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REHABILITATION SCIENCES AND THE RHEUMATIC DISEASES

Race Differences in Postacute Physical Therapy Utilization and Patient-Reported Function After Total Knee Arthroplasty

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Objective. This observational cohort study included patients of Black and White race and non-Hispanic ethnicity with end-stage knee osteoarthritis who were scheduled to receive total knee arthroplasty (TKA) surgery. Our objective was to examine whether race differences exist in the use of physical therapy (PT) across all postacute settings and to examine patient-reported physical function following TKA.

Methods. We collected pre- and postoperative physical function data and postoperative rehabilitation data on 104 Black and White individuals undergoing TKA. Regression analyses and independent samples *t*-tests were used to explore the predictive value of race on postoperative functional outcome and to compare PT utilization within each postacute setting and across all postacute rehabilitation settings.

Results. Total PT received was similar between White and Black participants, but significant race differences in PT utilization existed within specific settings. Race did not significantly predict function after TKA, but Black participants had slightly lower self-reported function both before and after surgery than White participants.

Conclusion. This is the first study to examine both PT utilization and functional outcomes in a sample of individuals undergoing TKA, and results indicate differences in where postoperative PT is received between Black and White patients.

INTRODUCTION

Knee osteoarthritis (OA) is a common cause of disability affecting older adults. The most effective treatment for end-stage knee OA is total knee arthroplasty (TKA) surgery (1,2). More than one-half of people with knee OA will undergo TKA, which is effective and cost-effective at improving function and quality of life (3–10).

Outcomes following TKA are positive, with 85–90% of recipients experiencing significant improvements in pain, function, and quality of life (8,9). Thus, making TKA surgery available to all those in need is important. However, race disparities in knee OA surgery are well-documented. Studies consistently demonstrate that Black individuals are less likely to undergo TKA than non-Hispanic White individuals (11–19).

Recent research has explored disparities among those receiving TKA surgery. Several studies found that Black patients receive TKAs at lower-quality and low-volume hospitals and are more likely to experience postoperative complications and readmissions (20–25). Unfortunately, research regarding race disparities in functional outcomes following TKA is scant. Lavernia et al found that Black race and Hispanic ethnicity were associated with poorer self-reported physical function and health-related quality of life following arthroplasty (26). A recent study by Riddle et al noted clinically relevant postoperative race differences in function among participants in a clinical trial (27).

To maximize functional outcomes, patients undergoing TKA require high-intensity rehabilitation for weeks or months beyond the postoperative hospitalization to regain strength and physical function (28,29). This rehabilitation is particularly important for

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SIGNIFICANCE & INNOVATIONS

- This research adds to a very limited body of research regarding disparities in functional outcomes following total knee arthroplasty for end-stage knee osteoarthritis.
- This is the first study to examine race disparities in both rehabilitation utilization and physical function in the same cohort of patients.
- The results of this study support the findings of prior research that found a similar magnitude of differences in physical function after total knee arthroplasty between White and Black patients.

Black patients because they tend to exhibit poorer function preoperatively, which may be due to Black patients having lower expectations regarding recovery following TKA and delaying surgery in favor of nonsurgical treatments (12,30,31). Freburger et al demonstrated that non-White patients receive less intensive postacute rehabilitation care, receiving fewer hours of rehabilitation daily and weekly than White patients (32). However, studies investigating postoperative disparities in TKA have not examined the role of physical therapy (PT) in functional outcomes.

Overall, evidence suggests that race disparities may exist in functional outcomes after TKA, but this possibility has not been well studied. Knowledge is also lacking regarding disparities in postoperative PT utilization. Therefore, the purposes of this study were to determine whether race predicts functional recovery and to investigate race differences in utilization of postacute PT following TKA.

MATERIALS AND METHODS

We employed a prospective observational cohort study design and recruited participants from 2015 to 2018 via advertisements in surgery offices, referrals from a research registry, and mailed advertisements. Participants provided informed consent prior to enrollment, and the study was approved by the University of Pittsburgh Institutional Review Board.

Inclusion criteria were a scheduled primary unilateral TKA, being White/Caucasian or Black/African American race and non-Hispanic ethnicity, and the ability to speak English. Potential participants were excluded if they were scheduled for simultaneous bilateral or revision TKA or if they failed to receive the scheduled surgery. Participants undergoing a staged bilateral TKA were eligible to participate in the study for their first TKA only.

Research procedures. Prior to surgery, participants completed questionnaires described below. After surgery, study personnel performed telephone or email check-ins monthly, but did not provide interventions or medical/rehabilitation advice. Follow-up questionnaires were collected 3 months postoperatively because research has demonstrated that most functional improvement occurs in the first 12 weeks (33). Participants were not required/encouraged to seek PT care from any particular clinic or provider.

Outcomes. Preoperatively, participants provided demographic/clinical information and a patient-reported outcome measure. Data collected included age, sex, race, ethnicity, marital status, educational attainment, income, health insurance, body mass index, TKA surgeon, TKA hospital, and medical comorbidities using the Functional Comorbidity Index (34). These variables were collected for evaluation as covariates because they have been shown in prior literature to correlate with outcomes following TKA (20–27,32,35–39).

The outcome measure for the primary aim (whether race predicts functional outcome at 3 months postoperatively) was the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). This patient-reported measure assesses pain, stiffness, and physical function and is reliable, valid, and responsive in individuals with knee OA and TKA (40–44). We used the 5-point Likert scale version and calculated a total WOMAC score (ranging from 0 to 96, with higher scores indicating worse symptoms) (45).

At 3 months postoperation, participants completed a follow-up WOMAC questionnaire and a survey regarding their postoperative recovery, including hospital length of stay and postoperative complications. Participants self-reported the length of stay in any inpatient rehabilitation facility following discharge from the hospital and the number of home health PT visits received. Finally, participants reported the name/location of any outpatient PT facility attended. To minimize reporting bias, upon enrollment participants were given an informational sheet describing the items that would be asked at follow-up and a form to document these variables as they occurred. During check-ins after surgery, study personnel reminded participants to regularly record this information. Study personnel performed reviews of participants' outpatient PT charts to record the number of visits, duration of care, and number of units and/or minutes billed at each visit.

The primary outcome for this aim of the study was the total hours of postacute PT received. Time spent in each postoperative rehabilitation setting was calculated as follows: 1) acute rehabilitation: length of stay (days) $\times$ 90 minutes/day (46–48); 2) skilled nursing facility (SNF) or subacute rehabilitation facility: length of stay (days) $\times$ 45 minutes/day (46–48); 3) home: number of visits by home care therapist $\times$ 60 minutes/visit (49,50); 4) outpatient: total minutes (from billing/Current Procedural Terminology code sheet, sum of all outpatient visits); 5) summary outcome measure of TOTAL amount of PT received: sum of all settings (in minutes)/60. The summary of rehabilitation provided a total number of hours of postacute PT received, rounded to the nearest tenth of an hour.

Statistical analysis. We used WOMAC means $\pm$ SDs from Allen et al to determine target sample size (51). We

Table 1. Baseline participant demographic and clinical characteristics by race*

Characteristic	White/Caucasian (n = 75)	Black/African American (n = 29)
Sex		
Male	28 (37.3)	9 (31.0)
Female	47 (62.7)	20 (69.0)
Age, mean ± SD years	64.3 ± 8.4	65.2 ± 6.2
Marital status		
Married/domestic partner	57 (76.0)	8 (27.6)
Divorced/separated	7 (9.3)	10 (34.5)
Widowed	5 (6.7)	8 (27.6)
Single, never married	6 (8.0)	3 (10.3)
Highest educational level completed		
Less than high school	0 (0.0)	1 (3.4)
High school	33 (44.0)	23 (79.3)
College	20 (26.7)	4 (13.8)
Postgraduate degree	22 (29.3)	1 (3.4)
Annual household income, US$		
<25,000	8 (10.7)	11 (37.9)
25,000 to <50,000	16 (21.3)	17 (58.6)
50,000 to <100,000	28 (37.3)	0 (0.0)
≥100,000	20 (26.7)	0 (0.0)
No response	3 (4.0)	1 (3.4)
Health insurance		
Medicare	36 (48.0)	16 (55.2)
Medicaid	1 (1.3)	1 (3.4)
Dual Medicare/Medicaid	4 (5.3)	3 (10.3)
Private	33 (44.0)	8 (27.6)
Veterans	1 (1.3)	0 (0.0)
No insurance	0 (0.0)	1 (3.4)
Comorbidities		
Arthritis	75 (100.0)	28 (96.6)
Osteoporosis	16 (21.3)	1 (3.4)
Asthma	9 (12.0)	6 (20.7)
Lung disease	4 (5.3)	1 (3.4)
Angina	0 (0.0)	0 (0.0)
Congestive heart failure	8 (10.7)	2 (6.9)
Myocardial infarction	8 (10.7)	1 (3.4)
Neurologic disease	4 (5.3)	0 (0.0)
Stroke or transient ischemic attack	2 (2.7)	0 (0.0)
Peripheral vascular disease	4 (5.3)	2 (6.9)
Diabetes mellitus I or II	3 (4.0)	6 (20.7)
Upper gastrointestinal disease	29 (38.7)	11 (37.9)
Depression	9 (12.0)	7 (24.1)
Anxiety/panic disorder	10 (13.3)	0 (0.0)
Visual impairment	19 (25.3)	6 (20.7)
Hearing impairment	9 (12.0)	1 (3.4)
Degenerative disc disease	18 (24.0)	12 (41.4)
Obesity	44 (58.7)	16 (55.2)
Preoperative WOMAC score, mean ± SD	50.5 ± 15.1	54.1 ± 13.4

* Values are the number (%) unless indicated otherwise. WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

calculated that 103 participants were needed to determine whether race is a moderate significant predictor of outcome, with alpha set at 0.05 and 80% power.

To explore the primary research question of whether race significantly predicts postoperative WOMAC score after adjusting for potential confounders, we first performed correlation analyses (continuous variables) and association analyses (categorical variables) to determine whether each potential demographic/clinical covariate was significantly related to both race and follow-up WOMAC. We set a threshold of *P* less than 0.10 for inclusion in regression analyses.

Next, we performed a series of linear regression analyses. We first performed a simple linear regression analysis (model 1) to examine the raw predictive value of race with respect to postoperative WOMAC score and then performed 3 different hierarchical linear regression analyses to adjust for covariates using information from the correlation/association analyses described above. We decided a priori to adjust for preoperative WOMAC score in our regression model. Therefore, model 2 reflects the predictive value of race on postoperative function after adjusting for preoperative function. In model 3, we adjusted for preoperative WOMAC score and all covariates that were significantly correlated to both race and postoperative WOMAC score. In model 4, we adjusted for preoperative WOMAC score and all covariates that were significantly correlated to either race or postoperative WOMAC score. We also included total hours of postoperative PT in model 4 to allow us to see the impact of rehabilitation utilization on the relationship between race and functional outcomes. In models 2–4, we adjusted for covariates in the first step of the regressions. In the second step, race was added to determine the additional predictive value of race on postoperative WOMAC score. The importance of race as a predictor was determined based on change in R^2 when race was added to each model. SPSS statistics data analysis software, version 25, was used for all analyses.

To compare total postacute care PT utilization between Black and White participants, we performed an independent samples *t*-test comparing the mean total hours of postacute PT between the 2 groups. We also performed additional independent samples *t*-tests to compare utilization within each PT setting and chi-square analyses to compare the likelihood of receiving PT in each setting. In the small number of cases with any missing outcomes data (n = 8), we imputed the mean value of the participants' race group.

RESULTS

We screened 135 participants by telephone. Of those screened, 104 met eligibility criteria, enrolled in the study, and completed baseline questionnaires. Ninety-six participants completed follow-up questionnaires; 8 participants (6 White and 2 Black) were lost to follow-up. Baseline demographic/clinical characteristics are described in Table 1. White and Black participants had similar average ages, and both groups skewed heavily female. White participants generally reported higher educational attainment and household income. Comorbidities differed somewhat between groups. White participants were more likely to have osteoporosis, hearing impairments, and anxiety or panic disorders. Black participants were more likely to have asthma, diabetes mellitus, depression, and degenerative disc disease.

Preoperatively, White participants had somewhat better total WOMAC scores (mean ± SD 50.5 ± 15.1) than Black participants (mean ± SD 54.1 ± 13.4) (Table 1). Both groups achieved substantial improvement pre- to postoperatively, but the magnitude of difference remained consistent at follow-up (Table 2). White participants' mean ± SD 3-month postoperative WOMAC score was 20.4 ± 16.6, compared to Black participants' mean ± SD WOMAC score of 25.2 ± 12.4, a 5% between-group difference in relation to the maximum possible score of 96. This finding does not meet the threshold of a clinically important difference of at least 6% (52).

Table 2. Postsurgical characteristics by race*

Characteristic	White/Caucasian (n = 75)	Black/African American (n = 29)
Surgical complications		
Yes	15 (20.0)	2 (6.9)
Wound infection, no.	2	0
DVT/PE, no.	4	0
Manipulation, no.	4	1
Other complication, no.	7	1
No	52 (69.3)	25 (86.2)
Unknown	8 (10.7)	2 (6.9)
Postoperative WOMAC, mean ± SD	20.4 ± 16.6	25.2 ± 12.4

* Values are the number (%) unless indicated otherwise. DVT = deep venous thrombosis; PE = pulmonary embolism; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index (higher scores = worse symptoms).

Table 2 shows postoperative complications and outcomes by race. Complications were less common among Black participants. The most common complications included manipulation under anesthesia (to address severe stiffness) and blood clots. Several variables significantly correlated with either postoperative WOMAC score or race (Table 3). Variables related to postoperative WOMAC score included sex (r = 0.274, $P = 0.007$; women had worse function), preoperative WOMAC score (r = 0.331, $P = 0.001$), household income (r = 0.179, $P = 0.088$; lower income associated with poorer WOMAC scores), and surgeon (r = 0.186, $P = 0.069$). Variables significantly related to Black race included marital status (r = 0.403, $P < 0.001$; Black patients were more likely to be unmarried), educational attainment (r = 0.420, $P < 0.001$; Black patients generally reported lower educational attainment), and household income (r = 0.543, $P < 0.001$; Black patients reported lower incomes). Income was the only potential covariate correlated with both race and postoperative WOMAC. Two medical comorbidities, diabetes mellitus and degenerative disc disease, were significantly more common among Black participants and were associated with poorer postoperative WOMAC scores.

Table 4 shows the results of regression analyses. The unadjusted model (model 1) demonstrated that race was not a significant predictor of postoperative WOMAC score ($P = 0.071$, adjusted $R^2 = 0.024$). After adjusting for baseline WOMAC score (model 2), the overall model fit was statistically significant ($P = 0.001$), but R^2 (adjusted $R^2 = 0.12$) and R^2_{change} (0.02) were both small when adding race into the model. Similar results were observed in model 3, adjusting for baseline WOMAC score, household income, and the presence of diabetes mellitus and/or degenerative disc disease ($P = 0.008$, adjusted $R^2 = 0.11$ [R^2_{change} when adding race into the model = 0.01]). Finally, we expanded the model to adjust for postoperative rehabilitation utilization and additional sociodemographic variables, including sex, marital status, educational attainment, household income, and surgeon (model 4). Again, overall model fit was statistically significant ($P = 0.001$), but adjusted R^2 (0.30) and R^2_{change} (0.003) when adding race into the model were both fairly small.

Table 3. Bivariate correlation matrix*

	WOMAC Post	Age	Sex	Race	Marital	Education	Income	Insurance	Hospital	Surgeon
WOMAC Post										
r	–	–	–	–	–	–	–	–	–	–
P	–	–	–	–	–	–	–	–	–	–
Age										
r	0.006	–	–	–	–	–	–	–	–	–
P	0.95	–	–	–	–	–	–	–	–	–
Sex										
r	0.274†	0.069	–	–	–	–	–	–	–	–
P	0.01	00.48	–	–	–	–	–	–	–	–
Race										
r	0.185	0.053	0.059‡	–	–	–	–	–	–	–
P	0.07	0.59	0.56	–	–	–	–	–	–	–
Marital										
r	0.018	0.080	0.209§	0.403§	–	–	–	–	–	–
P	0.86	0.42	0.03	<0.001	–	–	–	–	–	–
Education										
r	0.135	0.066	0.033‡	0.420§	0.234§	–	–	–	–	–
P	0.19	0.51	0.74	<0.001	0.02	–	–	–	–	–
Income										
r	0.179	0.202¶	0.028‡	0.543§	0.534§	0.572§	–	–	–	–
P	0.09	0.04	0.78	<0.001	<0.001	<0.001	–	–	–	–
Insurance										
r	0.022	0.547†	0.143‡	0.091‡	0.026‡	0.026‡	0.250§	–	–	–
P	0.84	<0.001	0.15	0.36	0.79	0.79	0.01	–	–	–
Hospital										
r	0.118	0.049	0.197§	0.031‡	0.071‡	0.024‡	0.053‡	0.032	–	–
P	0.25	0.62	0.05	0.75	0.48	0.81	0.60	0.75	–	–
Surgeon										
r	0.186	0.094	0.335§	0.044‡	0.022‡	0.058‡	0.064‡	0.188	0.622†	–
P	0.07	0.34	0.001	0.66	0.84	0.56	0.52	0.06	<0.001	–
WOMAC Pre										
r	0.331†	0.025	0.219¶	0.109	0.110	0.156	0.282†	0.063	0.015	0.094
P	0.001	0.80	0.03	0.27	0.27	0.11	0.01	0.52	0.88	0.34

* r = Pearson's correlation coefficient; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; WOMAC Pre = preoperative WOMAC score; WOMAC Post = postoperative WOMAC score.
† Statistically significant.
‡ Chi-square analyses (not correlation analyses).
§ Chi-square analyses (not correlation analyses). Statistically significant.
¶ Statistically significant.

Overall model fit was strongest for model 4, but rehabilitation utilization plus all sociodemographic/clinical factors only accounted for 30% of variability in follow-up WOMAC scores. Race had a small effect in all models that we studied.

Total postacute PT received. All participants reported receiving acute care/hospital PT, and hospital length of stay was nearly identical between White and Black participants. Zero participants reported utilization of acute inpatient rehabilitation. Table 5 shows the aggregate hours of postacute PT received. The mean between-group difference was 2.6 hours, indicating that Black participants averaged 156 fewer minutes of PT care than White participants ($P = 0.36$).

SNF PT. More Black participants (27.6%) than White participants (17.3%) were admitted to skilled nursing facilities (Table 5). In the full cohort of Black and White participants, neither length of stay ($P = 0.45$) nor hours of PT received ($P = 0.49$) in these facilities was significantly different between racial groups. Results were similar in the subsample of 21 participants who were discharged to an SNF.

Home health PT. A majority of participants in both groups reported receiving home health PT, but a significantly larger proportion of Black participants received home health ($\chi^2 = 5.58$, $P = 0.02$). The number of visits received was also significantly higher among Black participants (average of 6.2 visits) than White participants (average of 4.7 visits, $P = 0.05$) (Table 5).

Outpatient PT. Most participants received outpatient PT (88.0% of White participants and 82.8% of Black participants). Duration of care was shorter for White participants (mean 56.8 days) than for Black participants (mean 71.2 days), but this difference was not significant ($P = 0.06$) (Table 5).

Although Black participants averaged longer outpatient PT duration of care, on average they received 1 fewer visit

Table 4. Regression models with race as a predictor of follow-up WOMAC score after adjusting for sociodemographic and clinical factors*

Variable	Model 1	Model 2	Model 3	Model 4
Black	0.72 (−0.07, 1.51)	0.62 (−0.13, 1.37)	0.22 (−0.75, 1.18)	0.25 (−0.62, 1.1)
Baseline WOMAC score	–	0.04 (0.02, 0.06)	0.03 (0.002, 0.06)	0.04 (0.02, 0.07)
Annual income	–	–	−0.10 (−0.52, 0.33)	−0.32 (−0.79, 0.15)
Presence of DM	–	–	0.89 (−0.43, 2.20)	0.51 (−0.67, 1.7)
Presence of DDD	–	–	0.48 (−0.33, 1.29)	0.72 (−0.02, 1.5)
Female	–	–	–	0.63 (−0.15, 1.4)
Married or cohabitating	–	–	–	−0.26 (−0.52, −0.001)
College degree or higher	–	–	–	0.05 (−0.21, 0.06)
Surgeon	–	–	–	0.02 (−0.02, 0.06)
Postoperative PT, total hours	–	–	–	0.01 (−0.02, 0.04)
Overall model fit				
F (df)	3.32 (1, 94)	7.24 (2, 93)†	3.34 (5, 86)†	4.61 (10, 74)†
R^2	0.03	0.14	0.16	0.38
Adjusted R^2	0.02	0.12	0.11	0.30
R^2_{change} from race term	0.02	0.02	0.01	0.003

* Values are the beta coefficient (95% confidence interval [95% CI]) unless indicated otherwise. Beta coefficients and 95% CIs in Table 3 are difficult to interpret because the outcome variable (follow-up Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] score) had to be transformed to satisfy the normality assumption prior to running regression analyses. DDD = degenerative disc disease; df = degrees of freedom in regression models; DM = diabetes mellitus (type 1 or 2); PT = physical therapy.
† Statistical significance of overall model fit at $P < 0.05$.

(mean of 17.1 visits versus 16.1 visits; $P = 0.63$) and 5 fewer hours of outpatient PT (mean of 19.22 hours versus 14.08 hours; $P = 0.06$). This finding indicates that Black participants had less intensive outpatient PT, although neither between-group difference was statistically significant.

DISCUSSION

In this study, race did not predict postoperative WOMAC score following TKA. This result held true in unadjusted regression models and after adjusting for rehabilitation utilization and relevant demographic and clinical variables. Black participants received an average of 2.6 fewer hours of total postacute PT following TKA than White participants. This difference was not statistically significant. Minor differences were present across treatment settings, with Black participants overall receiving more SNF and home health PT, but less outpatient and total PT.

A paucity of research investigates race disparities in functional outcomes after TKA, but some studies have identified Black race as a risk factor for other negative outcomes such as

Table 5. Postacute physical therapy (PT) utilization by race*

	White/Caucasian, (n = 75)	Black/African American (n = 29)	Between-group *P*
Hospital/acute care: received PT? no. (%)	Yes: 75 (92.0); no: 0 (0.0); unknown: 0 (8.0)	Yes: 27 (93.1); no: 0 (0.0); unknown: 2 (6.9)	0.86
Hospital length of stay, days	2.3 ± 0.8	2.3 ± 0.8	0.87
Discharged to SNF? no. (%)	Yes: 13 (17.3); no: 56 (74.7); unknown: 6 (8.0)	Yes: 8 (27.6); no: 19 (65.5); unknown: 2 (6.9)	0.25
Length of stay in an SNF, days	12.6 ± 6.8	11.0 ± 2.3	0.45
Hours of SNF PT received†	1.52 ± 0.46	2.44 ± 0.76	0.49
Hours of SNF PT received‡	9.5 ± 5.1	8.3 ± 1.7	0.45
Received home health PT? no. (%)	Yes: 52 (69.3); no: 17 (22.7); unknown: 6 (8.0)	Yes: 26 (89.7); no: 1 (3.4); unknown: 2 (6.9)	0.02§
No. of home PT visits	4.7 ± 3.4	6.2 ± 3.4	0.05§
Hours of home health PT received	4.6 ± 0.44	6.2 ± 0.66	0.05
Received outpatient PT? no. (%)	Yes: 66 (88.0); no: 3 (4.0); unknown: 6 (8.0)	Yes: 24 (82.8); no: 3 (10.3); unknown: 2 (6.9)	0.22
Duration of outpatient PT care, days	56.8 ± 30.0	71.2 ± 37.7	0.06
No. of outpatient PT visits	17.1 ± 8.6	16.1 ± 9.0	0.63
Outpatient PT, hours	19.22 ± 1.55	14.08 ± 1.54	0.06
Total hours of postacute PT received	25.4 ± 1.7	22.8 ± 1.9	0.36

* Values are the mean ± SD unless indicated otherwise. SNF = skilled nursing facility.
† Analyzing all 104 patients.
‡ Analyzing the 21 patients who went to an SNF.
§ Statistically significant.

manipulation under anesthesia and lower Knee Society scores (indicating poorer range of motion, stability, and/or alignment) (53,54). We can reasonably hypothesize that patient-reported function may also be lower among Black patients after TKA. However, our findings do not support this hypothesis.

At both the preoperative and 3-month postoperative measurement points, White participants' total WOMAC scores were slightly better than those of Black participants. At follow-up, the between-group global WOMAC difference was 5% of the maximal score. Research by Angst et al has suggested that differences >6% of the maximal WOMAC score are clinically important in individuals with OA, so the between-group difference in the current study does not meet the threshold for clinical importance (52). In addition, the proportion of participants who would be classified as responders using Osteoarthritis Research Society International–Outcome Measures in Rheumatology criteria is very similar (72.0% of White participants and 72.4% of Black participants), which further supports the lack of a clinically important difference in function between Black and White patients in our sample (55).

However, physical therapists should still consider this information when treating patients post-TKA. A 4-point difference between 2 patients' global WOMAC scores could indicate that 1 patient experiences slightly more pain or difficulty on several functional tasks or substantially more pain or difficulty with 1 or 2 tasks. Physical therapists should therefore examine patient questionnaires to screen for difficulty with specific movements/tasks and tailor treatment plans to address tasks that are particularly problematic. Physical therapists should also consider supplementing patient-reported outcome measures (such as the WOMAC used in the current study) with performance-based measures of function because research is conflicting regarding the degree of correlation between the 2 types of measurement (56,57). One study noted that self-report measures, especially in the month after TKA, may significantly underestimate a patient's degree of functional deficits (57). Outpatient physical therapists are typically the final rehabilitation provider giving care to patients following TKA, so they are uniquely positioned to close the gap in postoperative function and maximize outcomes for all patients.

Our findings conflict with those of Lavernia et al, who noted that both Black race and Hispanic ethnicity were associated with poorer function and quality of life outcomes after TKA (26). In that single-surgeon study, Black patients were younger and had different preoperative diagnoses than White patients. Similar to our study, total WOMAC scores were higher (indicating worse symptoms) in Black patients preoperatively. In the current study, the difference was not clinically significant (between-group difference of 3.6 points in total average preoperative WOMAC score), but the difference was larger and clinically significant among participants in the Lavernia study (between-group difference of 8.6 points in total average preoperative WOMAC score). However, although the Lavernia study used a much larger overall sample size (n = 1,010 patients with TKA), ~90% of the sample was White (26). Our study involved a much smaller sample size (n = 104), but the race distribution was more equitable (28% Black and 72% White), and we investigated a larger number of demographic factors (e.g., insurance status, household income, and educational attainment). Both studies involved patients from a single urban region, and Black/White disparities in post-TKA function may differ by location due to geographic differences in health care utilization.

Our findings are consistent with those recently reported by Riddle et al (27). In a secondary analysis of 384 clinical trial participants, they noted that WOMAC function subscale scores were fairly similar at baseline between Black and non-Black participants. However, a larger gap in self-reported function was evident at a 2-month follow-up. This gap became smaller but persisted at 6- and 12-month follow-ups. These gaps are important because they demonstrate that the first 2 months after surgery, during which the large majority of postoperative PT services are delivered, may be an extremely important period in which to intervene to minimize race disparities. The participant sample in the study of Riddle et al was similar to ours with respect to age, sex, and comorbidities. However, all participants in their study demonstrated moderate or high pain catastrophizing at baseline, and two-thirds of the participants were randomized to receive interventions beyond usual clinical care (27).

Freburger et al found that 55% of patients were discharged home following total hip or knee arthroplasty surgery, compared to 72–80% of participants in the current study (32). This difference in the percentage of patients discharged may reflect differences in the samples because the current study included only patients receiving TKA, whereas Freburger et al included data from both knee and hip replacement recipients and did not report results separately by joint. Alternately, this difference with Freburger et al may reflect regional variation in postacute care patterns following joint replacement surgery. This difference may also reflect the time during which the data were collected. The Freburger study used a sample from 2005 and 2006, while the current study included data from 2015 to 2019; TKA care pathways have changed during that time.

Future research should investigate race disparities in long-term functional outcomes following TKA using validated measures of physical function over a longer time period (1 year or more) and using patients from a wider geographic region. In addition, future research should use large data sets that will provide the statistical power to detect differences between many different races and ethnicities rather than simply White and Black patients. Future work should use large data sets to track patients' PT utilization throughout all practice settings and explore the role of the various settings in functional recovery following TKA.

Overall, participants in our sample achieved similar functional outcomes on the WOMAC following TKA and received similar amounts of PT. These results support the hypothesis that when provision of rehabilitation is similar, disparities in function are minimal.

This study has several limitations. Most importantly, these results are based on analysis of 104 participants. Although we recruited the number of participants that were necessary for the primary aim per our power analysis, we were only powered to detect a moderate or larger relationship between race and functional outcomes. Some analyses in the secondary aim (postacute PT utilization) trended toward statistical significance, and a larger sample size may have increased power to detect differences that were statistically and clinically significant. However, a post hoc analysis indicated that we had 99% power to detect a significant between-group difference in total postoperative PT utilization.

In our sample, there were significant relationships between race and income, marital status, and educational attainment. By adjusting for these variables in our regression model, we possibly masked part of the effect of race on outcome. However, this masking is unlikely for 2 reasons. First, in the model where we only adjusted for income (the only demographic variable related to both race and WOMAC scores), the R^2_{change} when adding race into the model was very low. Second, average WOMAC scores were similar between White and Black patients at both baseline and follow-up. Therefore, our statistical methods are unlikely to have masked a between-group difference in function. A related concern may be the potential collinearity among demographic variables that are known to be correlated in American society (such as race, income, marital status, and educational attainment). However, all of our regression models, whether including or excluding those variables, resulted in similar conclusions, so we feel that the relationship between these variables did not substantially impact the conclusions to be drawn from the data.

This study was conducted within a single geographic region. Participants in the study received their TKAs from 29 surgeons at 17 hospitals, which enhances generalizability. However, PT utilization patterns observed in this study may be different from those in other geographic areas. In addition, we included TKA surgeon and hospital as covariates in our analysis but did not include PT clinic or clinician because there were >50 unique PT facilities and providers giving care to the participants in the study. Although postoperative PT following TKA is largely based on the surgeon's protocol, differences possibly existed between clinics or clinicians that were not captured by our analysis.

Recall bias may be a concern because participants were asked to self-report some measures of postoperative PT utilization. However, we minimized this concern by providing instructional handouts preoperatively and reminders during postoperative contacts. Recall bias is not a concern for outpatient PT data because those data were gathered directly from each participant's chart. We estimated the length of each home health PT visit and average length of daily PT visits in skilled nursing facilities based on published norms (46–50), but practice patterns may vary within the actual facilities/agencies providing care to the participants in our study. Finally, the racial and ethnic demographics of our region only allowed us to include patients of Black and White race and non-Hispanic ethnicity. Therefore, we cannot generate any conclusions regarding functional outcomes in patients of other races and ethnicities.

In this sample of 104 participants undergoing TKA, race was not a substantial independent predictor of postoperative functional outcomes. Total postacute PT utilization did not significantly differ, but differences were present within specific care settings. Additional research is needed, using larger data sets, to fully illuminate race disparities in function and PT utilization after TKA.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Bove had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Bove, Hausmann, Piva, Brach, Lewis, Fitzgerald.

Acquisition of data. Bove, Fitzgerald.

Analysis and interpretation of data. Bove, Hausmann, Piva, Brach, Lewis, Fitzgerald.

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Errata

In the article by Lee et al published in the December 2010 issue of *Arthritis Care & Research* (A 44-Year-Old Woman With Cutaneous Bullae and Extensive Skin Necrosis [pages 1805–1811]), the title of the article should read as follows: A 44-Year-Old Woman With Cutaneous Bullae and Extensive Skin Necrosis: Levamisole-Contaminated Cocaine Causing a Drug-Induced Vasculitis.

In the article by Beltai et al published in the December 2018 issue of *Arthritis Care & Research* (Cardiovascular Morbidity and Mortality in Primary Sjögren's Syndrome: A Systematic Review and Meta- Analysis [pages 5–6]), the Results section contained an error. In the section entitled "Odds of heart failure," three articles were cited. Valvular disease outcomes were incorrectly considered as proxies for heart failure in the articles by Vassilou et al and Chiang et al. As a result, we decided to exclude these two studies. In the retained Bartoloni et al study, the prevalence of heart failure in the selected cohort of 788 female patients with primary Sjögren's syndrome in comparison with the control group was not higher ($P = 0.139$). As a result of excluding the two studies, our conclusion is now no increased likelihood of heart failure for patients with primary Sjögren's syndrome versus the general population. The other conclusions of the study are not affected.

We regret the error.