Clin Orthop Relat Res (2011) 469:1838–1845
DOI 10.1007/s11999-011-1841-y

SYMPOSIUM: AAOS/ORS/ABJS MUSCULOSKELETAL HEALTHCARE DISPARITIES RESEARCH SYMPOSIUM

Ethnic and Racial Factors Influencing Well-being, Perceived Pain, and Physical Function After Primary Total Joint Arthroplasty

Carlos J. Lavernia MD, Jose C. Alcerro MD, Juan S. Contreras MD, Mark D. Rossi PhD

Published online: 16 March 2011

Abstract

Background Studies suggest, even when controlling for disease severity, socioeconomic status, education, and access to care, racial and ethnic minorities receive lower-quality health care and have worse perceived pain and function before and after total joint arthroplasty.

Question/purposes We evaluated the influence of race and ethnicity on well-being, pain, and function after total joint arthroplasty and determined whether race, ethnicity, sex, and joint involvement influenced perceived function and pain after total joint arthroplasty.

Patients and Methods We retrospectively reviewed the records of 1749 patients receiving total joint arthroplasty (739 hips and 1010 knees). Sixty-eight percent were women, with a mean age of 65 years at followup. We assessed patients preoperatively and at a minimum of 2 years (mean, 5.1 years; range, 2–16 years) on perceived well-being, function, and pain, as well as clinical assessment tools. Also, we assessed the behavior of dependent measures between groups over time.

Results Preoperatively, in both TKA and THA candidates, African American patients presented with worse scores. Postoperatively, all patients had substantial improvement, yet African Americans who had TKA or THA continued to have worse scores on some measures. In both TKA and THA, women had worse scores.

Conclusions Racial and ethnic minorities undergoing hip and knee arthroplasty appear to have worse patient-perceived outcomes (well-being, pain, and function) when compared to whites. This discrepancy is most pronounced for African Americans.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

One or more of the authors have received funding from Mercy Hospital (CJL), the Mercy Foundation (CJL), and the Arthritis Surgery Research Foundation, Inc (CJL). Dr. Carlos J. Lavernia is a consultant for MAKO Surgical Corp (Ft Lauderdale, FL) and has stock in Zimmer, Inc (Warsaw, IN) and Johnson & Johnson (New Brunswick, NJ).
Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at the Orthopaedic Institute at Mercy Hospital.

C. J. Lavernia (✉)
Orthopaedic Institute at Mercy Hospital, 3659 S Miami Avenue, Suite 4008, Miami, FL 33133, USA
e-mail: CLavernia@mercymiami.org

C. J. Lavernia, J. C. Alcerro, J. S. Contreras
Arthritis Surgery Research Foundation, Inc, Miami, FL, USA

M. D. Rossi
Department of Physical Therapy, Florida International University, Miami, FL, USA

Introduction

Total joint arthroplasty (TJA) relieves pain and improves functional ability secondary to knee and hip osteoarthritis [9, 10]. Several authors note disparities in the use of TJA among African Americans [5, 18, 40].

One report suggests minority populations are less likely to perceive any benefit and are more likely to recognize barriers when considering TJA [3]. Compared to whites, some minority populations are less likely to use this extremely effective procedure. For example, the rate of a particular race/ethnic group who undergoes TKA is much

higher for whites when compared to Hispanics and African Americans [38].

When compared to whites having THA or TKA, Hispanics and African Americans present with worse preoperative function [39] and higher incidence of infection-related complications [25].

Woman tend to experience less improvement in perceived function 6 months after THA [34]. Further, when compared to men, women are more likely to need assistance with walking and completing household chores 1 year after THA [23]. After TKA, women present with lower knee function scores than men [33] and require greater dependence on walking aids for 2 to 5 years after the intervention [37].

Recent prospective, randomized trials did not report race and ethnicity as covariates when analyzing data [6, 14, 31, 35, 36, 41]. Most of these studies disregard the importance of how these variables might influence patient well-being, perceived pain, and physical function, even though evidence shows fear, expectations, and treatment preferences clearly vary between different racial and ethnic backgrounds [12, 21, 29].

Considering the fact that patient characteristics can potentially influence functional levels after surgery, we determined whether race and ethnicity influence patient-perceived measures of well-being, function, and pain before and at minimum 2 years after primary TJA and whether race, ethnicity, sex, and joint involvement influence perceived function and pain after TJA.

Patients and Methods

We prospectively collected all data for inclusion in a joint registry. For this study, we retrospectively reviewed the records of all patients within our joint registry who underwent primary THA or primary TKA from June 1992 to June 2007 and had complete preoperative evaluation for all measures. Of the 1834 eligible patients, 1749 (739 patients who had THA and 1010 patients who had TKA) were included in the study. We excluded 85 patients (5%) secondary to having incomplete data at least 2 years postoperatively. Patients had surgery secondary to failed nonoperative treatments (medication, rehabilitation, and assistive devices), resulting in disabling pain. We obtained sociodemographic information from a self-administered questionnaire given to patients at their first office visit. The mean age of the cohort was 65.32 years (SD, 13.1 years); 68.1% were women. There were 1136 (65%) patients who were self-classified as white Hispanic, 392 (22%) as white non-Hispanic, 160 (9%) as African American non-Hispanic, and 61 (4%) as African American Hispanic (Table 1). Of the 739 patients with THA, 98 (13%) had bilateral THAs and of the 1010 patients with TKA, 234 (23%) had bilateral TKAs (Table 2). The underlying diagnosis was osteoarthritis (83%), rheumatoid arthritis (8%), avascular necrosis (7%), posttraumatic osteoarthritis (0.8%), femur neck fracture (0.5%), developmental dysplasia of the hip (0.5%), psoriatic arthritis (0.1%), and postseptic arthritis (0.1%). The minimum followup was

Table 1. Patient demographic data

Characteristic	Arthroplasty type	White non-Hispanic		White Hispanic		African American non-Hispanic		African American Hispanic	
		Men	Women	Men	Women	Men	Women	Men	Women
TJA (number)	THA	84 (28.4%)	132 (29.8%)	165 (55.7%)	240 (54.2%)	32 (10.8%)	54 (12.2%)	15 (5.1%)	17 (3.8%)
	TKA	79 (30.2%)	97 (13%)	163 (62.2%)	568 (75.9%)	16 (6.1%)	58 (7.8%)	4 (1.5%)	25 (3.3%)
Followup (years)*	THA	5.3 ± 0.3	5.4 ± 0.2	5.8 ± 0.2	5.4 ± 0.1	5.3 ± 0.4	5.2 ± 0.3	3.8 ± 0.4	6.3 ± 1.0
	TKA	4.4 ± 0.2	4.3 ± 0.2	4.8 ± 0.2	4.9 ± 0.1	3.3 ± 0.4	5.8 ± 0.3	4.0 ± 0.7	5.8 ± 0.5
Age (years)*	THA	61.67 ± 1.5	62.1 ± 1.2	58.8 ± 1.1	65.1 ± 0.9	50.5 ± 3.1	54.1 ± 1.9	52.7 ± 3.9	57.0 ± 4.8
	TKA	69.04 ± 1.2	66.5 ± 0.9	69.6 ± 0.7	69.5 ± 0.4	59.5 ± 2.2	64.3 ± 1.5	65.0 ± 3.0	63.9 ± 2.0

* Values are expressed as mean ± standard error of mean; TJA = total joint arthroplasty.

Table 2. Bilateral distribution of THA and TKA by race/ethnicity

Arthroplasty type	All patients	White non-Hispanic		White Hispanic		African American non-Hispanic		African American Hispanic	
		Men	Women	Men	Women	Men	Women	Men	Women
THA (number)	98 (13%)	15 (4%)	26 (7%)	29 (8%)	49 (13%)	6 (2%)	11 (3%)	4 (1%)	3 (1%)
TKA (number)	234 (23%)	15 (4%)	27 (7%)	37 (10%)	131 (35%)	2 (0.5%)	16 (4%)		6 (1%)

2 years (mean, 5.1 years; range, 2–16 years). All subjects gave written consent to be included in the joint registry, which the hospital's institutional review board approved.

A single surgeon performed all surgeries (CJL). For THAs, the surgeon used a modified direct lateral approach (Hardinge) surgical technique and a press-fit technique for the femoral component and the acetabular components. In all patients, the surgeon used screws in the acetabular component for supplemental fixation. We permitted full weightbearing as tolerated on Postoperative Day 1 and utilized an abduction pillow at all times whenever in bed. If we operated on the patient in the morning, we initiated supervised physical therapy in the afternoon or on the next day if we operated after midday. Acute care services performed physical therapy two times per day until discharge and included transfer (sit-to-stand), gait (with standard walker), and bed mobility training. Therapeutic exercises included active and passive ROM, gluteal and quadriceps isometric exercises, and resistive exercises using weights or manual resistance. After acute care services, we typically discharged the patient for home health care, which included physical therapy three times per week for 4 weeks.

We treated each TKA in a similar manner. The surgeon approached all knees through a medial parapatellar incision. Once the desired implant position and soft tissue balance was achieved, the surgeon tested varus-valgus laxity and AP laxity in extension and in 90° of flexion. On completion of the procedure, we initiated continuous passive motion in the recovery unit starting at 0° to 30°, increasing 10° a day, and discontinued it when the patient reached the target of 85° to 90° of flexion. We encouraged patients to ambulate using a walker the first day after surgery. If we operated on the patient in the morning, we initiated supervised physical therapy in the afternoon or on the next day if we operated after midday. We used perioperative antibiotics for prophylaxis and a standard protocol of postoperative warfarin for thromboembolism prophylaxis. In the absence of complications, we discharged most patients 3 to 4 days postoperatively. Physical therapy and discharge disposition were similar to those used in THA.

We scheduled routine followup evaluation at 3 months, 6 months, 1 year, and yearly thereafter. At these intervals, we evaluated the patients using a long-arm goniometer for hip and knee ROM. We also took radiographs; AP and lateral radiographs were taken with the patient standing. Both before and after surgery, at 1-year intervals, we collected the patients' Quality of Well-Being (QWB) scores, SF-36 scores, WOMAC scores, orthopaedic knee scores (Hospital for Special Surgery [HSS] score, Knee Society knee score [KSKS]), and orthopaedic hip scores (Harris hip score [HHS], Merle d'Aubigné-Postel score).

Kaplan and Bush [27] developed the QWB index to assess general quality of life. The QWB combines preference-weighted values for symptoms and functioning. Symptoms are assessed by questions about the presence or absence of different symptoms complexes. Functioning is assessed by three separate domains (mobility, physical activity, and social activity). The four domain scores are combined into a total score that provides a numerical point-in-time expression of well-being ranging from 0 (for death) to 1.0 (for asymptomatic optimum functioning). This index is validated for use in a variety of populations, including African Americans and Hispanics. We used this outcome measure preoperatively and at each postoperative followup.

The SF-36 is a validated measure of general physical and mental health status assessed for content and construct in various populations, such as African Americans, Hispanics, and whites [4]. The SF-36 contains eight different subscales. For this study, we used the physical function, bodily pain, social function, and physical component scores as outcome measures preoperatively and at each postoperative followup. All domains are scored separately on a 0- to 100-point scale, with higher numbers representing better health status. The pain and function subscales are the most sensitive to change in osteoarthritis patients after surgery.

The WOMAC is another current standard for evaluating results of TJA [7]. It is designed to provide information on three dimensions: perception of pain, stiffness, and physical function. The WOMAC consists of 24 items (five for pain, two for stiffness, and 17 for function). Point values from 0 to 4 are assigned to each response, and scores are totaled for each category. We used the pain, physical function, and stiffness scores as outcome measures preoperatively and at each postoperative followup.

The HSS considers the following: (1) function or walking ability, (2) transfer ability, (3) ability to climb stairs, (4) ROM, (5) muscle strength, (6) flexion deformity, and (7) instability. The points are subtracted from the total score for residual extension lag, varus and valgus deformity, and use of external aids. A perfect score is 100 points and an arthrodesed knee achieves 60 points on this scale. An excellent result is scored between 85 and 100 points, good 70 to 81, fair 60 to 69, and poor less than 60 points [1].

The KSKS is the evaluation system for knee rating and functional assessment. The main parameters evaluated in knee assessment are pain, stability, and ROM; 100 points are obtained by a well-aligned knee with no pain, 125° of motion, and negligible AP and mediolateral instability. Patient function is judged by walking distance and stair climbing, with deductions for walking aids. The maximum function score (100) is obtained by a patient who can walk an unlimited distance and go up and down stairs normally [26].

The HHS is based on a scale of 100 points and the maximum possible scores are pain (44), function (47), ROM (5), and absence of deformity (4) [22]. Of a total of 100 points, 100 to 90 points are considered excellent; 89 to 80, good; 79 to 70, fair; and less than 70, poor [22].

The Merle d'Aubigné-Postel score is a functional hip score designed to provide information on three dimensions: pain, mobility, and ability to walk. All domains are scored separately on a 0- to 6-point scale, with higher numbers representing better functional grading status (a very good score is P [pain] + W [walking] = 11/12; good, 10; medium, 9; fair, 8; poor, 7 or less). If the mobility is reduced to 4, the result is classed one grade lower. If the mobility is reduced to 3 or less, the result is classed two grades lower [13].

We stratified the patients into four classifications: African American non-Hispanic, African American Hispanic, white non-Hispanic, and white Hispanic. We used an analysis of covariance before and at postoperative followup to determine differences between groups who had TKA and THA. We entered all dependent measures into the model, with sex as the covariate. For the postoperative analyses, we used preoperative scores of all dependent measures as covariates in the model. We completed all pairwise comparisons as followups to determine differences among the four races by ethnicity subgroups. Also, we used a multivariate regression analysis to determine the influence of race, ethnicity, sex, and joint involvement on postoperative outcomes for individuals with TKA and THA (entire cohort). We entered all data into the joint registry via the Patient Analysis & Tracking System (Axis Clinical Software Inc, Portland, OR) and extracted data into Excel® (Microsoft Corp, Redmond, WA) to create spreadsheets. We completed all statistical analyses using SPSS® (Version 15.0; SPSS Inc, Chicago, IL).

Table 3. Effect of race/ethnicity on dependent measures before TKA

Dependent measure	Race/ethnicity		Score (points)*	p Value
QWB	White NH		0.535 ± 0.04	
		White H	0.514 ± 0.03	< 0.0001
		AA NH	0.503 ± 0.06	< 0.0001
SF-36 physical function	White NH		21.09 ± 1.27	
		White H	13.68 ± 0.92	< 0.0001
		AA NH	12.65 ± 1.98	< 0.0001
		AA H	11.35 ± 3.72	0.01
SF-36 bodily pain	AA NH		21.80 ± 2.26	
		White H	30.30 ± 1.05	0.001
		White NH	33.25 ± 1.46	< 0.0001
SF-36 social function	White NH		52.02 ± 2.17	
		White H	42.27 ± 1.57	< 0.0001
		AA H	38.26 ± 6.33	0.04
		AA NH	32.72 ± 3.37	< 0.0001
SF-36 physical component	AA NH		23.29 ± 0.78	
		White H	26.04 ± 0.36	0.001
		White NH	27.14 ± 0.50	< 0.0001
WOMAC function	White NH		42.82 ± 0.84	
		White H	47.12 ± 0.61	< 0.0001
		AA H	48.27 ± 2.45	0.03
		AA NH	49.20 ± 1.31	< 0.0001
WOMAC pain	AA NH		13.81 ± 0.42	
		White H	12.51 ± 0.19	0.006
		White NH	11.98 ± 0.27	< 0.0001
WOMAC stiffness	White H		3.63 ± 0.12	
		White NH	4.06 ± 0.16	0.03
		AA NH	4.45 ± 0.26	0.004
HSS knee score	AA NH		52.76 ± 2.19	
		White H	58.81 ± 0.55	0.008
		White NH	61.42 ± 1.00	< 0.0001

* Values are expressed as mean ± standard error of the mean; QWB = Quality of Well-Being; HSS = Hospital for Special Surgery; NH = non-Hispanic; H = Hispanic; AA = African American.

Results

For all individuals who had TKA, white non-Hispanics presented with better scores preoperatively for the majority of dependent measures, except for perceived joint stiffness, where white Hispanics had better scores (Table 3). For the majority of dependent measures, African American non-Hispanics had worse preoperative scores compared to white non-Hispanics and/or white Hispanics (Table 2). Postoperatively, African American non-Hispanic individuals presented with worse outcomes compared to white non-Hispanic individuals for the QWB and SF-36 physical component score. Further, African American non-Hispanics perceived worse quality of well-being, physical function, and knee stiffness than white Hispanics (Table 4). Postoperatively, African American Hispanic individuals, on average, had worse values for the HSS knee score than African American non-Hispanics, whites, and non-white Hispanics. Interestingly, when controlling for preoperative scores, white non-Hispanics scored worse on the QWB, WOMAC physical function and stiffness dimensions, and KSKS. On average, white Hispanics had worse scores for the HSS knee score and KSKS compared to white non-Hispanics and African American Hispanics, respectively. Preoperatively and postoperatively, sex influenced a multitude of dependent measures (Table 5). For individuals who had THA, white non-Hispanics presented with better scores compared to the other groups. This was the case for the QWB; SF-36 physical function, bodily pain, social function, and physical component scores; and WOMAC

Table 4. Effect of race/ethnicity on dependent measures after TKA

Dependent measure	Race/ethnicity		Score (points)*	p Value
QWB	AA NH		0.54 ± 0.19	
		White NH	0.59 ± 0.01	0.023
		AA H	0.61 ± 0.02	0.04
		White H	0.62 ± 0.05	< 0.0001
	White NH		0.59 ± 0.01	
		White H	0.62 ± 0.05	0.008
SF-36 physical component	AA NH		36.76 ± 1.74	
		White NH	41.39 ± 0.97	0.021
		White H	42.61 ± 0.43	0.001
WOMAC function	White H		5.75 ± 0.47	
		AA NH	10.4 ± 1.89	0.02
		White NH	10.1 ± 1.05	< 0.0001
WOMAC pain	White H		1.22 ± 0.14	
		White NH	2.13 ± 0.31	0.009
		AA NH	0.77 ± 0.81	0.033
WOMAC stiffness	White H		0.39 ± 0.57	
		White NH	1.10 ± 0.12	< 0.0001
		AA NH	1.61 ± 0.22	< 0.0001
HSS knee score	AA H		74.9 ± 3.07	
		White NH	83.0 ± 1.18	0.015
		AA NH	85.2 ± 2.11	0.006
		White H	85.7 ± 0.52	0.001
	White NH		83.0 ± 1.18	
		White H	85.7 ± 0.52	0.039
KSKS	White H		91.9 ± 0.72	
		White NH	88.0 ± 1.63	0.03
		AA H	82.5 ± 4.25	0.03

* Values are expressed as mean ± standard error of the mean; QWB = Quality of Well-Being; HSS = Hospital for Special Surgery; KSKS = Knee Society knee score; NH = non-Hispanic; H = Hispanic; AA = African American.

Table 5. Influence of sex on outcomes

Arthroplasty type	Dependent measure	Domain	Women versus men	
			Preoperative p value	Postoperative p value
TKA	QWB		0.05	0.21
	SF-36	Physical function	< 0.0001	< 0.0001
		Bodily pain	< 0.0001	0.002
		Social function	< 0.0001	0.20
		Physical component	< 0.0001	0.003
	WOMAC	Function	0.10	0.54
		Pain	0.001	0.76
		Stiffness	0.006	0.42
	Orthopaedic scores	HSS knee score	0.18	0.35
		KSKS	0.49	0.89
THA	QWB		< 0.0001	< 0.0001
	SF-36	Physical function	< 0.0001	< 0.0001
		Bodily pain	< 0.0001	< 0.0001
		Social function	< 0.0001	< 0.0001
		Physical component	< 0.0001	< 0.0001
	WOMAC	Function	< 0.0001	0.002
		Pain	< 0.0001	0.003
		Stiffness	0.001	0.049
	Orthopaedic scores	HHS	< 0.0001	0.30
		Merle d'Aubigné-Postel	< 0.0001	0.35

QWB = Quality of Well-Being; HSS = Hospital for Special Surgery; KSKS = Knee Society knee score; HHS = Harris hip score.

function and pain scores (Table 6). White Hispanics reported less perceived pain and stiffness before surgery compared to both African American Hispanics and African Americans non-Hispanic (Table 5). African American Hispanics and/or non-Hispanics had the worse scores for the majority of dependent measures preoperatively (Table 5).

At followup, white Hispanics and white non-Hispanics had less perceived pain and knee stiffness compared to African American non-Hispanics (Table 7). Individuals who classified themselves as African American Hispanics had worse scores than white Hispanics and white non-Hispanics for the WOMAC pain dimension (Table 6). Similar to the results of those who had TKA, sex was an influential factor in many dependent measures before and after surgery (Table 5). Results of the multivariate regression indicated race, ethnicity, and sex influenced outcomes for different dependent measures over the entire cohort (Table 8). However, the coefficients of determination were quite low, indicating other factors were potentially influencing outcome.

Discussion

Disparities in the access to health care are well documented. Minorities, such as African Americans and Hispanics, are less likely to undergo TJA for severe osteoarthritis [15, 17, 28]. Our study set out to define the influence of race and ethnicity on patient-oriented outcomes before and after TJA and determine whether patient characteristics could predict perceived levels of well-being, physical function, and pain after surgery.

Table 6. Effect of race/ethnicity on dependent measures before THA

Dependent measure	Race/ethnicity		Score (points)*	p Value
QWB	White NH		0.554 ± 0.005	
		White H	0.533 ± 0.002	< 0.0001
		AA H	0.527 ± 0.01	0.02
		AA NH	0.514 ± 0.007	< 0.0001
SF-36 physical function	White NH		24.18 ± 1.35	
		AA NH	19.92 ± 2.16	0.005
		White H	17.58 ± 0.65	< 0.0001
		AA H	16.58 ± 3.24	0.03
SF-36 bodily pain	White NH		24.18 ± 1.35	
		AA NH	19.92 ± 2.16	0.005
		White H	17.58 ± 0.65	< 0.0001
		AA H	16.58 ± 3.24	0.03
SF-36 social function	White NH		62.08 ± 2.62	
		White H	51.24 ± 1.26	< 0.0001
		AA NH	42.81 ± 4.17	< 0.0001
		AA H	42.0 ± 6.26	0.003
SF-36 physical component	White NH		29.31 ± 0.59	
		White H	27.46 ± 0.28	0.005
		AA NH	26.08 ± 0.94	0.004
		AA H	25.85 ± 1.41	0.02
WOMAC function	White NH		35.37 ± 1.00	
		White H	40.25 ± 0.48	< 0.0001
		AA NH	42.61 ± 1.59	< 0.0001
		AA H	43.70 ± 2.38	0.001
WOMAC pain	White NH		11.07 ± 0.29	
		White H	11.71 ± 0.14	0.04
		AA NH	12.77 ± 0.46	0.002
		AA H	13.33 ± 0.69	0.003
	White H		11.71 ± 0.14	
		AA NH	12.77 ± 0.46	0.02
		AA H	13.33 ± 0.69	0.02
WOMAC stiffness	White H		3.53 ± 0.86	
		AA NH	4.13 ± 0.28	0.04
		AA H	4.64 ± 0.42	0.01
HHS	White NH		42.02 ± 1.41	
		White H	37.04 ± 0.90	0.003
		AA NH	35.26 ± 2.28	0.01
Merle d'Aubigné-Postel	White NH		10.51 ± 0.29	
		White H	9.45 ± 0.18	0.003
		AA NH	9.16 ± 0.47	0.01
		AA H	8.05 ± 0.98	0.01

* Values are expressed as mean ± standard error of the mean; QWB = Quality of Well-Being; HHS = Harris hip score; NH = non-Hispanic; H = Hispanic; AA = African American.

Table 7. Effect of race/ethnicity on dependent measures after THA

Dependent measure	Race/ethnicity		Score (points)*	p Value
WOMAC pain	AA H		3.79 ± 1.11	
		White NH	1.16 ± 0.31	0.025
		White H	0.92 ± 0.18	0.012
	AA NH		2.55 ± 0.49	
		White NH	1.16 ± 0.31	0.02
		White H	0.92 ± 0.18	0.002
WOMAC stiffness	AA NH		1.31 ± 0.21	
		White NH	0.61 ± 0.13	0.006
		White H	0.42 ± 0.07	< 0.0001

* Values are expressed as mean ± standard error of the mean; NH = non-Hispanic; H = Hispanic; AA = African American.

There are limitations to this study. First, although our study was a retrospective analysis within our prospective joint registry, we excluded 85 patients (5%) owing to inadequate data. Given the relatively large number of cases, we suspect these exclusions would not modify the conclusions. Second, our patient population was predominantly white. This is consistent with population-based studies, showing, regardless of insurance status, TJA is underutilized by African American patients [16]. Third, the potential misclassification of race/ethnicity also remains an issue, particularly among Hispanic patients, as we utilized self-classification as reported by the patient on the intake questionnaire. Fourth, this was a single-surgeon study and our findings lack generalizability to the overall population. Finally, we did not account for bilateral cases, socioeconomic status, and level of education in statistical models.

In the preintervention period for TKA, the most common finding was that African Americans and Hispanics presented with worse perceived well-being and function compared to whites. Controlling for preoperative scores, at followup, African Americans had worse postoperative scores on five of the dependent measures of perceived well-being and function. Again controlling for preoperative scores, an interesting outcome at followup was that white non-Hispanics had worse perceived well-being, function, and knee stiffness, as well as worse scores on the KSKS. Before TKA, for six of the 10 dependent measures, women scored worse than men. However, at followup, women scored worse than men on only three of these dependent measures.

The common finding before THA was that white non-Hispanics reported better perceived well-being and function than African Americans and Hispanics. Postoperatively, and controlling for preoperative scores, African Americans presented with worse scores on only two dependent measures (pain and joint stiffness) than whites. Before THA, women scored worse than men on all dependent measures. This finding remained at postoperative followup, as women scored worse than men on eight of 10 dependent measures.

Table 8. Attribute variables as predictors of outcomes

Dependent variable	Race		Ethnicity		Sex		Joint	
	p Value	R^2	p Value	R^2	p Value	R^2	p Value	R^2
QWB	< 0.0001	0.012	0.006	0.005	0.16		0.41	
SF-36 physical function	0.001	0.007	0.16		< 0.0001	0.011	0.67	
SF-36 bodily pain	0.01	0.004	0.12		0.001	0.008	0.19	
SF-36 social function	0.14		0.05		0.005	0.005	0.13	
SF-36 physical component	0.002	0.007	0.34		0.001	0.008	0.56	
WOMAC function	< 0.0001	0.015	0.29		0.20		0.60	
WOMAC pain	< 0.0001	0.017	0.035	0.003	0.62		0.35	
WOMAC stiffness	< 0.0001	0.013	< 0.0001	0.009	0.87		0.002	0.007

QWB = Quality of Well-Being.

Although we found sex, race, and ethnicity predicted outcomes after TJA, our data suggest these factors only explained a very small portion of the patient-perceived outcomes, indicated by the low coefficient of determination. This suggests other patient-related factors, such as age, comorbidities, and preoperative function status, may account for some of the variability in outcomes after TJA. In an evaluation of outcomes after THA, based on the American Medical Group Association THA database, MacWilliam et al. [32] identified race and preoperative health status as predictors of pain and physical function. Their study reported African Americans had less improvement in bodily pain and physical function scores at 6 months postoperatively when compared to whites. Although we did not measure causality, the multifactorial origin of the disparities needs to be accounted for when defining a worse preoperative health status reported by minorities. There are physician indication biases and patient-related factors that may contribute to these differences. Some patient-related factors include ethnic differences in health valuation; African Americans are willing to pay lower amounts for joint pain relief or disability than whites [11]. At the same time, African Americans and Hispanics are less likely than whites to express willingness to consider TJA if the procedure is needed and recommended [24] and are more prone to the use of natural remedies, such as prayer, to help in the treatment of arthritis [2]. A recent publication describes how minority groups are more likely than whites to be uninsured or hold Medicaid insurance [8]. In a system where providing care is based on a patient's ability to pay, their insurance status is an absolute disadvantage.

A recent investigation examined patient-related factors to identify predictors of poor outcomes in 551 patients undergoing TKA [20] and determined ethnicity was not a predictor of outcomes 3 years after arthroplasty. Additionally, several studies reported disparities in expectations, access to care, preoperative differences, and use of healthcare services among racial and ethnic groups, as well as rates of complications based on ethnic and racial backgrounds [19, 29, 30], findings that could contribute to explain the multifactorial origin of these disparities.

In summary, our observations suggest race and ethnicity play a key role in perceived well-being, pain, and physical function before TJA. Although being African American or Hispanic was a negative factor for functional health status before TJA, by postoperative followup, the disparities were not as great or even resolved. Regarding patient characteristics, other patient-related factors may be stronger predictors of outcomes in arthroplasty. Further research is necessary to understand what factors contribute to long-term results after TJA and how these factors relate to racial and ethnic disparities before and after TJA.

References

1. Alicea J. Scoring systems and their validation for the arthritic knee. In: Insall JN, Scott WN, eds. *Surgery of the Knee*. 3rd ed. New York, NY: Churchill Livingstone; 2001:1507–1515
2. Ang DC, Ibrahim SA, Burant CJ, Siminoff LA, Kwoh CK. Ethnic differences in the perception of prayer and consideration of joint arthroplasty. *Med Care.* 2002;40:471–476.
3. Ang DC, Monahan PO, Cronan TA. Understanding ethnic disparities in the use of total joint arthroplasty: application of the health belief model. *Arthritis Rheum.* 2008;59:102–108.
4. Arocho R, McMillan CA, Sutton-Wallace P. Construct validation of the USA-Spanish version of the SF-36 health survey in a Cuban-American population with benign prostatic hyperplasia. *Qual Life Res.* 1998;7:121–126.
5. Baron JA, Barrett J, Katz JN, Liang MH. Total hip arthroplasty: use and select complications in the US Medicare population. *Am J Public Health.* 1996;86:70–72.
6. Barton TM, Gleeson R, Topliss C, Greenwood R, Harries WJ, Chesser TJ. A comparison of the long gamma nail with the sliding hip screw for the treatment of AO/OTA 31-A2 fractures of the proximal part of the femur: a prospective randomized trial. *J Bone Joint Surg Am.* 2010;92:792–798.
7. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to

antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol.* 1988;15:1833–1840.
8. Blustein J. Who is accountable for racial equity in health care? *JAMA.* 2008;299:814–816.
9. Bourne RB, Rorabeck CH. A critical look at cementless stems: taper designs and when to use alternatives. *Clin Orthop Relat Res.* 1998;355:212–223.
10. Bozic KJ, Saleh KJ, Rosenberg AG, Rubash HE. Economic evaluation in total hip arthroplasty: analysis and review of the literature. *J Arthroplasty.* 2004;19:180–189.
11. Byrne MM, O'Malley KJ, Suarez-Almazor ME. Ethnic differences in health preferences: analysis using willingness-to-pay. *J Rheumatol.* 2004;31:1811–1818.
12. Constantinescu F, Goucher S, Weinstein A, Fraenkel L. Racial disparities in treatment preferences for rheumatoid arthritis. *Med Care.* 2009;47:350–355.
13. d'Aubigné RM, Postel M. The Classic. Functional results of hip arthroplasty with acrylic prosthesis. 1954. *Clin Orthop Relat Res.* 2009;467:7–27.
14. Demey G, Servien E, Pinaroli A, Lustig S, Ait Si Selmi T, Neyret P. The influence of femoral cementing on perioperative blood loss in total knee arthroplasty: a prospective randomized study. *J Bone Joint Surg Am.* 2010;92:536–541.
15. Dunlop DD, Song J, Manheim LM, Chang RW. Racial disparities in joint replacement use among older adults. *Med Care.* 2003; 41:288–298.
16. Emejuaiwe N, Jones AC, Ibrahim SA, Kwoh CK. Disparities in joint replacement utilization: a quality of care issue. *Clin Exp Rheumatol.* 2007;25:44–49.
17. Escalante A, Espinosa-Morales R, del Rincon I, Arroyo RA, Older SA. Recipients of hip replacement for arthritis are less likely to be Hispanic, independent of access to health care and socioeconomic status. *Arthritis Rheum.* 2000;43:390–399.
18. Escarce JJ, Epstein KR, Colby DC, Schwartz JS. Racial differences in the elderly's use of medical procedures and diagnostic tests. *Am J Public Health.* 1993;83:948–954.
19. Figaro MK, Williams-Russo P, Allegrante JP. Expectation and outlook: the impact of patient preference on arthritis care among African Americans. *J Ambul Care Manage.* 2005;28:41–48.
20. Gandhi R, Dhotar H, Razak F, Tso P, Davey JR, Mahomed NN. Predicting the longer term outcomes of total knee arthroplasty. *Knee.* 2010;17:15–18.
21. Groeneveld PW, Kwoh CK, Mor MK, Appelt CJ, Geng M, Gutierrez JC, Wessel DS, Ibrahim SA. Racial differences in expectations of joint replacement surgery outcomes. *Arthritis Rheum.* 2008;59:730–737.
22. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am.* 1969;51:737–755.
23. Holtzman J, Saleh K, Kane R. Gender differences in functional status and pain in a Medicare population undergoing elective total hip arthroplasty. *Med Care.* 2002;40:461–470.
24. Ibrahim SA, Siminoff LA, Burant CJ, Kwoh CK. Differences in expectations of outcome mediate African American/white patient differences in "willingness" to consider joint replacement. *Arthritis Rheum.* 2002;46:2429–2435.
25. Ibrahim SA, Stone RA, Han X, Cohen P, Fine MJ, Henderson WG, Khuri SF, Kwoh CK. Racial/ethnic differences in surgical outcomes in veterans following knee or hip arthroplasty. *Arthritis Rheum.* 2005;52:3143–3151.
26. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. *Clin Orthop Relat Res.* 1989;248: 13–14.
27. Kaplan RM, Bush JW. Health-related quality of life measurement for evaluation research and policy analysis. *Health Psychol.* 1982;1:61–80.
28. Katz BP, Freund DA, Heck DA, Dittus RS, Paul JE, Wright J, Coyte P, Holleman E, Hawker G. Demographic variation in the rate of knee replacement: a multi-year analysis. *Health Serv Res.* 1996;31:125–140.
29. Lavernia CJ, Alcerro JC, Rossi MD. Fear in arthroplasty surgery: the role of race. *Clin Orthop Relat Res.* 2010;468:547–554.
30. Lavernia CJ, Lee D, Sierra RJ, Gomez-Marin O. Race, ethnicity, insurance coverage, and preoperative status of hip and knee surgical patients. *J Arthroplasty.* 2004;19:978–985.
31. Lewis SC, Warlow CP, Bodenham AR, Colam B, Rothwell PM, Torgerson D, Dellagrammaticas D, Horrocks M, Liapis C, Banning AP, Gough M, Gough MJ. General anaesthesia versus local anaesthesia for carotid surgery (GALA): a multicentre, randomised controlled trial. *Lancet.* 2008;372:2132–2142.
32. MacWilliam CH, Yood MU, Verner JJ, McCarthy BD, Ward RE. Patient-related risk factors that predict poor outcome after total hip replacement. *Health Serv Res.* 1996;31:623–638.
33. Parsley BS, Bertolusso R, Harrington M, Brekke A, Noble PC. Influence of gender on age of treatment with TKA and functional outcome. *Clin Orthop Relat Res.* 2010;468:1759–1764.
34. Quintana JM, Escobar A, Aguirre U, Lafuente I, Arenaza JC. Predictors of health-related quality-of-life change after total hip arthroplasty. *Clin Orthop Relat Res.* 2009;467:2886–2894.
35. Sandham JD, Hull RD, Brant RF, Knox L, Pineo GF, Doig CJ, Laporta DP, Viner S, Passerini L, Devitt H, Kirby A, Jacka M. A randomized, controlled trial of the use of pulmonary-artery catheters in high-risk surgical patients. *N Engl J Med.* 2003;348: 5–14.
36. Sandler RS, Halabi S, Baron JA, Budinger S, Paskett E, Keresztes R, Petrelli N, Pipas JM, Karp DD, Loprinzi CL, Steinbach G, Schilsky R. A randomized trial of aspirin to prevent colorectal adenomas in patients with previous colorectal cancer. *N Engl J Med.* 2003;348:883–890.
37. Singh JA, O'Byrne M, Harmsen S, Lewallen D. Predictors of moderate-severe functional limitation after primary total knee arthroplasty (TKA): 4701 TKAs at 2-years and 2935 TKAs at 5-years. *Osteoarthritis Cartilage.* 2010;18:515–521.
38. Skinner J, Weinstein JN, Sporer SM, Wennberg JE. Racial, ethnic, and geographic disparities in rates of knee arthroplasty among Medicare patients. *N Engl J Med.* 2003;349:1350–1359.
39. Slover JD, Walsh MG, Zuckerman JD. Sex and race characteristics in patients undergoing hip and knee arthroplasty in an urban setting. *J Arthroplasty.* 2010;25:576–580.
40. Wilson MG, May DS, Kelly JJ. Racial differences in the use of total knee arthroplasty for osteoarthritis among older Americans. *Ethn Dis.* 1994;4:57–67.
41. Zheng JP, Kang J, Huang SG, Chen P, Yao WZ, Yang L, Bai CX, Wang CZ, Wang C, Chen BY, Shi Y, Liu CT, Chen P, Li Q, Wang ZS, Huang YJ, Luo ZY, Chen FP, Yuan JZ, Yuan BT, Qian HP, Zhi RC, Zhong NS. Effect of carbocisteine on acute exacerbation of chronic obstructive pulmonary disease (PEACE Study): a randomised placebo-controlled study. *Lancet.* 2008; 371:2013–2018.