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# Racial differences in osteoarthritis pain and function: potential explanatory factors

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## Summary

*Objective*: This study examined factors underlying racial differences in pain and function among patients with hip and/or knee osteoarthritis (OA).

*Methods*: Participants were $n = 491$ African Americans and Caucasians enrolled in a clinical trial of telephone-based OA self-management. Arthritis Impact Measurement Scales-2 (AIMS2) pain and function subscales were obtained at baseline. Potential explanatory variables included arthritis self-efficacy, AIMS2 affect subscale, problem- and emotion-focused pain coping, demographic characteristics, body mass index, self-reported health, joint(s) with OA, symptom duration, pain medication use, current exercise, and AIMS2 pain subscale (in models of function). Variables associated with both race and pain or function, and which reduced the association of race with pain or function by $\geq$10%, were included in final multivariable models.

*Results*: In simple linear regression models, African Americans had worse scores than Caucasians on AIMS2 pain ($B = 0.65$, $P = 0.001$) and function ($B = 0.59$, $P < 0.001$) subscales. In multivariable models race was no longer associated with pain ($B = 0.03$, $P = 0.874$) or function ($B = 0.07$, $P = 0.509$), indicating these associations were accounted for by other covariates. Variables associated with worse AIMS2 pain and function were: worse AIMS2 affect scores, greater emotion-focused coping, lower arthritis self-efficacy, and fair or poor self-reported health. AIMS2 pain scores were also significantly associated with AIMS2 function.

*Conclusion*: Factors explaining racial differences in pain and function were largely psychological, including arthritis self-efficacy, affect, and use of emotion-focused coping. Self-management and psychological interventions can influence these factors, and greater dissemination among African Americans may be a key step toward reducing racial disparities in pain and function.
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*Key words*: Osteoarthritis, Race, Pain, Function, Health status disparities.

## Introduction

A number of studies have identified racial differences in osteoarthritis (OA) symptoms, with African Americans reporting greater pain and activity limitations than Caucasians[1–10]. However, underlying factors are not well understood, and identifying the key factors would represent an important first step toward reducing disparities, particularly if those factors were responsive to interventions. Research to date has shown that, in general, racial differences in arthritis-related pain and function have not been fully explained by demographic factors and radiographic severity, meaning that psychosocial or other factors may play an important role[1,6–8]. There is a need to examine other possible contributors to these racial differences.

This study examined the potential role of several psychological variables that have not been previously examined with respect to racial differences in pain and function: pain coping strategies, arthritis self-efficacy, and affect. We chose to examine these particular psychological variables because they are known important contributors to pain and functional limitations, but their potential contribution to racial disparities is not yet known. With respect to pain coping strategies, external and emotion-focused coping strategies have been associated with worse pain and other outcomes[11,12], whereas active and problem-focused coping strategies have been associated with better outcomes[11,13]. Several studies have reported greater use of external or emotion-focused pain coping strategies among African Americans than Caucasians with OA and other pain-related conditions[12,14–16], yet analyses have not examined whether racial differences in pain coping strategy use may underlie disparities in pain and functional outcomes. Arthritis self-efficacy has been one of the strongest and most consistent predictors of pain and function in OA[17–20], though racial differences have not been well studied. The association of affect with pain and function in OA has not been well studied, but the Arthritis Impact Measurement Scales 2 (AIMS2) affect subscale has found to be

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been significantly associated with both pain and function in some research[21]. Further, some psychological variables related to affect, particularly depressive symptoms, have been strongly associated with pain and function in previous studies[18,22]. While racial differences in AIMS2 affect subscales have not been reported, some studies of patients with arthritis have shown that African Americans have greater depressive symptoms than Caucasians[8,10].

In this study we examined whether each of these psychological variables, arthritis self-efficacy, affect, and pain coping strategies, as well as other key demographic and clinical factors, individually explained racial differences in pain and function among patients with hip and/or knee OA. We then used multivariable models to examine which factors may be the strongest contributors to racial differences in pain and function.

## Methods

### PARTICIPANTS AND RECRUITMENT

Participants were enrolled in the Self-Management of OsteoArthritis (SeMOA) in Veterans Study (Department of Veterans Affairs, Health Services Research & Development Study # 04-016). This study was reviewed and approved by the Institutional Review Board of the Durham VA Medical Center. Details of the SeMOA study have been published previously[23]. All SeMOA participants were patients at the Durham VA Medical Center who had symptomatic hip and/or knee OA, based on a clinician diagnosis and accompanying radiograph. SeMOA participants were randomly assigned to one of three groups for a 12-month study period: OA self-management, health education (attention control), or usual care. All participants continued with their care for OA at the Durham VA Medical Center.

### MEASURES

All measures in this study were collected at baseline, prior to study group randomization and delivery of any intervention.

#### *Racial status*

Participants reported the racial group they most closely identified themselves with, from the following list: White/Caucasian, Black/African American, Asian, Hawaiian/Pacific Islander, American Indian/Alaska Native, Don't Know, and Other. The analyses reported in this paper focused on comparisons between those who indicated being White/Caucasian vs Black/African American because prior research has identified differences in OA-related pain and function among these two racial groups specifically[2,4,8,10] and because other racial groups were not well represented in SeMOA. Among 516 participants enrolled in SeMOA, $N = 5$ reported a specific race other than White/Caucasian or Black/African American. In addition, $N = 6$ responded "Don't Know" to the question about race, and $N = 4$ indicated "Other"; these individuals were also excluded from these analyses. SeMOA participants also reported whether they were from Hispanic or Latino descent (irrespective of the racial group indicated). Because prior studies have also shown that Hispanic individuals have more arthritis-related pain and functional limitations than Caucasian non-Hispanics[4,8,9], those reporting Hispanic ethnicity were excluded from the White/Caucasian racial group in this study ($N = 8$). For consistency, we also excluded individuals who reported being Black/African American and Hispanic ($N = 2$). Thus, the final sample size for these analyses was $N = 491$.

#### *Pain and function measures*

The AIMS2 is an arthritis-specific health status measure with well documented internal consistency, test-retest reliability, construct validity, and sensitivity to change within the context of arthritis-specific interventions[24–30]. The AIMS2 pain subscale consists of five items that assess typical pain, pain severity, and pain during specific times of the day, using a 5-point Likert scale ("all days" to "no days"). The total possible range of scores for the AIMS2 subscale is 1–10, with higher scores corresponding to greater pain. The AIMS2 physical function subscale includes 28 items that measure aspects of mobility, walking and bending, hand and finger function, arm function, self-care, and household tasks. The total possible range of scores for the AIMS2 function subscale is 1–10, with higher scores corresponding to worse function.

#### *Potential explanatory variables*

We selected the following potential explanatory variables based on prior research showing they may be associated with race, pain, and/or function[1,8,10,14,16–18,31–41]:

*Psychological variables.* Arthritis Self-Efficacy Scale[42]; AIMS2 affect subscale (range of 1–10, higher scores = worse mood and tension); pain coping strategies. The Arthritis Self-Efficacy Scale includes 8-items asking respondents how certain they are that they can perform specific activities or tasks. Items are scored on a Likert Scale (1 = very uncertain to 10 = very certain). The AIMS2 affect subscale includes 10 items the assess mood (including questions related to depressive symptoms) and level of tension. All items are measured on a 5-point Likert scale (1 = all days to 5 = no days), and scores are standardized to a scale from 1 = 10, with higher scores pertaining to worse mood and tension. Pain coping was assessed using Stone and Neale's Daily Coping Inventory adapted for pain coping[43,44]. This inventory asks participants to indicate whether they have used each of seven different activities or thought processes to cope with OA-related pain. These seven activities were divided into two subscales: problem-focused coping (specific action to reduce pain, relaxation, distraction; possible score range of 0–3) and emotion-focused coping (redefinition of pain, venting emotions, seeking spiritual comfort, and seeking emotional support; possible score range of 0–4). A prior study has confirmed the 2-factor model of this scale, using principal component analysis[45]. The two subscales were examined separately in these analyses. All items on this inventory were asked with respect to pain coping behaviors used during the past week.

*Demographic variables.* Age; gender; marital status (married vs not married); education (completed at least some college vs no college); employment status (working full- or part-time vs not working); perceived income status (described below), health literacy using the Rapid Estimate of Adult Literacy (REALM; range of 0–66, higher scores = greater health literacy)[46]. Regarding perceived income status, participants were asked to describe their current household financial situation as one of the following: (1) After paying the bills, you still have enough money for special things that you want. (2) You have enough money to pay the bills, but little spare money to buy extra or special things. (3)You have money to pay the bills, but only because you have to cut back on things. (4)You are having difficulty paying the bills, no matter what you do. Participants were classified as having "Perceived Inadequate Income" if they selected one of the two latter responses.

*Health-related variables.* Self-rated health (excellent/very good/good vs fair/poor); body mass index (BMI; continuous variable based upon self-reported height and weight); site(s) of OA (knee only, hip only or both, based on radiograph reports in Durham VA electronic medical records); self-reported duration of OA symptoms in years; self-reported current pain medication use for OA (yes or no); self-report of current exercise Regarding current exercise, participants were asked to indicate the amount of time they spent during the past week on each of four categories of exercises: aerobic (with examples: walking, biking, swimming), strengthening, stretching, and other. Possible responses were: 0 min, >0 but <30 min, 30–60 min, >1 but <3 h, and >3 h. For each exercise type, individuals who reported doing 0 min per week were treated as the referent category, to which the other four response categories were compared. For analyses of the AIMS2 function subscale, the AIMS2 pain subscale was also included as a potential explanatory variable, since prior research has shown that pain is a key predictor of functional decline[17,41].

### ANALYSES

Our analytic strategy was based on the approach described by Baron and Kenny for examining potential mediator variables[47] and involved five steps. Step 1: We examined whether there were racial differences in pain and function, using simple linear regression models. Step 2: We examined whether each potential explanatory variable was associated with race at the $P < 0.1$ level, using Chi-Square and *t*-tests for categorical and continuous variables, respectively. We chose to evaluate these associations at the $P < 0.1$ level in order to avoid excluding any variables that may become important in subsequent multivariable analyses; however, we repeated these analyses using a criterion of $P < 0.05$, and results of our final multivariable model (described below) were unchanged. Step 3: For all potential explanatory variables that were associated with race, we conducted simple linear regression models to examine whether each variable was associated with pain and function, separately ($P < 0.05$). Step 4: For potential explanatory variables that were associated with pain or function in the simple regression models, we conducted linear regression models that included both race and the potential explanatory variable. Step 5: All potential explanatory variables that reduced the association between race and the outcome variable (pain or function) by at least 10% (i.e., based on the difference between coefficients for race in models from steps 1 and 4 above) were included in a final multivariable linear regression model. The threshold of 10% was chosen based on recommendations

Table I
*Participant characteristics according to race*

| | African American ($N = 221$) | Caucasian ($N = 270$) | $P$-value* |
|---|---|---|---|
| *Psychological variables* | | | |
| Mean arthritis self-efficacy score (SD) | 5.5 | 6.0 | 0.014 |
| Mean problem-focused coping score (SD) | 2.4 | 2.2 | 0.017 |
| Mean emotion-focused coping score (SD) | 2.1 | 1.5 | <0.001 |
| Mean AIMS affect score (SD) | 4.0 | 3.2 | <0.001 |
| *Demographic variables* | | | |
| Mean age (SD) | 57.1 (10.2) | 62.6 (9.7) | <0.001 |
| % Female | 9.1 | 4.8 | 0.062 |
| % Married | 63.4 | 72.6 | 0.028 |
| % With some college education | 67.4 | 66.7 | 0.860 |
| % Working full or part time | 41.1 | 36.1 | 0.307 |
| % With perceived inadequate income | 34.3 | 20.4 | <0.001 |
| Mean REALM literacy score (SD) | 68.9 | 62.8 | 0.257 |
| *Health-related variables* | | | |
| % With perceived fair or poor health | 38.5 | 27.0 | 0.007 |
| Mean body mass index (SD) | 32.9 | 33.1 | 0.849 |
| Joints with documented OA | | | |
| Knee only (%) | 80.1 | 78.9 | |
| Hip only (%) | 14.5 | 16.3 | |
| Knee and hip (%) | 5.4 | 4.8 | 0.831 |
| Mean # years with OA symptoms (SD) | 15.1 | 16.9 | 0.103 |
| % Taking pain medication for OA | 85.1 | 85.2 | 0.971 |
| % Performing aerobic exercises | 65.2 | 64.1 | 0.803 |
| % Performing strengthening exercises | 49.8 | 56.7 | 0.128 |
| % Performing stretching exercises | 65.2 | 65.2 | 0.995 |
| % Performing other exercises | 11.2 | 15.9 | 0.141 |

*$P$ = values calculated from t-test for continuous variables and Chi-Square tests for categorical variables.

for epidemiological studies, as well as procedures used in similar previous research[48,49]. For all linear regression models we report the regression coefficients (B), which represent the change in AIMS2 pain or function scores per unit change in the potential explanatory variable. SAS version 9.1.3 (Cary, NC, USA) was used for all statistical analyses. We conducted a sensitivity analysis using the SAS procedure GLMSELECT to examine if the final multivariable model would vary depending on the selection procedure used. We used two selection methods: least absolute shrinkage and selection operator (LASSO)[50,51] and backward selection, and we used both Schwarz Bayesian Information Criteria (SBC) and Akaike Information Criteria (AIC) for choosing models.

## Results

African Americans had higher (worse) mean AIMS2 pain scores than Caucasians (6.3 vs 5.6, $P = 0.001$), as well as higher mean AIMS2 function scores (2.8 vs 2.3, $P < 0.001$). In Step 1 of our analyses, both the AIMS2 pain subscale ($B = 0.65$, $P = 0.001$) and function subscale ($B = 0.59$, $P < 0.001$) differed according to race in simple linear regression models (Tables II and III). Participant characteristics according to race are shown in Table I. In Step 2 of our analyses, the following characteristics differed according to race at the $P < 0.1$ level: arthritis self-efficacy, AIMS2 affect subscale, problem-focused coping, emotion-focused coping, age, gender, marital status, perceived inadequate income, perceived fair or poor health, and current use of strengthening exercises. These variables were further evaluated for associations with pain and function, as the next step in assessing whether they may explain racial differences.

### STEPS 3 – 5 FOR AIMS2 PAIN SUBSCALE SCORES

In Step 3, participant characteristics associated with the AIMS2 pain subscale in simple (unadjusted) linear regression models included: arthritis self-efficacy, AIMS2 affect subscale, problem-focused coping, emotion-focused coping, age, perceived inadequate income, and perceived fair or poor health (Table II). In Step 4, when each of the following variables was included (separately) in a linear regression models with race, the association of race with AIMS2 pain subscale was reduced by at least 10%: arthritis self-efficacy, AIMS2 affect subscale, emotion-focused coping, age, perceived inadequate income, and perceived fair or poor health (Table II). In the model including race and AIMS2 affect scores, race was no longer associated with AIMS2 pain scores. For all other variables, the association of race with AIMS2 pain scores was still significant at the 0.05 level; this indicates these variables only partially accounted for the association of race with pain. In Step 5, which was a multivariable regression model including all variables that reduced the association of AIMS2 pain scores in Step 4, the following were associated with worse scores on the AIMS2 pain subscale (Table II): higher (worse) scores on the AIMS2 affect subscale score ($B = 0.29$), greater use of emotion-focused coping strategies ($B = 0.15$), and perceived fair or poor health ($B = 0.64$); greater arthritis self-efficacy scores were associated with lower (better) scores on the AIMS2 pain subscale ($B = -0.30$) The association of race with AIMS2 pain scores was reduced from $B = 0.65$ (unadjusted) to $B = 0.03$ ($P = 0.874$) in the final model.

### STEPS 3 – 5 FOR AIMS2 FUNCTION SUBSCALE SCORES

In Step 3, participant characteristics associated with the AIMS2 function subscale in simple (unadjusted) linear regression models included: arthritis self-efficacy, AIMS2 affect subscale, problem-focused coping, emotion-focused coping, perceived inadequate income, perceived fair or poor health,

Table II
*Unadjusted and adjusted associations of participant characteristics with AIMS2 pain scores*

| | Unadjusted | Race adjusted | | Final multivariable model |
|---|---|---|---|---|
| | B [95% CI]* *P*-value | B [95% CI] *P*-value for potential mediator | B [95% CI] *P*-value for race | B [95% CI] *P*-value |
| *African American race* | 0.65 [0.26, 1.04] $P = 0.001$ | – | – | 0.03 [−0.320.38] $P = 0.874$ |
| *Psychological variables* | | | | |
| Arthritis self-efficacy | −0.53 [−0.62, −0.45] $P < 0.001$ | −0.52 [−0.61, −0.44] $P < 0.001$ | 0.42 [0.07, 0.77] $P = 0.020$ | −0.30 [−0.39, −0.20] $P < 0.001$ |
| AIMS2 affect | 0.51 [0.43, 0.59] $P < 0.001$ | 0.50 [0.42, 0.58] $P < 0.001$ | 0.23 [−0.12, 0.58] $P = 0.202$ | 0.29 [0.20, 0.38] $P < 0.001$ |
| Problem-focused coping | 0.38 [0.14, 0.62] $P = 0.002$ | 0.34 [0.10, 0.58] $P = 0.005$ | 0.59 [0.20, 0.98] $P = 0.004$ | – |
| Emotion-focused coping | 0.35 [0.20, 0.50] $P < 0.001$ | 0.31 [0.15, 0.46] $P < 0.001$ | 0.46 [0.05, 0.86] $P = 0.026$ | 0.15 [0.02, 0.29] $P = 0.028$ |
| *Demographic variables* | | | | |
| Age | −0.04 [−0.06, −0.02] $P < 0.001$ | −0.03 [−0.05, −0.01] $P < 0.001$ | 0.46 [0.06, 0.87] $P = 0.025$ | −0.01 [−0.03, 0.00] $P = 0.080$ |
| Female | −0.37 [−1.16, 0.43] $P = 0.365$ | – | – | – |
| Not married | −0.16 [−0.59, 0.26] $P = 0.456$ | – | – | – |
| Perceived inadequate income | −0.99 [−1.43, −0.55] $P < 0.001$ | −0.89 [−1.34, −0.45] $P < 0.001$ | 0.56 [0.16, 0.95] $P = 0.006$ | 0.19 [−0.58, 0.20] $P = 0.342$ |
| *Health-related variables* | | | | |
| Fair or poor health | 1.37 [0.96, 1.78] $P < 0.001$ | 1.30 [0.90, 1.71] $P < 0.001$ | 0.50 [0.12, 0.88] $P = 0.010$ | 0.64 [0.26, 1.01] $P < 0.001$ |
| *Strengthening exercises* | | | | |
| 0 min/week | – | – | – | – |
| <30 min/week | 0.34 [−0.24, 0.93] $P = 0.251$ | | | |
| 30−60 min/week | 0.25 [−0.35, 0.85] $P = 0.421$ | | | |
| >60 min, <3 h/week | −0.03 [−0.64, 0.59] $P = 0.934$ | | | |
| >3 h/week | −0.06 [−0.75, 0.62] $P = 0.852$ | | | |

*B = regression coefficient; CI = confidence interval.

current use of strengthening exercises, and AIMS2 pain subscale (Table III). In Step 4, when each of these variables was included (separately) in a linear regression model with race, the following reduced the association of race with AIMS2 function subscale by at least 10%: arthritis self-efficacy, AIMS2 pain subscale, emotion-focused coping, perceived inadequate income, perceived fair or poor health, and AIMS2 affect subscale (Table II). In each of these models, the association of race with AIMS2 function scores was still significant at the 0.05 level, indicating that the potential mediators only partially accounted for the association of race with pain. In Step 5, which was a multivariable regression model including all variables that reduced the association of AIMS2 function scores in Step 4, the following were associated with worse scores on the AIMS2 function subscale (Table III): higher (worse) scores on the AIMS2 affect subscale scores (B = 0.17), greater use of emotion-focused coping strategies (B = 0.15), perceived fair or poor health (B = 0.79), and higher (worse) scores on the AIMS2 pain subscale scores (B = 0.20); greater arthritis self-efficacy scores were associated with lower (better) scores on the AIMS2 function subscale (B = −0.11). The association of race with AIMS2 function scores was reduced from B = 0.59 (unadjusted) to B = 0.07 ($P = 0.509$) in the final model.

In the sensitivity analyses using different variable selection methods we found similar results to our multivariable models for both pain and function. The psychological variables were still the most important variables explaining racial differences in pain, and race was not significantly associated with pain or function in final models using any selection scenario we applied.

## Discussion

We found that among patients with hip and/or knee OA, African Americans reported worse pain and poorer function than Caucasians, which is consistent with previous research[1–10]. The racial differences in AIMS2 pain and function scores in this study were relatively small (<1 point). However, it should be noted that the AIMS2 subscales comprise a small range of scores (1−10), and African Americans' mean scores on the pain and function subscales were 13% and 22% worse than Caucasians' mean scores, respectively. While clinically meaningful differences in AIMS2 scores among patients with lower extremity OA have not been reported, data regarding another measure of lower extremity pain and function indicate differences as small as 12% may be clinically meaningful[52].

This study extends prior research, showing that for both pain and function, factors explaining racial differences were arthritis self-efficacy, affect (mood and level of tension), emotion-focused coping, and general self-rated health. It is particularly interesting that a constellation of

Table III
*Unadjusted and adjusted associations of participant characteristics with aims2 function scores*

| | Unadjusted | Race adjusted | | Final multivariable model |
|---|---|---|---|---|
| | B [95% CI]* *P*-value | B [95% CI] *P*-value for Potential Mediator | B [95% CI] *P*-value for Race | B [95% CI] *P*-value |
| *African American race* | 0.59 [0.30, 0.87] $P < 0.001$ | – | – | 0.07 [−0.14, 0.29] $P = 0.509$ |
| *Psychological Variables* | | | | |
| Arthritis self-efficacy | −0.37 [−0.43, −0.31] $P < 0.001$ | −0.36 [−0.42, −0.29] $P < 0.001$ | 0.43 [0.17, 0.68] $P = 0.001$ | −0.11 [−0.17, −0.04] $P < 0.001$ |
| AIMS2 affect | 0.40 [0.35, 0.46] $P < 0.001$ | 0.39 [0.34, 0.45] $P < 0.001$ | 0.26 [0.01, 0.50] $P = 0.038$ | 0.17 [0.11, 0.23] $P < 0.001$ |
| Problem-focused coping | 0.25 [0.07, 0.42] $P = 0.005$ | 0.21 [0.04, 0.38] $P = 0.017$ | 0.55 [0.27, 0.83] $P < 0.001$ | – |
| Emotion-focused coping | 0.34 [0.24, 0.45] $P < 0.001$ | 0.31 [0.19, 0.42] $P < 0.001$ | 0.39 [0.11, 0.67] $P = 0.007$ | 0.15 [0.07, 0.24] $P < 0.001$ |
| *Demographic Variables* | | | | |
| Age | 0.00 [−0.01, 0.02] $P = 0.751$ | – | – | – |
| Female | −0.17 [−0.74, 0.39] $P = 0.546$ | – | – | – |
| Not married | 0.01 [−0.30, 0.31] $P = 0.960$ | – | – | – |
| Perceived inadequate income | −0.86 [−1.17, −0.54] $P < 0.001$ | −0.77 [−1.08, −0.45] $P < 0.001$ | 0.50 [0.22, 0.78] $P < 0.001$ | 0.12 [−0.13, 0.36] $P = 0.356$ |
| *Health-Related Variables* | | | | |
| Fair or poor health | 1.45 [1.18, 1.73] $P < 0.001$ | 1.40 [1.12, 1.68] $P < 0.001$ | 0.43 [0.17, 0.69] $P = 0.001$ | 0.79 [0.55, 1.02] $P < 0.001$ |
| *Strengthening exercises* | | | | |
| 0 min/week | – | – | – | – |
| >0 but <30 min/week | 0.32 [−0.09, 0.74] $P = 0.127$ | 0.34 [−0.07, 0.75] $P = 0.714$ | 0.56 [0.28, 0.85] $P < 0.001$ | |
| 30−60 min/week | −0.24 [−0.67, 0.18] $P = 0.265$ | −0.23 [−0.65, 0.20] $P = 0.109$ | | |
| > 60 min but <3 h/week | −0.16 [−0.60, 0.27] $P = 0.466$ | −0.08 [−0.51, 0.35] $P = 0.013$ | | |
| >3 h/week | −0.66 [−1.15, −0.18] $P = 008$ | −0.61 [−1.09, −0.13] $P = 0.017$ | | |
| AIMS2 pain | 0.40 [0.35, 0.45] $P < 0.001$ | 0.39 [0.34, 0.44] $P < 0.001$ | 0.33 [0.09, 0.57] $P = 0.006$ | 0.20 [0.14, 0.26] $P < 0.001$ |

*B = regression coefficient; CI = confidence interval.

psychological variables (self-efficacy, affect, and emotion-focused coping) were key factors that reduced the racial differences in OA-related pain and function. Prior studies have shown that arthritis self-efficacy is a key factor associated with OA-related outcomes[17,20]. However, to our knowledge this is the first study showing that arthritis self-efficacy is a potentially important contributor to racial differences in OA-related pain and function. It is well established that psychological health is strongly associated with pain and function[18,53], and in some studies of patients with arthritis, African Americans have reported greater depressive symptoms than Caucasians[8,10]. This study shows that aspects of psychological health, particularly mood and level of tension (as measured by the AIMS2 affect subscale) are important in explaining racial differences in pain and function among patients with OA. These results are in agreement with recent analyses of the Johnston County Osteoarthritis Study cohort, in which depressive symptoms were an important factor explaining racial differences in pain and function among patients with knee OA[10]. It is also noteworthy that the AIMS2 affect subscale was the only variable that resulted in a non-significant association of race with AIMS2 pain scores in a model that did not include other covariates. This indicates that affect had a particularly strong role in explaining racial differences in pain.

Studies have also shown that greater use of emotion-focused coping strategies is associated with worse OA-related outcomes[11,12] and that African Americans are more likely than Caucasians to employ these types of pain coping strategies[12,14–16]. This study adds to prior research in this area, indicating that use of emotion-focused coping is also an important contributor to racial differences in OA-related pain and function. Self-management programs, coping skills training, and other psychosocial and behavioral interventions have been shown to improve arthritis self-efficacy, depressive symptoms, psychological disability, and confidence in coping with pain, as well as downstream clinical outcomes such as improved pain and function[54–61]. Greater dissemination of these types of programs among African Americans may be an important step toward reducing racial disparities in OA-related pain and function.

It is not surprising that poorer overall self-reported health was associated with worse pain and function. While the AIMS2 pain and function scales ask patients specifically about arthritis-related pain and functional limitations, it is possible that other chronic health problems could have influenced participants' reports. In addition, individuals

with overall poorer health may be less active, leading to worse OA-related symptoms[18]. African American participants in this sample (as well as in the general US population[62]) had poorer health status, and this difference partly explained differences in OA-related pain and function. In clinical practice, as well as in the delivery of psychosocial interventions, consideration should be given to the possible greater burden of comorbid illness among African Americans, which may impact ability to perform some self-management behaviors such as exercise.

Prior research, including longitudinal studies, has shown that pain severity is an important predictor of function in OA[10,17,41]. The present results provide evidence that racial differences in pain are important in explaining racial differences in function. However, it also important to note that the other factors described above (arthritis self-efficacy, emotion-focused coping, affect, and general self-rated health) were still important in explaining racial differences in function when controlling for pain.

Interestingly, demographic factors were not significantly associated with pain or function in final multivariable models. Income levels in particular were strongly associated with pain and function in bivariate analyses but were markedly reduced in final models. Lower income is generally associated with poorer psychological health[63]. Therefore, although lower income was not significantly associated with pain or function in final models, socioeconomic status may still be an important contributor to pain and function, *via* its influence on psychological profiles (i.e., poorer affect, lower arthritis self-efficacy).

There are some differences between these results and those recently reported for the Johnston County Osteoarthritis Study cohort, which to our knowledge is the only other study to date that has systematically examined factors explaining racial differences in pain and function among individuals with OA[10]. Specifically, gender, education, and BMI were significantly associated with pain and function Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores in the Johnston County group, but not in the present study. This is likely because our study involved a veteran patient sample, in which there were very few females, and education and BMI did not significantly differ according to race (and therefore did not explain racial differences in pain and function).

There are several limitations to this study. First, radiographic severity of hip and knee OA were not known and could therefore not be controlled for in analyses. Radiographic severity has not mediated racial differences in pain or function in prior research[7,10]. However, it is still possible that radiographic severity may have contributed to racial differences in pain and/or function in this sample. Second, this veteran sample included mostly men, and the generalizability of the findings to women may therefore be limited. Third, there were also very few Hispanic participants in this study, therefore this ethnic group could not be included in these analyses. Since studies have also shown poorer outcomes among Hispanic individuals with arthritis (compared with Caucasian non-Hispanics[8,64]), this is an important area for future research. Fourth, African Americans and Caucasians in this sample were more similar in some characteristics (i.e., BMI, education, literacy) than what may be observed in other patient samples. Therefore it is possible that these factors play a more important in explaining racial differences in OA outcomes in other samples. Fifth, because this was a cross-sectional study causality cannot be inferred. For example, these results cannot determine whether poorer psychological variables (i.e., affect, self-efficacy, emotion-focused coping) led to worse pain and function, or whether worse pain and function caused poorer psychological variables.

In summary, this study showed that among a group of patients with knee and/or hip OA, important factors explaining racial differences in pain and function were largely psychological in nature, including arthritis self-efficacy, use of emotion-focused coping, and affect (mood and level of tension). This is an important finding, since factors mediating these racial differences have not previously been identified. While there may be other variables not examined in this study that may also contribute to racial differences in OA-related pain and function, the factors identified here can be modified *via* previously tested interventions. Therefore an important next step in this area of research is to proceed with efforts to more widely disseminate interventions that can improve arthritis self-efficacy, coping effectiveness, and psychological health among African Americans with OA. In some cases this may require adaptation of existing interventions into formats that take into account issues of cultural sensitivity and relevance. In addition, this will require consideration of the most appropriate approaches of intervention delivery among African Americans, such as targeted, community-based outreach.

## Conflict of interest

None of the authors have any conflicts of interest to disclose regarding this manuscript, including employment, consultancies, stock ownership, honoraria, paid expert testimony, patient applications, or grants/funding.

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