Published in final edited form as:
Arthritis Care Res (Hoboken). 2020 September ; 72(9): 1196–1204. doi:10.1002/acr.24018.

Racial differences in performance-based function and potential explanatory factors among individuals with knee osteoarthritis

Portia P.E. Flowers, PhD[1], **Todd A. Schwartz, DrPH**[2], **Liubov Arbeeva, MS**[1], **Yvonne M. Golightly, PT, MS, PhD**[1], **Ami Pathak, SPT**[3], **Jennifer Cooke, PT, DPT**[4], **Jyotsna J. Gupta, PT, PhD**[4], **Leigh F. Callahan, PhD**[1], **Adam P. Goode, DPT, PhD**[5], **Michela Corsi, BS**[6], **Kim M. Huffman, MD, PhD**[7], **Kelli D. Allen, PhD**[1]

[1]Thurston Arthritis Research Center, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States.

[2]Department of Biostatistics, University of North Carolina at Chapel Hill Gillings School of Global Public Health, Chapel Hill, North Carolina, United States.

[3]Comprehensive Physical Therapy Center, Chapel Hill, North Carolina, United States.

[4]Division of Physical Therapy, Department of Allied Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States.

[5]Duke Clinical Research Institute, Department of Orthopedic Surgery, Duke University School of Medicine, Durham, North Carolina, United States.

[6]Northeastern Ohio Medical University, Northeastern Ohio Medical University, Ohio, United States.

[7]Duke Molecular Physiology Institute, Division of Rheumatology and Immunology, Duke University School of Medicine, Durham, North, Carolina, United States

Abstract

Objective: In people with knee osteoarthritis (OA), self-reported physical function is poorer in Blacks than Whites, but it is unclear whether this holds true for objective assessments. This study examined racial differences in performance-based physical function as well as potential underlying factors contributing to these racial differences.

Methods: Participants with knee OA from a randomized controlled trial (ClinicalTrials.gov number NCT02312713) completed the 2-minute step tests (2MST), timed-up-and-go (TUG), and 30-second chair stands (30s-CST) at baseline. Race differences in performance-based function were assessed by logistic regression. Separate models were adjusted for sets of demographic, socioeconomic, psychological health, and physical health variables.

Results: In persons with knee OA (n=322; women: 72%, Black: 22%, age=66±11 years, BMI=31±8 kg/m^2), Blacks (vs. Whites) had greater unadjusted odds of poorer function (30s-CST:

Address correspondence to: Kelli Allen, PhD, Thurston Arthritis Research Center, The University of North Carolina at Chapel Hill, 3300 Thurston Boulevard, CB# 7280, Chapel Hill, NC 27599-7280. Phone: 919-966-0558. Fax: 919-966-1739. kdallen@email.unc.edu.

Declaration of interest statement: No potential conflict of interest was reported by the authors.

OR [95% CI] = 2.79 [1.65–4.72]; 2MST: 2.37 [1.40–4.03]; TUG: 3.71 [2.16 – 6.36]). Relationships were maintained when adjusted for demographic and psychological health covariates, but they were either partially attenuated or non-significant when adjusted for physical health and socioeconomic covariates.

Conclusion: Black adults with knee OA had poorer unadjusted performance-based function than Whites. Physical health and socioeconomic characteristics diminished these differences, emphasizing that these factors may be important to consider in mitigating racial disparities in function.

Introduction

Osteoarthritis (OA) is a leading cause of disability and is a painful and common disease of the joint[1,2]. The lifetime risk of developing symptomatic knee OA by the age of 85 years old is 44.7% [3]. Compared to those without knee OA, individuals with knee OA have poorer functional ability[4], and factors, such as older age[5], quadriceps weakness[5], obesity[6], and anterior cruciate ligament injury[7] increase the risk for poor function.

Racial differences occur in multiple aspects of knee OA. Black people have a greater prevalence [8,9] and higher hazard of progression[10] of knee OA, as well as more severe tibiofemoral OA [11] compared to Whites. Black people also report poorer physical function compared to Whites [12,13], which some studies have indicated may be explained by other factors. For example, in a sample of veterans with hip and/or knee OA[14], differences in functional scores between Blacks and Whites were no longer statistically significant after controlling for physical (pain, perceived poor health) and psychological (self-efficacy, emotion-focused coping) health-related variables. In the Johnston County Osteoarthritis Project, differences in functional scores between Black and White people with knee OA were attenuated by controlling for BMI and depressive symptoms[13].

Currently, much of the literature describing the racial differences in physical function between Blacks and Whites in knee OA have been based upon-self report. While self-reported physical function is informative, inexpensive, and easy to collect, it is inherently subjective, limited by cognitive ability, and dependent on memory. Such challenges in self-reporting may lead to biases such as over- or under-estimation of physical function. This bias can be reduced by including objective physical performance measures. In a 2007 study of racial differences in function between Black and White older adults with knee OA, there were no significant differences in self-reported walking ability. However, six-minute walking (6MW) test performance revealed Black people had significantly worse functional performance compared to White people, illustrating the potential for an overestimation of functional ability and the importance of objective functional assessments [15]. Self-reported and performance-based functional tests also measure different but complementary domains of function; thus, both forms of assessment should be utilized to best evaluate functional ability[16]. Outcome measures such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) or the 36-Item Short Form Survey (SF-36) have been found to be influenced by psychosocial factors, like pain and depression, while performance-based measures such as the 6MW or the timed-up-and-go (TUG) are influenced by self-efficacy

[17]. So while both are influenced by psychosocial factors, they are not affected in the same way.

Little is known about associations of race with performance-based physical function. Furthermore, the roles demographic, socioeconomic, psychological, and physical health factors may play in the relationship between race and performance-based function among individuals with knee OA remains unclear. Such information could be useful in identifying at-risk populations to aid in the development of interventions that target underlying factors contributing to racial disparities. To address these gaps, the objectives of this cross-sectional study were to determine if differences in performance-based function measures exist between Black and White individuals with knee OA and to examine whether race-related differences are attenuated when accounting for demographics, socioeconomics, psychological health, and physical health in multivariable models. We expected that Black people would have poorer functional outcomes compared to White individuals and underlying factors that contribute to racial differences would be identified.

Patients and Methods

Study sample

Participants for this cross-sectional study were taken from the PhysicAl THerapy vs INternet-Based Exercise Training (PATH-IN) for Patients with Knee Osteoarthritis study (ClinicalTrials.gov number NCT02312713), a randomized controlled trial comparing the effectiveness of physical therapy versus an internet based exercise intervention among individuals with symptomatic knee OA [18]. Participants with knee OA were recruited via advertisements for self-referral and actively recruited from the University of North Carolina and the surrounding area, as well as from the Johnston County Osteoarthritis Project, a community-based observational study of non-institutionalized White and Black residents from rural communities within Johnston County, North Carolina[8]. Symptomatic knee OA was defined as a diagnosis of OA at the knee, along with the presence of symptoms at the knee. Knee OA diagnosis was identified based on previous radiographs from the Johnston County Study, medical records from UNC Healthcare system database, and self-reported assessment based on the American College of Rheumatology criteria. Symptoms were defined as the presence of pain, aching, or stiffness in one or both knees on most days of the week. Racial identity was obtained via self-report (or medical record if self-report was not available) and expressed as a dichotomous variable (Black/White). Individuals who did not identify as Black or White were excluded from the analysis because there were very few participants (N=28) in other racial groups in the study. This study was approved by the Institutional Review Boards of the University of North Carolina School of Medicine and Duke University Medical Center. All participants provided a written informed consent prior to data collection. Data for these analyses were assessed at baseline, prior to randomization or taking part in any study intervention.

Performance-based function assessments

Timed-Up-and-Go (TUG): Participants were asked to rise from a chair, walk a distance of 3m, turn around, walk back to the chair, and sit down; time to complete this task was

recorded in seconds. TUG is a common measurement of mobility in elderly populations, has a high test-retest reliability ($ICC_{2,1}$ = 0.95–0.97) and has been validated for function (r = −0.78), gait speed (r = −0.61), and balance (r = −0.81) in a study population with an age range of 60–90 years old [19],with a standard measurement error of 1.07 seconds in people with end-stage hip and knee OA[20].

2-Minute Step Test (2MST): Standing next to a wall, participants were instructed to lift each leg, bending at the knee, to a height at least half the distance between the patella than the iliac crest, stepping in place as many times as possible within a 2-minute time period. The 2MST was developed as an aerobic endurance test to be used as an alternative to tests like the 6MW when space is prohibitive[21]. It has a moderate correlation with treadmill performance (R = 0.74)[22].

30-Second Chair Stand Test (30s-CST): From a seated position in a chair of standard height, participants rose to a full standing position and returned to a seated position as many times as possible within a 30-second time period. The 30s-CST was developed for and is commonly used in populations over 60 years of age to assess lower body strength [23]. It has a high test-retest reliability (R = 0.89) and a moderate correlation with leg-press performance (R = 0.77)[23].

Covariates

Because age[24], sex[24], BMI[24], physical activity[25], pain[24], physical health[26], depression[27], fear of movement[28], education[29], employment[30], financial status[29], and marital status[31] are associated with OA development, the following variables were selected as covariates.

Demographic characteristics

Age (years), sex (man/woman), and marital status (married or living with partner vs. single, separated, divorced, or widowed) were self-reported.

Socioeconomic characteristics

These self-reported variables included education (less than bachelor’s degree vs. bachelor’s degree or post-graduate work), household financial status (just enough to or cannot meet basic expenses vs. meeting basic expenses with extra money available), and employment status (working or student vs. retired, unemployed, or disabled)

Psychological health

Patient Health Questionnaire-8 (PHQ-8): PHQ-8 was developed from the Primary Care Evaluation of Mental Disorders (PRIME-MD) questionnaire, a depressive symptoms assessment tool. The questionnaire consists of 8-items rated on a scale of 0 (not at all) to 3 (nearly every day) with a total overall score ranging from 0 (no significant depressive symptoms) to 24 (severe depressive symptoms). A score of 10 or greater suggests clinically significant depression[32].

Brief Fear of Movement Scale (BFMS): The BFMS, derived from the Tampa Scale for Kinesiophobia for use in an OA population[33], is a 6-item survey rated on a scale of 1 (strongly agree) to 4 (strongly disagree) with a total overall score ranging from 6 to 24. Higher scores correspond to greater fear of movement.

Physical health

Body mass index (BMI): BMI was calculated as weight/(height^2). Height was measured using a calibrated stadiometer, and weight was measured using a balance-beam scale. Both measures were taken without shoes for analyses.

Physical Activity Scale for the Elderly (PASE): The PASE questionnaire was developed and has been validated to assess physical activity in older adults[34]. Participants reported their activity within a 1-week period. Scores were calculated summing the product of the participation (yes/no) or duration (hours/week) of each activity by a derived weight for each item[34]. Higher scores indicate greater levels of physical activity.

Western Ontario and McMasters Universities Osteoarthritis Index (WOMAC) pain score: Participants completed the WOMAC questionnaire which measures self-reported lower extremity pain, stiffness and functional ability and has been commonly used in elderly and OA populations[35]. Self-reported pain was assessed via a 5-item subscale, was rated from 0 (no symptoms) to 4 (extreme symptoms) and summed with an overall score ranging from 0 to 20.

Self-reported health: Physical health status was assessed via questionnaire consisting of one question: *"How do you rate your current health?"* Health was reported as "excellent", "very good", "good", "fair" or "poor". Responses were then dichotomized for analyses (fair or poor vs. excellent, very good, or good).

Statistical analysis:

Descriptive statistics were calculated for participant demographic characteristics and other items inquiring about self-reported health and physical activity using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Racial group differences were determined via t-test (continuous variables) or chi-squared test (categorical variables), as appropriate. Functional measures were categorized into respective three-level ordinal variables based upon quartiles for 2MST, 30s-CST and TUG, grouped as lowest, two middle and upper quartiles to better assess the extremes of physical function outcomes (worst to best). Higher scores for 2MST and 30s-CST and lower TUG scores corresponded to better function. For the ordinal 2MST, 30s-CST, and TUG response variables, we fitted proportional odds logistic regression models. First, we examined the bivariate association of race with each functional outcome. Next, for each functional outcome, four multivariable models were developed by adding the variables in separate blocks: 1) Demographic (age, gender, and marital status), 2) Socioeconomic (education, household financial state, and employment status), 3) Psychological health (PHQ-8 and BFMS), and 4) Physical health (BMI, PASE, WOMAC pain subscale, and self-reported health). Finally, we included all terms as independent variables in "full"

multivariable models. We used odds ratios as measures of association between race and each functional outcome, and 95% CI's were used to express the variation around the odds ratios. All statistical analyses were conducted using SAS System Software 9.4 (SAS Institute, Inc., Cary, NC).

Results

Sample demographics

Among 415 individuals eligible for participation, 350 enrolled in the PATH-IN study; 28 were not included in this secondary analysis because they did not self-identify as either Black or White (Figure 1). Of the remaining 322 participants in these analyses, 72% were women, 21.7% were Black, the mean age was 66 ± 10.8 years old, and the mean BMI was 31.4 ± 8 kg/m^2 (Table 1). Compared to White participants, Black participants were younger, less likely to be partnered, and were more likely to be women. Black participants reported more pain and fear of movement, poorer health, and had greater BMI (with Black participants ranging from normal to obese-class III[36,37], as compared to Whites, who ranged from mildly underweight to obese-class III[36,37]). Black participants were also less likely to have a college degree or a high financial status. There were no significant differences between racial groups in occupational status, depressive symptoms, or physical activity. Compared to White participants, Black participants had worse 30s-CST (10 ± 4 steps vs 8 ± 3 steps), worse 2MST (55 ± 27 steps vs 43 ± 30 steps), and worse TUG scores (11.1 ± 3.4s vs 13.9 ± 5.3s) (Supplemental Table). All participants were comparable to normative 30s-CST and 2MST functional data, however, all participants had lower TUG scores compared to normative data.

Associations of participant characteristics with 30-Second Chair Stand

We tested whether the proportional odds assumption was valid; in all models, the test was not significant ($p>0.07$), indicating that this assumption is reasonable. Compared to White participants, in bivariate analyses, Black participants 30s-CST performance was poorer (Table 2; OR = 2.79, 95% CI = 1.65–4.72). This difference was maintained when adjusted for demographics (Table 2, Model 1: age, gender, and marital status; OR = 2.46, 95% CI = 1.39–4.36) and when adjusted for psychological health (Table 2, Model 3: depressive symptoms and fear of movement; OR = 2.51, 95% CI = 1.47–4.28).

However, this racial difference for 30s-CST was no longer statistically significant when adjusted for socioeconomic status (Table 2, Model 2: education, financial status, and employment status; OR = 1.73, 95% CI = 0.97–3.09), nor when adjusted for physical health measures (Table 2, Model 4: physical activity, pain, self-reported health, and BMI; OR = 1.78, 95% CI = 0.99–3.20). Similarly, in the full model adjusting for all covariates, there was no racial difference in 30s-CST performance (Table 2, Model 5; OR = 1.28, 95% CI = 0.67–2.47).

Associations of participant characteristics with 2-Minute Step Test

Compared to White participants, in unadjusted analysis, Black participants were more likely to have poorer 2MST performance (Table 3; OR = 2.37, 95% CI = 1.40–4.03). This

difference was maintained after adjusting for demographic (Table 3, Model 1; OR = 2.24, 95% CI = 1.25–4.02) and psychological health (Table 3, Model 3; OR = 2.23, 95% CI = 1.30–3.81) covariates.

The poorer performance of Black participants on 2MST was no longer present after adjusting for socioeconomic (Table 3, Model 2; OR = 1.17, 95% CI = 0.65–2.11) or physical health covariates (Table 3, Model 4; OR = 1.12, 95% CI = 0.61–2.06).

In the full multivariate model (Table 3, Model 5), after adjusting for all covariates, there was an inverse relationship between Black participants and 2MST, though it was not statistically significant (OR = 0.71, 95% CI = 0.35–1.44).

Associations of participant characteristics with Timed-Up-and-Go

Compared to White participants, in the unadjusted model, Black participants had a higher odds of having poorer TUG performance (Table 4; OR = 3.71, 95% CI = 2.16–6.36). This difference was maintained in each of the demographic (Table 4, Model 1; OR = 3.74, 95% CI = 2.07–6.77), socioeconomic (Table 4, Model 2; OR = 2.24, 95% CI = 1.24–4.06), psychological health (Table 4, Model 3; OR = 3.47, 95% CI = 2.00–6.03), and physical health models (Table 4, Model 4; OR = 2.01, 95% CI = 1.09–3.73).

In the full multivariate model (Table 4, Model 5), after adjusting for all covariates, Black participants continued to have poorer TUG performance as compared to White participants, though no longer statistically significant (OR = 1.76, 95% CI = 0.88–3.55).

Discussion

Black participants had worse unadjusted performance-based functional outcomes compared to White participants. Specifically, they had more than twice the odds of having poor 30s-CST and 2MST outcomes and nearly 70% greater odds of poor TUG outcomes. Racial differences in functional tests were attenuated but remained significant in models adjusted for demographic and psychological health covariates, but racial differences were no longer statistically significant in models accounting for socioeconomic and physical health covariates. Additionally, racial differences did not maintain statistical significance when adjusting for all four covariate groups in the full models. Although prior studies have examined racial differences in performance-based measures in a knee OA population, the current study adds to the previous literature by including additional psychological health factors.

Racial differences in 30s-CST and 2MST outcomes were no longer significant when considering socioeconomic factors, reiterating the relationship between social status with health status and chronic disease that has been documented in prior studies, and is thought to be a primary mediator in health disparities[38,39]. Compared to White participants, a smaller proportion of Black participants in the current study reported having collegiate education or having extra money left over after paying basic expenses, which is consistent with previous studies reporting lower educational levels and lower financial status in Black participants compared to White participants [40,41]. However, few have examined the

relationships among race, socioeconomic status, and function. One such study reported significantly lower performance-based function in Black participants compared to non-Hispanic White participants, even after adjusting for age, BMI, income, education, and study site [42]. However, an earlier study[38] reported a link between race and poor function related to chronic disease and found that socioeconomic factors explained nearly all of the differences in functional ability between Whites, Blacks, and Hispanics. The authors suggested that while the exact mechanism underlying the relationship between socioeconomic factors and health outcomes remains unclear, in some cases chronic disease outcomes may reflect the summation of past behaviors and experiences that were shaped by socioeconomic status, which also have the potential to affect future disease progression and need for surgery. In another study, patients with lower socioeconomic status at the time of total knee arthroplasty had worse self-reported function and higher pain scores than those who had higher socioeconomic status[43], illustrating the potential influence of socioeconomics on disease progression and need for surgical intervention. Though our study did not consider health behavior or health care quality or access in our analysis, results may reflect the impact of socioeconomic influences on such factors, which can affect disease progression and functional limitations. Additionally, because our data provide just a snapshot of current socioeconomic status, we cannot interpret our results as an indicator of long-term social status related to chronic disease. The direction of the relationship between socioeconomic status and development of OA cannot be determined.

Racial differences in 30s-CST and 2MST were significantly mitigated by accounting for physical health factors, including pain, BMI, and physical activity, all of which have been documented in previous studies as contributing to poor function and are possible sources of racial disparities. For the overall cohort in the present study, every 1-unit increase in pain led to a 10–18% greater odds of poor performance. Pain levels were greater for Black participants, which is consistent with prior studies[13,42]. While the relationship between worsening pain and progressive dysfunction is inconclusive[44,45], Black participants may still benefit from earlier screening, diagnosis, and treatment of OA-related pain to help prevent or decelerate future functional disability. The relationship between poor health and functional ability in this sample was highlighted by the association of poorer function with higher BMI. Obesity was more common in Black participants than White participants in this study, as indicated by differences in mean BMI and BMI classes by race. Previous studies have shown that obesity is a known comorbidity of OA[46], is a risk factor for knee OA development and progression[24], and is associated with limited functional ability[47]. Weight loss interventions specifically targeting groups susceptible to obesity, like Black individuals, could be helpful in reducing the odds of functional limitations in a knee OA population. In the present study, poorer functional ability was associated with less physical activity. Higher levels of physical activity have been shown to be associated with better functional ability[48], yet Black people tend to report less physical activity than White people[49]. In a 2005 study, Black people with knee OA had worse 6-minute walk times compared to their White counterparts. However after an 18 month exercise intervention, statistically significant differences were no longer present[50]. Therefore, interventions that reduce body weight and increase physical activity without increasing pain may be ideal for Black participants with knee OA to maintain or improve functional ability.

Interestingly, significant racial differences in TUG performance were only slightly attenuated when adjusting for socioeconomic and physical health differences and significant racial differences in TUG remained despite adjusting for demographic and psychological health. Such variations in results may be indicative of inherent differences in each functional test. Unlike the 30s-CST, which assesses lower body [23], and the 2MST, which assesses endurance[21], TUG assesses mobility with short-distance walking and turning, which may involve more complex movement and balance. It is possible that other variables may have a stronger association with walking tasks than the covariates included in the present study. Considering that on average, participants had worse TUG scores than normative data, it is possible that these results reflect an inability of the TUG to discriminate between differences in function beyond a certain level of capability or variability [20].

Racial differences in performance were independent of demographic and psychological health variables included in multivariable models. These results were unexpected since individually, many of these covariates are known risk factors for poor function and OA. It is possible that such relationships, particularly psychological health, may be more evident in self-reported, rather than performance-based, function. For example, in a previous study exploring the relationship between race and self-reported function, among those with knee OA, this relationship (after adjusting for age, gender, education, and OA severity) was no longer significant with the addition of depressive symptoms and BMI; depressive symptoms were also associated with worse self-reported function [13]. Therefore, self-reported physical function and depression symptoms may capture similar health domains that are distinct from performance-based measures of physical function.

There are several limitations in this study. The study sample was selected from individuals within one clinical trial, thus limiting the generalizability of our results. We did not conduct de novo radiographs and therefore could not control for objective OA severity. Instead of utilizing objective measures of physical activity, we used self-report, requiring respondents to recall activity over the last 7 days, which may introduce measurement error. Furthermore, because the PASE scale combines information on various domains and dimensions of physical activity, it is impossible to identify specific aspects of physical activity that most relate to function and OA. We also acknowledge there are other variables that may be important factors in explaining racial differences in function that were not collected in this study, including history of joint injury, self-efficacy, pain coping, and more detailed measures of socioeconomic status. Future studies should examine longitudinal relationships between race and function in an OA population. In addition, there should be an examination of the underlying mechanisms behind the relationships among socioeconomics, race, and function, and among physical health, race, and function. Further work is needed to identify additional factors that may contribute to the relationship between race and function in an OA population.

In conclusion, the results of this study showed that racial differences in performance-based function persisted even when controlling for certain demographic and psychological factors. However, some were mitigated when adjusting for physical health or socioeconomic factors. These results highlight potential opportunities for the development of population-specific interventions since some of these factors are modifiable and clinically relevant, particularly

physical activity and BMI. Further defining the role socioeconomic factors play in limiting functional ability is a key next step for designing interventions to improve health across a wide range of educational and financial levels.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Financial Support: This study was funded by the Patient-Centered Outcomes Research Institute (CER-1306–02043) All statements, including its findings and conclusions, are solely those of the authors and do not necessarily represent the views of the Patient-Centered Outcomes Research Institute (PCORI), its Board of Governors or Methodology Committee.

References

1. Brault MW, Hootman J, Helmick CG, Theis KA, Armour BS. Prevalence and most common causes of disability among adults--United States, 2005. MMWR Morb Mortal Wkly Rep 2009;58:421–426. [PubMed: 19407734]
2. Murray CJL, Abraham J, Ali MK, Alvarado M, Atkinson C, Baddour LM, Bartels DH, Benjamin EJ, Bhalla K, Birbeck G, et al. The State of US Health, 1990–2010. JAMA 2013;310:591. [PubMed: 23842577]
3. Murphy L, Schwartz TA, Helmick CG, Renner JB, Tudor G, Koch G, Dragomir A, Kalsbeek WD, Luta G, Jordan JM. Lifetime risk of symptomatic knee osteoarthritis. Arthritis Rheum 2008;59:1207–1213. [PubMed: 18759314]
4. Hurley MV, Scott DL, Rees J, Newham DJ. Sensorimotor changes and functional performance in patients with knee osteoarthritis. Ann Rheum Dis 1997;56:641–8. [PubMed: 9462165]
5. McAlindon TE, Cooper C, Kirwan JR, Dieppe PA. Determinants of disability in osteoarthritis of the knee. Ann Rheum Dis 1993;52:258–62. [PubMed: 8484690]
6. Miller GD, Nicklas BJ, Davis C, Loeser RF, Lenchik L, Messier SP. Intensive Weight Loss Program Improves Physical Function in Older Obese Adults with Knee Osteoarthritis*. Obesity 2006;14:1219–1230. [PubMed: 16899803]
7. Lohmander LS, Östenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. Arthritis Rheum 2004;50:3145–3152. [PubMed: 15476248]
8. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, Fang F, Schwartz TA, Abbate LM, Callahan LF, et al. Prevalence of knee symptoms and radiographic and symptomatic knee osteoarthritis in African Americans and Caucasians: the Johnston County Osteoarthritis Project. J Rheumatol 2007;34:172–180. [PubMed: 17216685]
9. Nelson AE, Renner JB, Schwartz TA, Kraus VB, Helmick CG, Jordan JM. Differences in multijoint radiographic osteoarthritis phenotypes among African Americans and Caucasians: The Johnston County Osteoarthritis Project. Arthritis Rheumatol 2011;63:3843–3852.
10. Kopec JA, Sayre EC, Schwartz TA, Renner JB, Helmick CG, Badley EM, Cibere J, Callahan LF, Jordan JM. Occurrence of Radiographic Osteoarthritis of the Knee and Hip Among African Americans and Whites: A Population-Based Prospective Cohort Study. Arthritis Care Res (Hoboken) 2013;65:928–935. [PubMed: 23281251]
11. Braga L, Renner JB, Schwartz TA, Woodard J, Helmick CG, Hochberg MC, Jordan JM. Differences in radiographic features of knee osteoarthritis in African-Americans and Caucasians: the Johnston County Osteoarthritis Project. Osteoarthr Cartil 2009;17:1554–1561. [PubMed: 19735758]
12. Golightly YM, Dominick KL. Racial variations in self-reported osteoarthritis symptom severity among veterans. Aging Clin Exp Res 2005;17:264–269. [PubMed: 16285190]

13. Allen KD, Helmick CG, Schwartz TA, DeVellis RF, Renner JB, Jordan JM. Racial differences in self-reported pain and function among individuals with radiographic hip and knee osteoarthritis: the Johnston County Osteoarthritis Project. Osteoarthr Cartil 2009;17:1132–1136. [PubMed: 19327733]
14. Allen KD, Oddone EZ, Coffman CJ, Keefe FJ, Lindquist JH, Bosworth HB. Racial differences in osteoarthritis pain and function: potential explanatory factors. Osteoarthr Cartil 2010;18:160–167. [PubMed: 19825498]
15. Burns R, Graney MJ, Lummus AC, Nichols LO, Martindale-Adams J. Differences of self-reported osteoarthritis disability and race. J Natl Med Assoc 2007;99:1046–51. [PubMed: 17913116]
16. Stratford PW, Kennedy DM. Performance measures were necessary to obtain a complete picture of osteoarthritic patients. J Clin Epidemiol 2006;59:160–167. [PubMed: 16426951]
17. Maly MR, Costigan PA, Olney SJ. Determinants of Self-Report Outcome Measures in People With Knee Osteoarthritis. Arch Phys Med Rehabil 2006;87:96–104. [PubMed: 16401446]
18. Williams QI, Gunn AH, Beaulieu JE, Benas BC, Buley B, Callahan LF, Cantrell J, Genova AP, Golightly YM, Goode AP, et al. Physical therapy vs. internet-based exercise training (PATH-IN) for patients with knee osteoarthritis: study protocol of a randomized controlled trial. BMC Musculoskelet Disord 2015;16:264. [PubMed: 26416025]
19. Podsiadlo D, Richardson S. The Timed “Up & Go”: A Test of Basic Functional Mobility for Frail Elderly Persons. J Am Geriatr Soc 1991;39:142–148. [PubMed: 1991946]
20. Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. BMC Musculoskelet Disord 2005;6:3. [PubMed: 15679884]
21. Rikli RE, Jones CJ. Development and Validation of a Functional Fitness Test for Community-Residing Older Adults. J Aging Phys Act 1999;7:129–161.
22. Johnston J The Validation of a 2-Minute Step Test in Older Adults 1999.
23. Jones CJ, Rikli RE, Beam WC. A 30-s Chair-Stand Test as a Measure of Lower Body Strength in Community-Residing Older Adults. Res Q Exerc Sport 1999;70:113–119. [PubMed: 10380242]
24. Arden N, Nevitt MC. Osteoarthritis: Epidemiology. Best Pract Res Clin Rheumatol 2006;20:3–25. [PubMed: 16483904]
25. Vuori IM. Dose-response of physical activity and low back pain, osteoarthritis, and osteoporosis. Med Sci Sports Exerc 2001;33:S551–S586. [PubMed: 11427782]
26. Dominick KL, Ahern FM, Gold CH, Heller DA. Health-related quality of life among older adults with arthritis. Health Qual Life Outcomes 2004;2:5. [PubMed: 14720300]
27. Rosemann T, Backenstrass M, Joest K, Rosemann A, Szecsenyi J, Laux G. Predictors of depression in a sample of 1,021 primary care patients with osteoarthritis. Arthritis Rheum 2007;57:415–422. [PubMed: 17394226]
28. Heuts PHT., Vlaeyen JW, Roelofs J, de Bie RA, Aretz K, van Weel C, van Schayck OC. Pain-related fear and daily functioning in patients with osteoarthritis. Pain 2004;110:228–235. [PubMed: 15275772]
29. Callahan LF, Cleveland RJ, Shreffler J, Schwartz TA, Schoster B, Randolph R, Renner JB, Jordan JM. Associations of educational attainment, occupation and community poverty with knee osteoarthritis in the Johnston County (North Carolina) osteoarthritis project. Arthritis Res Ther 2011;13:R169. [PubMed: 22011570]
30. Rossignol M Primary osteoarthritis and occupation in the Quebec national health and social survey. Occup Environ Med 2004;61:729–35. [PubMed: 15317912]
31. Verbrugge LM, Gates DM, Ike RW. Risk factors for disability among U.S. adults with arthritis. J Clin Epidemiol 1991;44:167–182. [PubMed: 1825325]
32. Kroenke K, Strine TW, Spitzer RL, Williams JBW, Berry JT, Mokdad AH. The PHQ-8 as a measure of current depression in the general population. J Affect Disord 2009;114:163–73. [PubMed: 18752852]
33. Shelby RA, Somers TJ, Keefe FJ, DeVellis BM, Patterson C, Renner JB, Jordan JM. Brief fear of movement scale for osteoarthritis. Arthritis Care Res (Hoboken) 2012;64:862–871. [PubMed: 22290689]

34. Washburn RA, McAuley E, Katula J, Mihalko SL, Boileau RA. The Physical Activity Scale for the Elderly (PASE): Evidence for Validity. J Clin Epidemiol 1999;52:643–651. [PubMed: 10391658]
35. Bellamy N, Buchanan W, Goldsmith C, Campbell J, Stitt L. Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. J Orthop Rheumatol 1988;1:95–108.
36. WHO EC. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363:157–163. [PubMed: 14726171]
37. Anon. Executive Summary. Obes Res 1998;6:51S–179S. [PubMed: 9813653]
38. Kington RS, Smith JP. Socioeconomic status and racial and ethnic differences in functional status associated with chronic diseases. Am J Public Health 1997;87:805–10. [PubMed: 9184510]
39. Hirata S, Ono R, Yamada M, Takikawa S, Nishiyama T, Hasuda K, Kurosaka M. Ambulatory physical activity, disease severity, and employment status in adult women with osteoarthritis of the hip. J Rheumatol 2006;33.
40. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, Posner S. Socioeconomic Status in Health Research. JAMA 2005;294:2879. [PubMed: 16352796]
41. Williams DR, Mohammed SA, Leavell J, Collins C. Race, socioeconomic status, and health: Complexities, ongoing challenges, and research opportunities. Ann N Y Acad Sci 2010;1186:69–101. [PubMed: 20201869]
42. Cruz-Almeida Y, Sibille KT, Goodin BR, Petrov ME, Bartley EJ, Riley JL, King CD, Glover TL, Sotolongo A, Herbert MS, et al. Racial and Ethnic Differences in Older Adults With Knee Osteoarthritis. Arthritis Rheumatol 2014;66:1800–1810. [PubMed: 24729357]
43. Feldman CH, Dong Y, Katz JN, Donnell-Fink LA, Losina E. Association between socioeconomic status and pain, function and pain catastrophizing at presentation for total knee arthroplasty. BMC Musculoskelet Disord 2015;16:18. [PubMed: 25768862]
44. van Dijk GM, Dekker J, Veenhof C, van den Ende CHM. Course of functional status and pain in osteoarthritis of the hip or knee: A systematic review of the literature. Arthritis Rheum 2006;55:779–785. [PubMed: 17013827]
45. de Rooij M, van der Leeden M, Heymans MW, Holla JFM, Häkkinen A, Lems WF, Roorda LD, Veenhof C, Sanchez-Ramirez DC, de Vet HCW, et al. Prognosis of Pain and Physical Functioning in Patients With Knee Osteoarthritis: A Systematic Review and Meta-Analysis. Arthritis Care Res (Hoboken) 2016;68:481–492. [PubMed: 26316234]
46. Burton BT, Foster WR, Hirsch J, Van Itallie TB. Health implications of obesity: an NIH Consensus Development Conference. Int J Obes 1985;9:155–70.
47. Dekker J, van Dijk GM, Veenhof C. Risk factors for functional decline in osteoarthritis of the hip or knee. Curr Opin Rheumatol 2009;21:520–524. [PubMed: 19550331]
48. Dunlop DD, Song J, Semanik PA, Sharma L, Chang RW. Physical activity levels and functional performance in the osteoarthritis initiative: A graded relationship. Arthritis Rheum 2011;63:127–136. [PubMed: 20862681]
49. Barbour KE, Helmick CG, Boring M, Brady TJ. Vital Signs: Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation - United States, 2013–2015. MMWR Morb Mortal Wkly Rep 2017;66:246–253. [PubMed: 28278145]
50. Foy CG, Penninx BWH, Shumaker SA, Messier SP, Pahor M. Long-Term Exercise Therapy Resolves Ethnic Differences in Baseline Health Status in Older Adults with Knee Osteoarthritis. J Am Geriatr Soc 2005;53:1469–1475. [PubMed: 16137274]

Health Research Alliance Author Manuscript

Significance and Innovations

- Prior studies have reported racial differences in self-reported physical function among people with knee osteoarthritis (OA), but differences in performance-based function have not been well studied.
- Black people with knee OA in this study had poorer unadjusted performance-based function than Whites and this difference remained when adjusting for psychological (e.g., depressive symptoms, fear of movement) and demographic factors (age, sex, marital status).
- Adjusting for socioeconomic and physical health factors resulted in either diminished or non-significant associations of race and performance-based function, suggesting these factors may be important to consider in mitigating racial disparities in function.

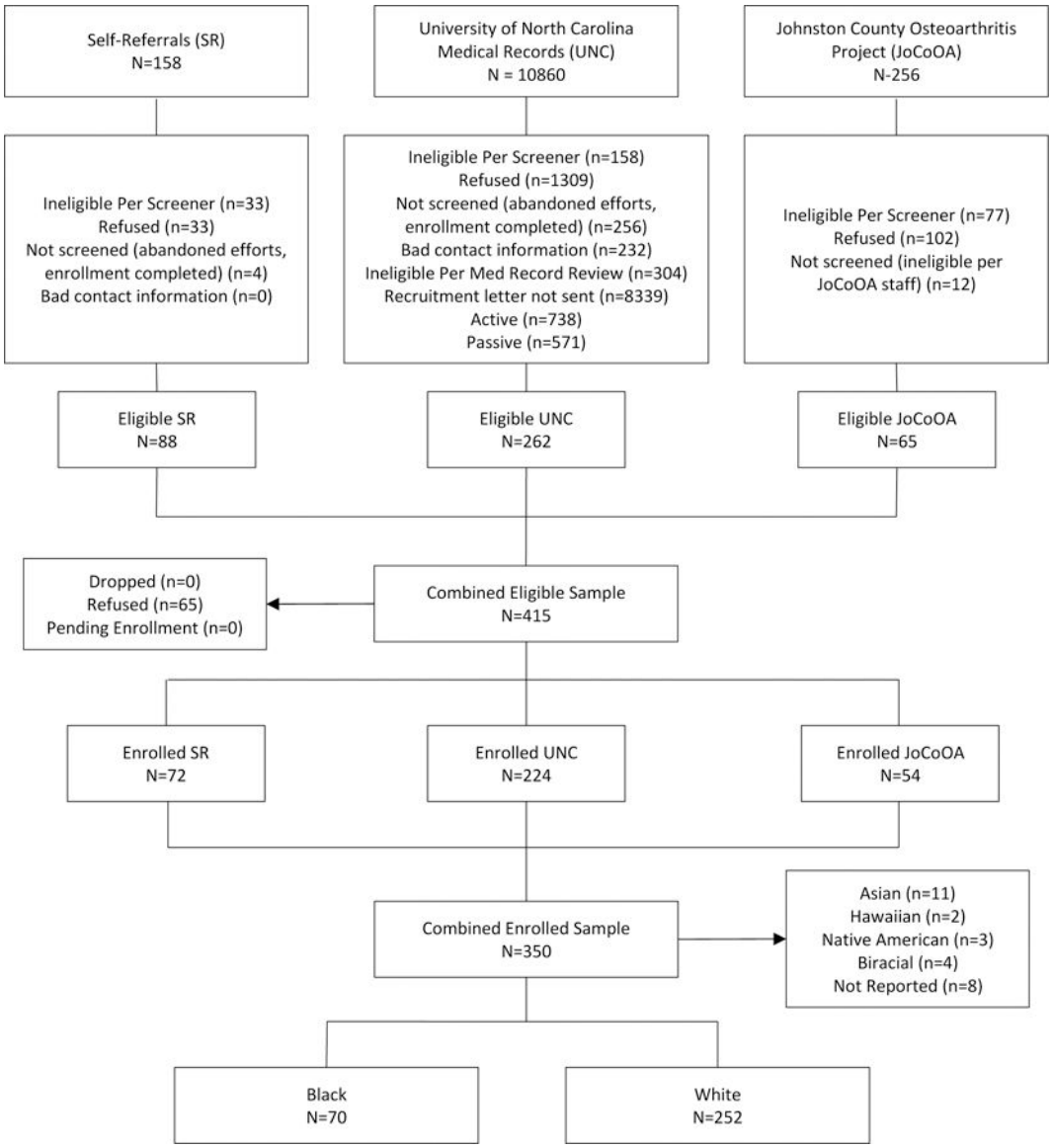

Figure 1 –.
PATH-IN Participants for analysis

Table 1 –

Participant Characteristics

	Total (N = 322)	Black (N = 70, 21.7%)	White (N = 252, 78.3%)	p-value
Age (years), Mean ± SD, *range*	66 ± 10.8, *27.7–90.9*	61.2 ± 12.7, *27.7–80.9*	67.3 ± 9.9, *30.7–90.9*	**<0.001**
Women*, n (%)	232 (72)	62 (88.6)	170 (67.5)	**<0.001**
BMI (kg/m^2), Mean ± SD, *range*	31.4 ± 8, *17.5–65.6*	37.2 ± 9.6, *20.2–65.6*	29.8 ± 6.7, *17.5–52.7*	**<0.001**
Married or living with partner*, n (%)	198 (61.5)	24 (34.3)	174 (69.0)	**<0.001**
Bachelor's degree or Post-graduate work*, n (%)	192 (59.6)	19 (27.1)	173 (68.7)	**<0.001**
Higher financial status*, n (%)	267 (83.2)	41 (59.4)	226 (89.7)	**<0.001**
Working or student*, n (%)	127 (39.4)	26 (37.1)	101 (40.1)	0.657
Depressive symptoms (PHQ-8, range 0–24), Mean ± SD	3.8 ± 4.1	4.5 ± 4.9	3.6 ± 3.9	0.154
Fear of movement (BFMS score, range 6–24), Mean ± SD	13 ± 3.3	13.8 ± 3.8	12.8 ± 3.1	**0.033**
Physical activity (PASE, range 0–400), Mean ± SD	125.3 ± 71.4	112.8 ± 72.1	128.7 ± 71.0	0.109
Pain (WOMAC pain score, range 0–20), Mean ± SD	6 ± 3.7	8.4 ± 4.4	5.4 ± 3.2	**<0.001**
Fair or poor self-reported health, n (%)	43 (13.4)	20 (28.6)	23 (9.1)	**<0.001**

* - Between-group comparisons analyzed using χ^2 tests or t-tests, as appropriate. Bold text indicates statistically significant between-group differences.

PHQ-8= Patient Health Questionnaire-8, BFMS = Brief Fear of Movement Scale, PASE = Physical Activity Scale for the Elderly, WOMAC= Western Ontario and McMasters Universities Osteoarthritis Index

Table 2 –

Associations of race with 30-Second Chair Stand (30s-CST) adjusted for demographics, socioeconomics, psychological health, and physical health

	Unadjusted OR [95% CI]	Model 1 – Demographic OR [95% CI]	Model 2 – Socioeconomic OR [95% CI]	Model 3 – Psychological Health OR [95% CI]	Model 4 – Physical Health OR [95% CI]	Model 5 – Full Multivariable OR [95% CI]
Black race	**2.79 [1.65 – 4.72]**	**2.46 [1.39 – 4.36]**	1.73 [0.97 – 3.09]	**2.51 [1.47 – 4.28]**	1.78 [0.99 – 3.20]	1.28 [0.67 – 2.47]
Age (per 10 years)		1.18 [0.97 – 1.44]				1.22 [0.95 – 1.57]
Female gender		**1.84 [1.13 – 2.99]**				**1.85 [1.10 – 3.11]**
Married or living with partner		**0.62 [0.39 – 0.99]**				0.71 [0.43 – 1.16]
Bachelor's degree or Post-graduate work			**0.54 [0.34 – 0.87]**			0.73 [0.44 – 1.23]
Higher financial status			**0.37 [0.20 – 0.70]**			0.51 [0.26 – 1.02]
Working or student			0.66 [0.43 – 1.02]			0.93 [0.54 – 1.59]
Depressive symptoms (per 1 scale unit)				1.02 [0.96 – 1.08]		0.96 [0.90 – 1.03]
Fear of movement (per 1 scale unit)				**1.15 [1.07 – 1.23]**		**1.14 [1.05 – 1.23]**
Physical activity (per 20 units)					**0.92 [0.86 – 0.98]**	0.96 [0.89 – 1.03]
Pain (per 1 scale unit)					**1.10 [1.02 – 1.17]**	1.04 [0.96 – 1.12]
Fair or poor self-reported health					1.22 [0.60 – 2.47]	1.34 [0.62 – 2.86]
Body mass index (per 5 units)					1.09 [0.93 – 1.27]	1.12 [0.95 – 1.32]

Notes: For all function variables, referent is the lowest quartile of scores. Bold text indicates statistically significant associations. Higher category indicates better function for 30s-CST.

Table 3 –

Associations of race with 2-Minute Step Test (2MST) adjusted for demographics, socioeconomics, psychological health, and physical health

	Unadjusted OR [95% CI]	Model 1 – Demographic OR [95% CI]	Model 2 – Socioeconomic OR [95% CI]	Model 3 – Psychological Health OR [95% CI]	Model 4 – Physical Health OR [95% CI]	Model 5 – Full Multivariable OR [95% CI]
Black race	**2.37 [1.40 – 4.03]**	**2.24 [1.25 – 4.02]**	1.17 [0.65 – 2.11]	**2.23 [1.30 – 3.81]**	1.12 [0.61 – 2.06]	0.71 [0.35 – 1.44]
Age (per 10 years)		**1.64 [1.32 – 2.02]**				**2.24 [1.67 – 3.01]**
Female gender		**2.53 [1.53 – 4.18]**				**3.52 [1.98 – 6.24]**
Married or living with partner		**0.59 [0.37 – 0.95]**				0.71 [0.42 – 1.20]
Bachelor's degree or Post-graduate work			**0.34 [0.21 – 0.56]**			0.58 [0.34 – 1.01]
Higher financial status			**0.37 [0.20 – 0.72]**			**0.45 [0.21 – 0.96]**
Working or student			**0.53 [0.34 – 0.82]**			0.96 [0.54 – 1.70]
Depressive symptoms (per 1 scale unit)				1.05 [0.99 – 1.11]		0.95 [0.89 – 1.02]
Fear of movement (per 1 scale unit)				**1.07 [1.00 – 1.14]**		1.01 [0.93 – 1.09]
Physical activity (per 20 units)					**0.91 [0.85 – 0.97]**	0.99 [0.92 – 1.07]
Pain (per 1 scale unit)					**1.18 [1.10 – 1.27]**	**1.19 [1.09 – 1.30]**
Fair or poor self-reported health					1.50 [0.71 – 3.16]	**2.56 [1.11 – 5.90]**
Body mass index (per 5 units)					**1.26 [1.06 – 1.50]**	**1.52 [1.24 – 1.84]**

Notes: For all function variables, referent is the lowest quartile of scores. Bold text indicates statistically significant associations. Higher category indicates better function for 2MST.

Table 4 –

Associations of race with Timed Up and Go (TUG) adjusted for demographics, socioeconomics, psychological health, and physical health

	Unadjusted OR [95% CI]	Model 1 – Demographic OR [95% CI]	Model 2 – Socioeconomic OR [95% CI]	Model 3 – Psychological Health OR [95% CI]	Model 4 – Physical Health OR [95% CI]	Model 5 – Full Multivariable OR [95% CI]
Black race	**3.71 [2.16 – 6.36]**	**3.74 [2.07 – 6.77]**	**2.24 [1.24 – 4.06]**	**3.47 [2.00 – 6.03]**	**2.01 [1.09 – 3.73]**	1.76 [0.88 – 3.55]
Age (per 10 years)		**1.45 [1.16 – 1.79]**				**1.61 [1.23 – 2.13]**
Female gender		**2.43 [1.47 – 4.02]**				**2.56 [1.47 – 4.46]**
Married or living with partner		0.68 [0.43 – 1.09]				0.84 [0.50 – 1.42]
Bachelor's degree or Post-graduate work			**0.42 [0.26 – 0.69]**			0.63 [0.37 – 1.08]
Higher financial status			**0.44 [0.23 – 0.82]**			0.66 [0.32 – 1.35]
Working or student			**0.52 [0.33 – 0.81]**			1.09 [0.62 – 1.90]
Depressive symptoms (per 1 scale unit)				**1.11 [1.05 – 1.18]**		1.05 [0.98 – 1.13]
Fear of movement (per 1 scale unit)				1.07 [1.00 – 1.15]		1.04 [0.97 – 1.13]
Physical activity (per 20 units)					**0.85 [0.79 – 0.91]**	**0.92 [0.85 – 0.99]**
Pain (per 1 scale unit)					**1.12 [1.04 – 1.20]**	1.07 [0.99 – 1.17]
Fair or poor self-reported health					1.69 [0.79 – 3.62]	2.01 [0.88 – 4.59]
Body mass index (per 5 units)					**1.20 [1.01 – 1.41]**	**1.27 [1.06 – 1.52]**

Notes: For all function variables, referent is the lowest quartile of scores. Bold text indicates statistically significant associations. Higher category indicates better function for TUG.