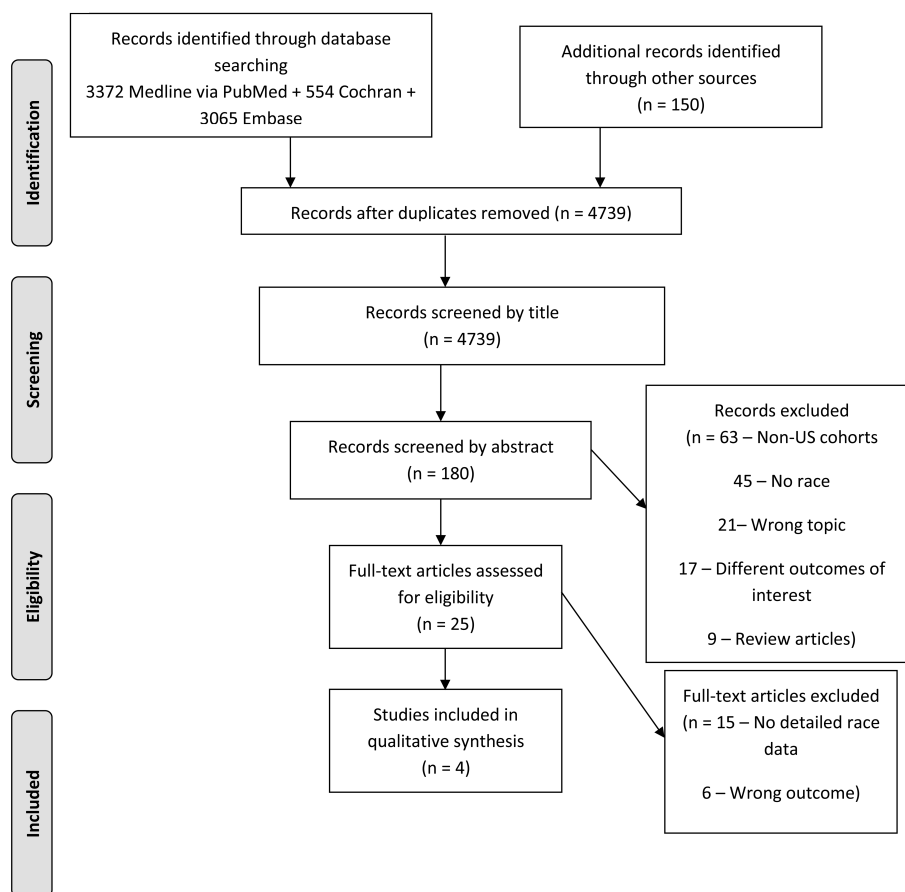


Figure 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2009 flow diagram.

with a higher fear score ( $p = 0.002$ ), cognitive subscale, and total PASS score ( $p = 0.04$ ) compared with whites.

Allen Butler, *et al*<sup>19</sup> published a prospective randomized study that enrolled 102 patients who were randomized to receive 1 of 2 different implants. Detailed patient data were collected preoperatively and included race, diagnosis, age, sex, insurance status, medical comorbidities, tobacco and alcohol use, household income, educational level, and history of treatment for lumbar spine pathology. Detailed baseline and followup data at (minimally) 2 years included HHS, Medical Outcomes Study Short Form-12, WOMAC, pain drawing, and UCLA activity rating and satisfaction questionnaire. They found no difference in outcome between the 2 implant types, but found that blacks, those with less education, those with income under the poverty level, and those with poorer baseline hip scores were at higher risk for a poor HHS ( $< 90$ ), greater thigh pain on a pain drawing, and a visual analog scale (VAS)  $\geq 3$  at 2 years.

Lavernia, *et al*<sup>20</sup> performed a retrospective review of prospectively acquired data of 1749 patients receiving total joint arthroplasty (739 hips and 1010 knees) between 1992 and 2007. The data were analyzed to determine the influence

of race and ethnicity on well-being, pain, and function 2–16 years after total joint arthroplasty was performed. Blacks consisted of 32 (10.8%) of the non-Hispanic men and 54 (12.2%) of the non-Hispanic women undergoing THA, and among the black Hispanics undergoing THA, 15 (5.1%) were men and 17 (3.8%) were women. Blacks presented with worse pain and poorer function across multiple measures, and the disparity in outcomes persisted for WOMAC pain and stiffness after surgery. Blacks had worse WOMAC pain scores (mean range 2.55–3.79) compared to whites (mean range 0.92–1.16) on a 4-point scale. This study collected extensive quality-of-life data, but did not include education or income in the analysis.

Lavernia and Villa<sup>21</sup> performed another retrospective review of prospectively collected data of 2142 primary THA and TKA (1665 patients) performed by the senior author (CJL) in a single institution from May 2003 to November 2012. The cases included 105 blacks, 46 of whom underwent THA. Only 39/105 blacks (37%) had 1-year followup. Patients undergoing TKA and THA were analyzed together. More blacks than whites underwent surgery for avascular necrosis (15% vs 3%) and inflammatory arthritis (7% vs 3%).

Table 2. Included studies.

Studies	Yrs	Duration Followup, yrs	Type of Study	Outcomes Analyzed	Total, n = 1588	White, n = 1348	Black, n = 240	Significantly Worse in Black Patients	Notes
Lavernia and Villa, CORR <sup>21</sup>	2003–2012	1–9	Retrospective study	WOMAC, VAS, QWB, SF-36	564	518	46	Preoperative pain intensity, well-being score, postoperative pain intensity statistically significant, but not clinically significant	Performed by 1 surgeon
Allen Butler, <i>et al</i> , CORR <sup>19</sup>	2000–2003	2–5	Prospective study	WOMAC, HHS, VAS, pain drawing**, UCLA activity score*, SF-12, satisfaction <sup>†</sup>	102	52	50	HHS, thigh pain, satisfaction at 2 yrs	Socioeconomic factors and preoperative status have more effect on clinical outcome than the implant-related factors
Lavernia, <i>et al</i> , CORR <sup>20</sup>	1992–2007	2–16	Retrospective study	WOMAC, HHS, MAP score, ROM, radiographs, QWB, SF-36	739	621	118	Bodily pain, social function, SF-36, QWB, worse patient-perceived well-being and function	Performed by 1 surgeon, bilateral THA were excluded
Lavernia, <i>et al</i> , CORR <sup>18</sup>	2000–2002	3–8	Prospective study	WOMAC, QWB, PASS***, SF-36	183	157	26	WOMAC (pre- and postoperative), PASS, QWB	Performed by 3 surgeons

\*Survey designed by The University of California, Los Angeles (UCLA); patient indicates his or her most appropriate activity level on a 10-point scale. \*\*Qualitative measure of perceived leg and/or hip pain. Patient is given an anatomical drawing and asked to rate pain of indicated hip and leg regions on a 5-point scale. \*\*\*Self-reported measure of general pain-related anxiety (summation of 4 distinct anxiety subscales: cognitive, fear, escape/avoidance, and physiological anxiety). <sup>†</sup> Patient rates satisfaction with: overall knee function, ability to perform daily activities, and pain relief after THA, each on a 4-point Likert scale. CORR: Clinical Orthopedic and Related Research; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; VAS: visual analog scale; QWB: Quality of Well-being score; SF-36: Medical Outcomes Study Short Form-36; HHS: Hamilton Hip Score; SF-12: Medical Outcomes Study Short Form-12; MAP score: Merle d'Aubigné-Postel score; ROM: range of motion; PASS: Pain Anxiety Symptom Scale; THA: total hip replacement.

Blacks were younger than whites at the time of surgery (mean age  $63 \pm 13.2$  vs  $70 \pm 9.9$  yrs), but there was no difference in the Charlson Comorbidity Index or the American Society of Anesthesiologists score between groups. Small differences were noted in preoperative VAS pain ( $8 \pm 1.8$  vs  $8 \pm 2.0$ ; mean difference 0.76, SD 0.34–1.1;  $p < 0.001$ ) and preoperative WOMAC function ( $42 \pm 13$  vs  $38 \pm 12$ ; mean difference 4.9, SD 2.2–7.5;  $p < 0.001$ ) between black and white patients, but these differences, while statistically significant, are not clinically significant. Postoperative differences were noted in pain, WOMAC, and overall well-being and the differences were again statistically but not clinically significant. The higher proportion of blacks diagnosed with inflammatory arthritis and avascular necrosis may have also skewed the results, and no information regarding education or income was included in the analysis.

**Synthesis of results.** All 4 studies included in this systematic literature review noted more pain and poorer scores for function for blacks after THA, and although differences were statistically significant, they were not clinically significant. One study sought and identified less satisfaction for blacks after THA, and 1 study showed worse fear and anxiety scores in blacks. The data could not be metaanalyzed because of the heterogeneity in outcome measures. There were no randomized controlled trials, and all observational studies were considered low to moderate quality.

## DISCUSSION

Our systematic review aimed to compare quality-of-life outcomes of pain, function, and satisfaction after THA between blacks and whites in the United States after 2000. However, of 4739 publications identified, only 4 contained adequate information to evaluate racial disparities in THA outcomes in the United States. These 4 studies reported on a total of 1588 THA, and included data on 240 blacks (15%), describing greater pain and poorer function and less satisfaction after THA for US blacks. The largest differences in quality-of-life outcomes were in the study by Allen Butler, *et al*<sup>19</sup> that included a high proportion of patients living in poverty, and identified race, income below poverty, and less education as significant risk factors for poor outcomes. It is striking that despite the documented persistence of racial disparities in the use of arthroplasty<sup>4</sup>, and the emphasis by the US Surgeon General and the Institute of Medicine on the importance of eliminating racial disparities in health, the study of racial disparities in THA outcomes has been quite limited<sup>22,23</sup>. Similar to our previous systematic literature review addressing differences in TKA outcomes between whites and blacks<sup>17</sup>, our current study highlights the omission of race and socioeconomic status in most studies of THA outcomes.

Overall, patients undergoing THA are more satisfied and show greater improvement than similar patients undergoing



TKA<sup>24,25</sup>, yet there is no difference in the disparity in use of THA compared to TKA, indicating that disparities in arthroplasty use are multifactorial. Minority patients who prefer “culturally alike” physicians may have difficulty finding them because black and Hispanic physicians account for < 10% of all physicians in the United States<sup>26</sup>. Prior studies have identified poorer baseline pain and function as a risk factor for poor outcomes after THA; however, race and socioeconomic status have not been analyzed<sup>27,28</sup>. Previous studies analyzing race have revealed that black patients undergoing TKA have worse pain and function both at baseline and at followup<sup>17,29,30,31,32,33</sup>. However, the racial disparity in outcomes after TKA is seen only in neighborhoods with high poverty levels, demonstrating an interaction of race and poverty that contributes to healthcare outcomes<sup>16</sup>. The risk of TKA revision has also been linked to race. A recent metaanalysis revealed that race was a significant risk factor for TKA revision, although in studies using the Medicare (health insurance for the elderly) 5% sample, insurance status (Medicaid eligibility; health insurance for low-income people, a surrogate for socioeconomic status) was a confounder<sup>10</sup>. Because more blacks live in poverty than whites<sup>34</sup>, and poverty is associated with poorer health outcomes<sup>35</sup>, attribution of mediators of risk in healthcare outcomes can be difficult. While poorer outcomes after THA may contribute to disparities in THA use, the differences are small, and multiple other factors are likely to contribute to THA use.

Our conclusions are limited by the paucity of studies available for inclusion. An additional weakness to our analysis is that all 4 studies were performed in southern cities; 3 of the studies reflect a single surgeon’s experience in Miami, Florida, and the fourth study describes a small cohort collected in New Orleans, Louisiana, limiting the generalizability of this systematic review. In addition, 1 study combined THA and TKA in the final analysis.

Race and socioeconomic status are infrequently included in studies of THA outcomes. Understanding and addressing the reasons for persistent racial disparities in the use and outcomes of successful procedures such as THA will require inclusion of both race and other significant socioeconomic variables, such as education and poverty in studies of THA. Future studies should address these deficiencies so that the multidimensional factors leading to healthcare disparities can be addressed.

## REFERENCES

- Harris WH, Sledge CB. Total hip and total knee replacement (2). *N Engl J Med* 1990;323:801-7.
- Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. *Lancet* 2007;370:1508-19.
- 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;89:780-5.
- Singh JA, Lu X, Rosenthal GE, Ibrahim S, Cram P. Racial disparities in knee and hip total joint arthroplasty: an 18-year analysis of national Medicare data. *Ann Rheum Dis* 2014; 73:2107-15.
- Nelson AE, Golightly YM, Renner JB, Schwartz TA, Kraus VB, Helmick CG, et al. Brief report: differences in multijoint symptomatic osteoarthritis phenotypes by race and sex: the Johnston County Osteoarthritis Project. *Arthritis Rheum* 2013;65:373-7.
- Ang DC, James G, Stump TE. Clinical appropriateness and not race predicted referral for joint arthroplasty. *Arthritis Rheum* 2009;61:1677-85.
- Hausmann LR, Mor M, Hanusa BH, Zickmund S, Cohen PZ, Grant R, et al. The effect of patient race on total joint replacement recommendations and utilization in the orthopedic setting. *J Gen Intern Med* 2010;25:982-8.
- Groeneveld PW, Kwok CK, Mor MK, Appelt CJ, Geng M, Gutierrez JC, et al. Racial differences in expectations of joint replacement surgery outcomes. *Arthritis Rheum* 2008;59:730-7.
- Ibrahim SA, Franklin PD. Race and elective joint replacement: where a disparity meets patient preference. *Am J Public Health* 2013;103:583-4.
- Bass AR, McHugh K, Fields K, Goto R, Parks ML, Goodman SM. Higher total knee arthroplasty revision rates among United States blacks than whites: a systematic literature review and meta-analysis. *J Bone Joint Surg Am* 2016;98:2103-8.
- Ibrahim SA, Stone RA, Han X, Cohen P, Fine MJ, Henderson WG, et al. Racial/ethnic differences in surgical outcomes in veterans following knee or hip arthroplasty. *Arthritis Rheum* 2005; 52:3143-51.
- Dy CJ, Marx RG, Ghomrawi HM, Pan TJ, Westrich GH, Lyman S. The potential influence of regionalization strategies on delivery of care for elective total joint arthroplasty. *J Arthroplasty* 2015;30:1-6.
- SooHoo NF, Farn E, Zingmond DS. Disparities in the utilization of high-volume hospitals for total hip replacement. *J Natl Med Assoc* 2011;103:31-5.
- Katz JN, Phillips CB, Baron JA, Fossel AH, Mahomed NN, Barrett J, et al. Association of hospital and surgeon volume of total hip replacement with functional status and satisfaction three years following surgery. *Arthritis Rheum* 2003;48:560-8.
- Katz JN, Losina E, Barrett J, Phillips CB, Mahomed NN, Lew RA, et al. Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States medicare population. *J Bone Joint Surg Am* 2001;83:1622-9.
- Goodman SM, Mandl LA, Parks ML, Zhang M, McHugh KR, Lee YY, et al. Disparities in TKA outcomes: census tract data show interactions between race and poverty. *Clin Orthop Relat Res* 2016;474:1986-95.
- Goodman SM, Parks ML, McHugh K, Fields K, Smethurst R, Figgie MP, et al. Disparities in outcomes for African Americans and whites undergoing total knee arthroplasty: a systematic literature review. *J Rheumatol* 2016;43:765-70.
- Lavernia CJ, Alcerro JC, Rossi MD. Fear in arthroplasty surgery: the role of race. *Clin Orthop Relat Res* 2010;468:547-54.
- Allen Butler R, Rosenzweig S, Myers L, Barrack RL. The Frank Stinchfield Award: the impact of socioeconomic factors on outcome after THA: a prospective, randomized study. *Clin Orthop Relat Res* 2011;469:339-47.
- Lavernia CJ, Alcerro JC, Contreras JS, Rossi MD. Ethnic and racial factors influencing well-being, perceived pain, and physical function after primary total joint arthroplasty. *Clin Orthop Relat Res* 2011;469:1838-45.
- Lavernia CJ, Villa JM. Does race affect outcomes in total joint arthroplasty? *Clin Orthop Relat Res* 2015;473:3535-41.
- US Department of Health and Human Services. Elimination of health disparities. [Internet. Accessed December 5, 2017.] Available from: [www.surgeongeneral.gov/priorities/prevention/strategy/elimination-of-health-disparities.html](http://www.surgeongeneral.gov/priorities/prevention/strategy/elimination-of-health-disparities.html)

23. Office of Disease Prevention and Health Promotion. Healthy People 2020. Disparities. [Internet. Accessed December 5, 2017.] Available from: [www.healthypeople.gov/2020/about/foundation-health-measures/Disparities](http://www.healthypeople.gov/2020/about/foundation-health-measures/Disparities)
24. Bourne RB, Chesworth B, Davis A, Mahomed N, Charron K. Comparing patient outcomes after THA and TKA: is there a difference? *Clin Orthop Relat Res* 2010;468:542-6.
25. Bachmeier CJ, March LM, Cross MJ, Lapsley HM, Tribe KL, Courtenay BG, et al. A comparison of outcomes in osteoarthritis patients undergoing total hip and knee replacement surgery. *Osteoarthritis Cartilage* 2001;9:137-46.
26. Reede JY. A recurring theme: the need for minority physicians. *Health Aff* 2003;22:91-3.
27. Singh JA, Lewallen D. Predictors of pain and use of pain medications following primary Total Hip Arthroplasty (THA): 5,707 THAs at 2-years and 3,289 THAs at 5-years. *BMC Musculoskeletal Disord* 2010;11:11-90.
28. Buirs LD, Van Beers LW, Scholtes VA, Pastoors T, Sprague S, Poolman RW. Predictors of physical functioning after total hip arthroplasty: a systematic review. *BMJ Open* 2016;6:2015-25.
29. Kamath AF, Horneff JG, Gaffney V, Israelite CL, Nelson CL. Ethnic and gender differences in the functional disparities after primary total knee arthroplasty. *Clin Orthop Relat Res* 2010;468:3355-61.
30. Lopez-Olivo MA, Landon GC, Siff SJ, Edelstein D, Pak C, Kallen MA, et al. Psychosocial determinants of outcomes in knee replacement. *Ann Rheum Dis* 2011;70:1775-81.
31. Maratt JD, Lee YY, Lyman S, Westrich GH. Predictors of satisfaction following total knee arthroplasty. *J Arthroplasty* 2015;30:1142-5.
32. Jacobs CA, Christensen CP, Karthikeyan T. Patient and intraoperative factors influencing satisfaction two to five years after primary total knee arthroplasty. *J Arthroplasty* 2014;29:1576-9.
33. Barrack RL, Ruh EL, Chen J, Lombardi AV Jr, Berend KR, Parvizi J, et al. Impact of socioeconomic factors on outcome of total knee arthroplasty. *Clin Orthop Relat Res* 2014;472:86-97.
34. Centers for Disease Control and Prevention. Fact sheet — CDC health disparities and inequalities report — U.S., 2011. [Internet. Accessed December 6, 2017.] Available from: [www.cdc.gov/minorityhealth/chdir/2011/factsheet.pdf](http://www.cdc.gov/minorityhealth/chdir/2011/factsheet.pdf)
35. Browne JA, Novicoff WM, D'Apuzzo MR. Medicaid payer status is associated with in-hospital morbidity and resource utilization following primary total joint arthroplasty. *J Bone Joint Surg Am* 2014;96:180.