

# Disparities in Outcomes for African Americans and Whites Undergoing Total Knee Arthroplasty: A Systematic Literature Review

Susan M. Goodman, Michael L. Parks, Kelly McHugh, Kara Fields, Rie Smethurst, Mark P. Figgie, and Anne R. Bass

**ABSTRACT. Objective.** African Americans in the United States undergo total knee arthroplasty (TKA) less often than whites, in part because of lower expectations among African Americans for successful surgery. Whether this lower expectation is justified is unknown. Our objective is to compare health-related quality of life (HRQOL) and satisfaction after TKA between African Americans and whites.

**Methods.** A systematic review of English language articles using Medline, the Cochrane register, Embase (April 21, 2015), and a hand search of unlisted disparities journals was performed. Search terms included total knee replacement, quality of life, outcomes, and satisfaction. High-quality cohort studies that examined HRQOL in African Americans and white adults 6 months or more after TKA were included.

**Results.** Of the 4781 studies screened by title, and 346 by abstract, 7 studies included race in their analysis. Results included 5570 TKA patients, 4077 whites (89%), and 482 (11%) blacks. Because studies used different outcome measures and were inconsistent in their adjustment for confounders, we could not perform a quantitative synthesis of results. In 5 studies, US blacks had worse pain, in 5 worse function, and in 1 less satisfaction 6 months to 2 years after TKA.

**Conclusion.** US blacks may derive less benefit from TKA than whites as measured by HRQOL, pain, function, and satisfaction. Many studies assessing predictors of patient-related TKA outcomes fail to analyze race as a variable, which limited our study. More studies assessing the effect of race and socioeconomic factors on TKA outcome are needed. (J Rheumatol First Release February 1 2016; doi:10.3899/jrheum.150950)

*Key Indexing Terms:*

ARTHROPLASTY      HEALTH ASSESSMENT QUESTIONNAIRE      KNEE  
 PATIENT SATISFACTION      QUALITY OF LIFE

Although osteoarthritis (OA) affects 45% of both blacks and whites in the United States<sup>1</sup>, there are persistent racial disparities in the use of total knee arthroplasty (TKA). There are no disease-modifying agents for OA, and TKA remains the most effective therapy for endstage disease. TKA is among

the most successful surgical procedures with an excellent track record for restoring function and diminishing pain; 90% of patients who undergo TKA report improvement<sup>2,3,4</sup>. It is anticipated that TKA use will increase > 673% by 2030<sup>5</sup>. However, TKA use among black men was 37% lower than for white men in 2000 and 39% lower in 2006<sup>1</sup>. Racial disparities in TKA use and in important short-term outcomes, such as readmission and mortality, have remained constant between 1991 and 2008<sup>6</sup>.

*From the Division of Rheumatology, Weill Cornell Medical School, and departments of Medicine and Orthopedics at the Hospital for Special Surgery, New York, New York, USA.*

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*S.M. Goodman, MD, Department of Medicine, Weill Cornell Medical College, Division of Rheumatology, Hospital for Special Surgery; M.L. Parks, MD, Associate Professor of Clinical Orthopedic Surgery, Weill Cornell College of Medicine, Adult Reconstructive and Joint Replacement Service, Hospital for Special Surgery; K. McHugh, BA, Research Coordinator, Hospital for Special Surgery; K. Fields, MA, Statistical Analyst, Hospital for Special Surgery; R. Smethurst, MSLIS, Medical Librarian, Hospital for Special Surgery; M.P. Figgie, MD, Professor of Orthopedic Surgery, Weill Cornell College of Medicine, Attending Orthopedic Surgeon, Chief of Surgical Arthritis Service, Hospital for Special Surgery; A.R. Bass, MD, Associate Professor of Clinical Medicine, Weill Cornell Medical College, Rheumatology Fellowship Program Director, Hospital for Special Surgery.*

*Address correspondence to Dr. S.M. Goodman, Hospital for Special Surgery, 535 East 70th St., New York, New York 10021, USA.  
 E-mail: GoodmanS@hss.edu*

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The reason for disparities in TKA use is not well understood. Physician bias does not seem to have a significant involvement because blacks are as likely to be considered or referred for TKA as whites<sup>7,8,9</sup>. This suggests that patient-level factors may be involved. US blacks are more likely than whites to use nontraditional methods such as prayer to improve OA symptoms<sup>10</sup>, and they are less likely to consider arthroplasty even after a recommendation from their doctor<sup>11</sup>. US blacks expect less improvement from arthroplasty than whites, and while they are less familiar with arthroplasty than whites, they nonetheless expect greater pain and disability after surgery than whites do<sup>12,13,14</sup>.

Are US blacks' lower expectations for TKA outcomes

justified? The purpose of our study was to systematically review the literature comparing TKA outcomes for blacks and whites. Specifically, we were interested in comparing levels of pain, function, and overall satisfaction 6 months to 5 years from the time of surgery.

## MATERIALS AND METHODS

We performed a systematic literature review of English language articles using guidelines contained in the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement<sup>15</sup> to determine whether there are differences between US blacks and whites in quality of life outcomes of TKA, including pain, function, and satisfaction.

**Inclusion criteria.** Preestablished criteria for the included studies were (1) inclusion of population of interest: black adults (age  $\geq 18$ ); (2) comparator: white adults; (3) intervention: elective TKA; (4) outcome: health-related quality of life including pain, function, and/or satisfaction using validated instruments (see below); (5) country: the United States; (6) followup:  $\geq 6$  months; and (7) language: English.

**Outcome measures.** For pain and function measurements, the instruments had to be validated for use after TKA. The included studies used the Western Ontario and McMasters Osteoarthritis Index (WOMAC), the Knee Society Score (KSS), or the Knee Society Rating Scale (KSRS). These disease-specific measures assess change in multiple domains specific to TKA, including physical and emotional health and physical and social function. Satisfaction was systematically queried and measured using either a Likert scale in 2 studies or a binary response in a third. Patients were asked “are you satisfied?” and only yes/no answers were included.

**Exclusion criteria.** We excluded expert opinion review articles, abstracts, duplicate articles, case series ( $< 100$  patients), and case reports.

**Assessment of study quality.** The quality of the data was assessed using the Oxford Center Levels of Evidence<sup>16</sup>. No randomized controlled trials were available. High-quality, peer-reviewed, prospective cohort studies classed 2b using the Oxford Center classification, with low risk of bias, were included. Potential sources of bias were examined and included selection, recall bias, loss of followup, and lack of generalizability. Included studies accounted for these potential sources of bias.

**Search strategy.** A librarian-assisted search was performed in Medline by PubMed, Embase, and Cochrane Library (including the Cochrane Central Register of Controlled Trials, Health Technology Assessment Database, and National Health Service Economic Evaluation Database) on April 21, 2015. We also reviewed journals not in these databases that focused on healthcare disparities by hand-searching the individual journals. The following search strategy was used: (“Arthroplasty, Replacement, Knee”[Majr] OR (total[Title/Abstract] AND knee[Title/Abstract] AND (arthroplasty[Title/Abstract] OR replacement[Title/Abstract]))) AND (“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 Koos[All Fields] OR WOMAC[All Fields] OR (“patient satisfaction”[MeSH Terms] OR (“patient”[All Fields] AND “satisfaction”[All Fields]) OR “patient satisfaction”[All Fields])) AND (“2000/01/01”[PDAT]: “3000/12/31”[PDAT]).

We limited the search to English-language articles published starting in 2000. Changes in surgical approach and outcomes could add significant heterogeneity if older studies were included. No other limitation was imposed on the initial search. The search returned 4723 results. Fifty-eight additional articles identified by hand-searching journals not listed in available electronic databases were screened by title from healthcare disparities-focused journals. The 2 senior authors (SG, AB) reviewed all titles, abstracts, and full texts. Both senior authors (SG, AB) extracted data from the selected manuscripts, and the final data were assembled into tables by a

third independent reviewer (KM) and verified by the senior authors.

**Data extraction.** Data extracted included age, surgical procedure, duration of followup, satisfaction, and pain and function measures (WOMAC, KSS) in blacks versus whites. Additional clarifying information was obtained through direct communication with the authors of 2 papers<sup>17,18</sup>.

## RESULTS

The search strategy yielded 4781 studies screened by title, of which 346 were screened by abstract, and 18 were reviewed in full (Figure 1). Seven studies remained after eliminating duplicates, abstracts, reviews, opinion papers, and non-US-based studies. Consensus was reached by the senior authors prior to the inclusion of studies in the final synthesis of data. Taken together, these 7 cohort studies represented 5570 patients undergoing TKA, of whom 482 (11%) were black (Table 1). In 5 studies, prospectively gathered registry data were analyzed retrospectively, while 2 studies were prospective in design. Heterogeneous outcome measures and analytical designs in the studies prevented us from performing a metaanalysis.

**Pain.** Blacks were reported to have worse pain after TKA in 4 out of the 7 included studies. Pain was defined using the WOMAC pain score in the studies by Maratt, *et al*<sup>18</sup>, Styron, *et al*<sup>17</sup>, and Lavernia, *et al*<sup>19</sup>, and using KSS in the study by Kamath, *et al*<sup>20</sup>.

**Function.** In those 4 of the 7 studies, blacks reported worse function after TKA. Styron, *et al*<sup>17</sup> used the WOMAC function score, Lavernia, *et al*<sup>19</sup> used both the WOMAC and KSS scores, and Barrack, *et al*<sup>21</sup> used a series of previously published questions about activities such as the ability to get in and out of a car and climb stairs. While Lopez-Olivo, *et al*<sup>22</sup> used both the WOMAC and the KSRS scores, function was worse only for non-whites on the KSRS.

**Satisfaction.** Barrack, *et al*<sup>21</sup> and Jacobs, *et al*<sup>23</sup> both queried satisfaction, but only Jacobs, *et al* found that blacks were less likely to be satisfied.

**Summary of the literature.** Maratt, *et al* performed a retrospective analysis of predictors of satisfaction with TKA using prospectively gathered baseline and 2-year registry data<sup>18</sup>. Data collected included baseline demographics and health characteristics, and standard outcome measures including the WOMAC and pain measured on a visual analog scale (VAS). Satisfaction was assessed on a 6-point scale and was used to determine the minimally clinically important change (MCIC). Of 2350 patients included in the study, 101 (4.3%) were black. Black patients were less likely to achieve an MCIC for WOMAC pain (OR for not achieving MCIC 2.01, 95% CI 1.12–3.61), but not WOMAC stiffness or function. Age, sex, and ethnicity were not consistently associated with worse outcomes. A potential source of bias was a large number of excluded cases, although the selection criteria for the final analysis was based on disability status and not race or ethnicity.

Barrack, *et al* retrospectively analyzed TKA outcomes using prospectively gathered registry data that included 661

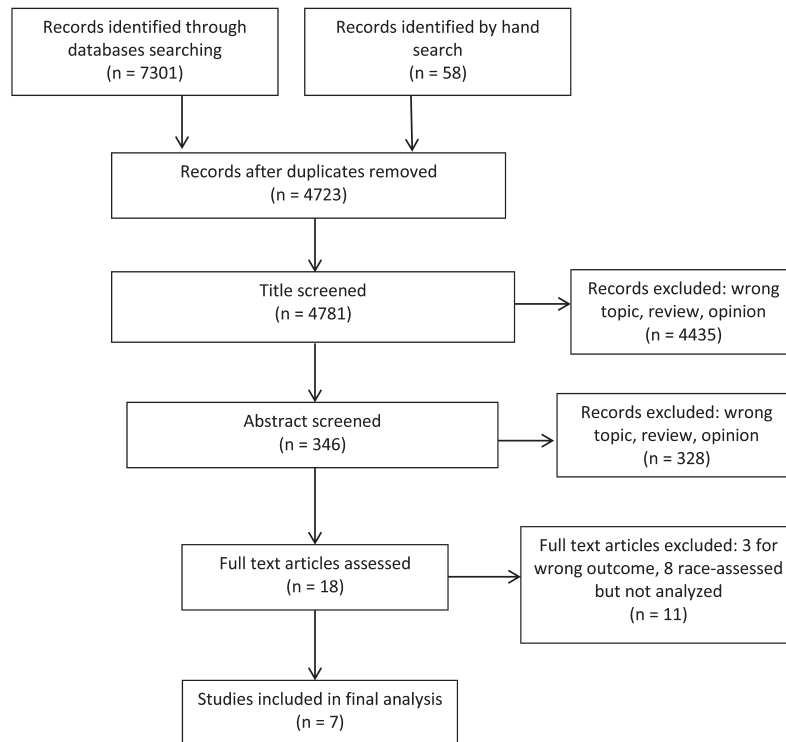


Figure 1. Flow chart of the identification of included studies. Records identified through computer databases (n = 7301) and records identified by review of journals known to publish articles about health disparities but not listed in available databases (“hand searched”, n = 58).

of 1139 potential subjects<sup>21</sup>. Consecutive cases were selected from the existing registries of 5 different orthopedic centers meeting criteria of age < 60 years and date of surgery, with systematic exclusion of cases with comorbidities or complications. There was a 64% survey response rate among the selected cases. Eighty-five participants (13%) were black. Satisfaction and function were assessed with a previously published questionnaire using a 5-point Likert scale through a telephone interview. In multivariable analysis, only low income (< \$25,000 US), but not race or ethnicity, was significantly associated with dissatisfaction with overall function (OR 2.29, 95% CI 1.13–4.64), dissatisfaction with daily activities (OR 2.01, 95% CI 1.03–3.93), and pain relief (OR 2.49, 95% CI 1.23–5.04). Black and Hispanic patients were more likely to have problems with function such as getting in and out of a car (OR 1.67, 95% CI 1.01–2.78), getting in and out of a chair (OR 1.75, 95% CI 1.05–2.92), and limping (OR 2.04, 95% CI 1.23–4.35). The retrospective design of the study introduced the potential for recall bias because the surveys were sent  $\geq 1$  year after arthroplasty. Selection bias may have been introduced by systematically excluding cases with complications and comorbidities.

Jacobs, *et al* used prospectively gathered registry data to retrospectively analyze whether patient factors, including race, age, body mass index (BMI), and sex, or intraoperative surgical factors were associated with satisfaction after

TKA<sup>23</sup>. Satisfaction was determined by asking patients if they were satisfied yes/no at the most recent visit with a mean followup of 3.5 years. Only “yes” answers were included. (“Not sure” was an option and was not counted.) Of the 989 TKA performed in 755 patients, 94 patients (12%) were dissatisfied. Age, BMI, and sex were equally distributed among the satisfied and dissatisfied patients, but blacks were almost 3 times more likely than whites to be dissatisfied (11.7% vs 4.5%, OR 3.0, 95% CI 1.5–6.0,  $p = 0.0002$ ). Patients with more severe radiographic OA tended to be more satisfied, but no data on the radiographic severity in the black patients were provided. A potential source of bias included the failure to quantify socioeconomic status or severity of radiographic arthritis in the analysis. The conclusion that more blacks were dissatisfied would be stronger if the severity of preoperative arthritis for the blacks were accounted for.

Kamath, *et al* retrospectively studied 202 patients who underwent TKA with a minimum followup of 2 years, collecting demographics, comorbidities, and KSS<sup>20</sup>. Ninety patients were black. The black patients had worse KSS and range of motion at 2 years when compared with white patients. While the retrospective study design may have introduced recall and selection bias, the authors controlled for confounders including comorbidity scores and status at presentation.

Table 1. Summary of studies used in the review.

Studies	Study Yrs	Followup Duration	Outcomes Analyzed	Total, n	White, n	Black, n	Significantly Worse in Black Patients	Age Adjusted	Sex Adjusted	LOS Adjusted	Comorbidity Adjusted	Adjusted SES	Notes
Maratt, <i>et al</i> <sup>18</sup>	2001–2007	2 yrs	WOMAC pain, stiffness, function	2322	2108	101	Pain	Yes	Yes	Yes	Yes	Yes	Retrospective analysis of consecutive prospective cases
Barrack, <i>et al</i> <sup>21</sup>	NA	1–4 yrs	UWSC, satisfaction*, function	661	573	85	Pain, function**	Yes				Yes	Retrospective analysis of consecutive prospective cases
Jacobs, <i>et al</i> <sup>23</sup>	NA	2–5 yrs	Satisfaction†	989	830	49	Satisfaction	Yes	Yes			No	Retrospective analysis of consecutive prospective cases
Kamath, <i>et al</i> <sup>20</sup>	2004	2–5 yrs	ROM, KSS	185	87	90	Pain, function, ROM		Yes			No	Retrospective study
Lavernia, <i>et al</i> <sup>19</sup>	1992–2007	2–16 yrs	ROM, WOMAC, HSS, KSRS	1010	176	74	Pain, function		Yes			No	Single surgeon, retrospective analysis of consecutive prospective cases
Lopez-Olivo, <i>et al</i> <sup>22</sup>	2004–2005	6 mos	WOMAC pain and function, KSRS total, KSRS function	241	166	61	Function				Yes	Yes	Prospective cohort study
Styron, <i>et al</i> <sup>17</sup>		1, 3, 6 mos	WOMAC, SF-12	162	137	22	Pain, function	Yes	Yes				Prospective cohort study

\* Survey designed by the UWSC; targeted satisfaction with overall knee function, ability to perform daily activities, and pain relief using a 5-point Likert scale. \*\* Questions worse in black and Hispanic patients included: problems getting in and out of the car or chair, difficulty going up and down stairs, experienced pain in the last 30 days, and limp while walking. † Patients were asked if they were satisfied with their surgery and given the options “yes,” “no,” or “I’m not sure” — “yes” were categorized as satisfied. LOS: length of hospital stay; SES: socioeconomic status; NA: not applicable; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; UWSC: University of Wisconsin Survey Center; ROM: range of motion; KSS: Knee Society Score; HSS: Hospital for Special Surgery; KSRS: Knee Society Rating Score; SF-12: Medical Outcomes Study Short Form-12.

Lavernia, *et al* used registry data that was collected prospectively between 1992 through 2007 to analyze the effect of race and ethnicity on pain and function after arthroplasty using multiple instruments, including the WOMAC<sup>19</sup>. There were 1834 eligible patients; 5% (85) were excluded because of the lack of followup. Of the 1749 patients included in the study, 1010 underwent TKA. In the overall cohort, 160 (9%) were non-Hispanic blacks, 61 (4%) were Hispanic blacks, 1136 (65%) were Hispanic whites, and 392 (22%) were non-Hispanic whites. Non-Hispanic blacks had worse preoperative pain and function than whites (Hispanic or non-Hispanic) prior to TKA, and worse scores for physical function and quality of life after TKA compared with whites (Hispanic or non-Hispanic). In a regression model adjusting for race, ethnicity, sex, joint involvement, and preoperative status, race was a significant predictor of WOMAC pain, function, stiffness, and quality of life. However, the low coefficient of determination (WOMAC pain  $p = 0.0001$ ,  $R^2 < 0.017$ ; WOMAC function  $p \leq 0.0001$ ,  $R^2 = 0.015$ ) suggested that the involvement of race was minimal. This

was a single-surgeon study so the results may not be generalizable; however, the large size of the cohort makes the results important to consider.

Lopez-Olivo, *et al* prospectively collected WOMAC and KSRS on 241 patients undergoing TKA, both preoperatively and 6 months after surgery<sup>22</sup>. The study included 61 blacks (25%) and 11 Hispanics (5%). Non-whites had worse KSRS, but not worse WOMAC pain or function scores. Only 75% of patients contacted agreed to participate in the study, which may have biased the results. All patients received care in a private healthcare system, limiting generalizability. The discrepancy between WOMAC and KSRS is difficult to explain, but may reflect the broader scope of the KSRS.

Styron, *et al* analyzed return to work after TKA in 162 patients, of whom 22 (13.6%) were black and 1 (0.6%) was Hispanic<sup>17</sup>. An acceleration factor (AF) was calculated from a survival analysis based on the time from surgery to return to work, with an AF of  $> 1$  indicating an individual with a greater than the median time to return to work and an AF  $< 1$  indicating the opposite as compared with the reference group.



Non-whites did not have a slower return to work, either part-time (AF 1.014, 95% CI 0.796–1.293,  $p = 0.909$ ) or full-time (AF 1.041, 95% CI 0.808–1.341,  $p = 0.755$ ). Receiving workers' compensation had a strong association with a slower return to work, both part-time (AF 4.360, 95% CI 1.632–11.650,  $p = 0.003$ ) and full-time (AF 4.146, 95% CI 1.573–10.923,  $p = 0.004$ ). A review of unpublished WOMAC data provided by the author revealed that, after controlling for age, sex, BMI, and TKA laterality, there was less improvement in pain [adjusted difference in mean change (ADMC)  $-16.9$ , 95% CI  $-27.7$  to  $-6.2$ ,  $p = 0.006$ ] and function (ADMC  $-13.9$ , 95% CI  $-23.0$  to  $-4.9$ ,  $p = 0.008$ ) for blacks versus whites at 1 month, but not at 3 or 6 months postoperatively. A limitation was the small number of black and Hispanic patients assessed, particularly at the 3-month and 6-month timepoints; WOMAC survey followup rates at 1, 3, and 6 months were 73%, 72%, and 65% for whites, but only 77%, 64%, and 32% for blacks. Because responders may have been the patients with better outcomes, this study may underestimate the difference between blacks and whites.

## DISCUSSION

To our knowledge, ours is the first systematic literature review to examine differences in pain, function, and satisfaction after TKA in US whites and blacks. We found that of 346 high-quality studies addressing TKA outcomes, only 7 contained adequate information to allow assessment of racial disparities. Taken together, results from these 7 studies included 5570 patients undergoing TKA, of whom 482 were black. Postoperative pain, function, satisfaction, and quality of life appeared to be worse for black patients compared with white patients. The systematic literature review also brought to light the frequent omission of race and socioeconomic status in most studies of TKA outcomes.

Although TKA is usually a successful procedure, 19% of TKA patients are dissatisfied with their outcome<sup>24,25,26</sup>. Dissatisfaction following TKA is associated with experiencing postoperative complications, poor WOMAC outcomes at 1 year, and failure of the operation to meet preoperative expectations<sup>24,26</sup>. In the study by Barrack, *et al*, being black and Hispanic did not predict dissatisfaction, despite having poorer functional outcomes in several domains (getting in and out of a car, walking with a limp)<sup>21</sup>. In the study by Jacobs, *et al*, more black patients were dissatisfied, as were patients with less severe radiographic OA. Radiographic severity in the black patients was not described<sup>23</sup>. Maratt, *et al* reported that black patients were less likely to achieve the minimal clinically important change in WOMAC pain after TKA (though not stiffness and function), but the study did not directly address satisfaction among those with poorer scores<sup>18</sup>.

Risk factors for pain and poor function following TKA include preoperative pain, depression, and comorbidities<sup>27,28</sup>. That is, postoperative pain and function is generally worse

among patients with greater pain and poorer functional status prior to surgery. Of note, blacks are reported to delay TKA longer and present with more advanced arthritis than whites<sup>27,28</sup>. Preoperative pain scores were worse for black patients in the studies by Lavernia, *et al*, Kamath, *et al*, and Maratt, *et al*<sup>18,19,20</sup>. Postoperative function scores were worse in the studies by Kamath, *et al*, Lavernia, *et al*, Lopez-Olivo, *et al*, and Barrack, *et al*<sup>19,20,21,22</sup>, but inconsistencies emerged depending on the instrument used. That is, scores for WOMAC function and the KSS were not congruent across studies. Styron, *et al* used a novel endpoint of return to work and found that for non-whites, the return to work was no different from that of the reference group<sup>17</sup>.

We have qualitatively reviewed the literature to assess differences in TKA outcomes between US blacks and whites, and found that blacks have poorer outcomes compared with whites after TKA. This in turn may contribute to the lower use of TKA among blacks. Providing healthcare that does not differ by race was described as an overarching goal of the Institute of Medicine (IOM), yet the IOM summary document published in 2003 determined that racial and ethnic disparities existed in a wide variety of areas including cardiovascular reperfusion, human immunodeficiency virus, and cancer screening and therapy, and racial and ethnic minorities were less likely to be considered for renal transplant.

A major finding of our study was that race and socioeconomic status are often not reported or analyzed in studies of TKA outcomes, despite these factors being important at the patient, provider, and healthcare system level. Given that there are such dramatic healthcare disparities in the United States, it is important that the effect of race, ethnicity, and socioeconomic status be measured in studies that address healthcare outcomes<sup>29</sup>. Only in this way can our progress in addressing such disparities be assessed.

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