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Excess Body Weight and 4-Year Function Outcomes: Comparison of African-Americans and Caucasians in the Osteoarthritis Initiative

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Abstract

We evaluated whether African-Americans in the Osteoarthritis Initiative have a greater risk (vs. Caucasians) of poor 4-year function outcome within strata defined by gender, BMI, and waist circumference.

Using WOMAC function, 20 meter walk, and chair stand performance, poor outcome was defined as moving into a worse function group or remaining in the 2 worst groups over 4 years. Logistic regression was used to evaluate the relationship between racial group and outcome within each stratum, adjusting for age, education, and income, and then further adjusting for BMI, comorbidity, depressive symptoms, physical activity, knee pain, and OA severity.

In 3695 persons with or at higher risk for knee OA, higher BMI and large waist circumference were each associated with poor outcome. Among women with high BMI and among women with large waist circumference, African-Americans were at greater risk for poor outcome by every measure, adjusting for age, education, and income. From fully adjusted models, potential explanatory factors included income, comorbidity, depressive symptoms, pain, and disease severity. Findings were less consistent for men, emerging only for the 20 meter walk or chair stand outcomes, and potentially explained by age and knee pain.

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Among OAI women with excess body weight, African-Americans are at greater risk than Caucasians for poor 4-year outcome. Modifiable factors that may help to explain these findings in the OAI include comorbidity, depressive symptoms, and knee pain. Targeting such factors, while supporting weight loss, may help to lessen the outcome disparity between African-American and Caucasian women.

INTRODUCTION

Knee osteoarthritis (OA) is a common condition and a major source of chronic disability. In longitudinal studies of persons with knee OA, factors shown to be associated with greater function decline, a precursor to disability, include greater age, female gender, greater body mass index (BMI), knee pain, comorbid medical conditions, depressive symptoms, decreased knee confidence, varus-valgus laxity, malalignment, greater radiographic disease severity, and proprioceptive inaccuracy; greater physical activity, aerobic exercise, strength, self-efficacy, and social support each have been associated with a reduced risk of function decline (1–12). Given the heterogeneity of the impact of knee OA among individuals, it is important to identify groups who are at higher risk for poor outcome. A better understanding of the underlying differences between risk groups may lead to development of more effective strategies to prevent or delay function decline and subsequent disability.

Elevated body weight is a strong risk factor for incident knee OA and is often present in persons with established knee OA. As recently demonstrated, the prevalence of knee pain and symptomatic knee OA rose substantially between 1974 and 1994, findings partially explained by obesity (13). It has been estimated that 66% of adults in the U.S. are overweight or obese and that, by 2015, this figure will rise to 75% (14). The prevalence of excess body weight differs by gender and race/ethnicity. In 1999–2002, the combined prevalence of overweight and obesity was 77.2% among non-Hispanic black women vs. 57.2% in non-Hispanic white women, with similar estimates for central obesity, 70.4% and 54.0% respectively (14). Losina et al recently demonstrated substantial losses in quality-adjusted life years due to knee OA and obesity; black and Hispanic women had disproportionately high losses (15). The impact of elevated body weight, i.e. above what is considered healthy, within racial groups on more proximal outcomes is not well understood.

We tested the hypothesis that African-Americans have a greater risk (compared to Caucasians) of poor baseline-to-48-month physical function outcome within 4 strata, women with high BMI, women with large waist circumference, men with high BMI, and men with large waist circumference. The Osteoarthritis Initiative (OAI) cohort study, enriched with individuals above a healthy body weight, provided an ideal setting to evaluate this question.

METHODS

Sample

The OAI is a prospective, observational cohort study of men and women, ages 45–79 years, all with or at increased risk to develop symptomatic, radiographic knee OA, who were enrolled at one of four sites: Baltimore, Maryland; Columbus, Ohio; Pittsburgh, Pennsylvania; and Pawtucket, Rhode Island (see http://www.oai.ucsf.edu/datarelease/About.asp). All racial/ethnic groups were eligible to enroll, and the recruitment goal was 23% of the cohort from racial/ethnic minority groups. To be eligible for the progression subcohort of the OAI, persons were required to have symptomatic, radiographic knee OA, defined as the presence of both of the following in at least one native knee at baseline: pain, aching, or stiffness in or around the knee on most days for at least one month during the past 12 months; and a definite tibiofemoral osteophyte [osteophyte grade ≥ 1, using the OARSI

atlas (16)]. Persons were eligible for the incidence subcohort of the OAI if they did not have symptomatic, radiographic knee OA in either knee at baseline, but had characteristics that placed them at increased risk for developing it during the study. Age-specific criteria for determining increased risk were identified from within the following set of established risk factors: knee symptoms in a native knee in the past 12 months; overweight, defined using gender and age-specific cutpoints for weight; knee injury causing difficulty walking for at least a week; history of any knee surgery; family history of a total knee replacement for OA in a biological parent or sibling; Heberden's nodes; repetitive knee bending at work or outside work; age 70–79 years. (See http://www.oai.ucsf.edu/datarelease/About.asp and Appendix B at that site for greater detail regarding the rationale and approach taken to derive the criteria.)

Exclusion criteria were: rheumatoid arthritis or inflammatory arthritis; severe joint space narrowing in both knees on the baseline knee radiograph, or unilateral total knee replacement and severe joint space narrowing in the other knee; bilateral total knee replacement or plans to have bilateral knee replacement in the next 3 years; inability to undergo a 3.0T MRI exam of the knee because of contraindications or inability to fit in the scanner or in the knee coil (including men over 285 lbs and women over 250 lbs); positive pregnancy test; inability to provide a blood sample for any reason; use of ambulatory aides other than a single straight cane for more than 50% of the time in ambulation; comorbid conditions that might interfere with the ability to participate in a 4-year study; current participation in a double-blind randomized trial.

Assessment of Body Weight, Height and Waist Circumference

Body weight was measured in the OAI using a standard balance beam scale, with the participant in lightweight clothes, without shoes or heavy jewelry, and with pockets emptied, and following a detailed protocol, which may be found at: http://oai.epi-ucsf.org/datarelease/operationsManuals/WeightV1_0p.pdf

Height was measured using a wall mounted stadiometer, with the participant barefoot or wearing thin stockings or socks, following a detailed protocol: http://oai.epi-ucsf.org/datarelease/operationsManuals/HeightV1_0p.pdf

BMI was calculated as the weight in kg divided by the height in meters squared. In analysis, BMI was categorized as high (above what is considered healthy) when ≥ 25.0 kg/m^2. Waist circumference is an indicator of subcutaneous and deep adipose tissue, has been used to define central obesity, is well understood by the general public, and may better predict health outcomes (14). In the OAI, waist circumference was measured using a flexible, inelastic fiberglass tape following a detailed protocol: http://oai.epi-ucsf.org/datarelease/operationsManuals/Abdominal_circumferenceV1_0p.pdf

Waist circumference was classified as large when > 102 cm in men and > 88 cm in women (17).

Assessment of Baseline-to-4-Year Physical Function Outcome

Physical function was assessed at baseline and at 48 months using: 1) the WOMAC physical function scale; 2) 20 meter walk performance; and 3) chair-stand performance. To characterize the baseline to 4-year function experience of each participant, quintile grids were used, with *poor outcome* defined as remaining within the same low functioning group (the two worst quintile groups) or moving into a worse function quintile group (6,11,18).

The WOMAC is a self-report instrument with 17 questions comprising the physical function scale. It is extensively validated and widely recommended and used in studies of individuals

with knee OA (19,20). A higher score indicates worse function. Participants were categorized by WOMAC function score quintile derived from the OAI cohort at baseline, ranging from worst to best function, as follows: first quintile (> 20.19); second quintile (> 10.00 and ≤ 20.19); third quintile (> 3.40 and ≤ 10.00); fourth quintile (> 0 and ≤ 3.40); and fifth quintile (0). The WOMAC outcome grid is shown in Table 1, with shaded squares representing a poor baseline-to-4-year WOMAC function outcome.

The 20 meter walk was evaluated as a rate (meters per minute). Participants were categorized by baseline walk rate quintile, ranging from worst to best function, as follows: first quintile (≤ 68.65, or unable); second quintile (> 68.65 and ≤ 76.09); third quintile (> 76.09 and ≤ 82.48); fourth quintile (> 82.48 and ≤ 89.55); and fifth quintile (> 89.55). Chair stand test performance, i.e. time required for five repetitions of rising from a chair and sitting down (21), was evaluated as a rate (number of stands per minute calculated from the time required to complete 5 stands). Participants were categorized by baseline chair stand rate quintile, ranging from worst to best function, as follows: first quintile (≤ 21.60, or unable); second quintile (> 21.60 and ≤ 26.40); third quintile (> 26.40 and ≤ 30.60); fourth quintile (> 30.60 and ≤ 36.60); and fifth quintile (> 36.60).

Assessment of Covariates

Education was assessed as response to “What is the highest grade or year of school that you completed?”, with possible responses: less than high school graduate, high school graduate, some college, college graduate, some graduate school, and graduate degree. Income was queried as personal family annual income of: less than $10,000; $10,000 to < $25,000; $25,000 to < $50,000; $50,000 to < $100,000; and $100,000 or greater. Medical comorbidity was assessed using a questionnaire version of the Charlson Index (22). Depression was assessed using the Center for Epidemiologic Studies Depression Scale (CESD) (23). Physical activity was assessed using the Physical Activity Scale for the Elderly (PASE) (24). Pain was assessed using the WOMAC pain scale, adapted by the OAI to score pain separately for each knee; data from the worse knee were used in analysis. To assess OA radiographic disease severity within each tibiofemoral compartment, joint space was graded (0–3) in the medial and lateral compartments separately using the OARSI atlas (16). Bilateral isometric knee extensor strength was measured using the Good Strength isometric strength chair at a knee angle of 60° from full extension (Metitur, Jyvaskyla, Finland) (25,26). Details of this protocol may be found at http://oai.epi-ucsf.org/datarelease/operationsManuals/isometric_strengthv1_2p.pdf

Statistical Analyses

Our analyses utilized the OAI public data release (clinical data V0.2.2 and V6.2.1 and x-ray data V0.5). All analyses were at the level of the person. Baseline characteristics are summarized using percentages for categorical variables and means ± standard deviations (SDs) for continuous variables, overall and stratified by BMI, waist circumference, race, and gender. Descriptive statistics for outcomes are presented as percentages of persons with poor baseline-to-48-month function outcome for each of the physical function measures. As described above, poor baseline-to-48-month function outcome was defined as moving into a worse function group or remaining within the two lowest functioning groups.

To evaluate the hypothesis, the relationship between racial group and outcome was examined within each of 4 strata: women with high BMI; women with large waist circumference; men with high BMI; and men with large waist circumference. Using multiple logistic regression, unadjusted and adjusted odds ratios (ORs) and associated 95% confidence intervals (CIs) were calculated from a sequence of three nested models (based on prespecified groups of covariates), with covariates entered as follows: first, African-

American vs. Caucasian (reference) race (unadjusted OR); second, race (African-American vs. Caucasian), plus age, education, and income simultaneously in the model; and third, previously listed variables plus BMI, comorbidity, depressive symptoms, physical activity, knee pain (worse score of two knees), and radiographic disease severity (worse of two knees). The socioeconomic factors are standard factors recognized to influence outcome in models evaluating race/ethnicity. Since these factors are not (or have limited ability to be) modifiable in older adults, it is informative to understand their influence separate from health related factors. Health-related covariates were identified *a priori* as factors that may vary across the racial groups and potentially explain an association between racial group and outcome in the OAI population. Covariates were continuous except for race and depressive symptoms which were categorized high (CESD score ≥ 16) or low.

The 95% CIs that exclude 1 indicate statistically significant associations with the outcome, based on the pre-determined nominal 5% significance level for testing. Analyses were performed using SAS software version 9.2 (SAS Institute Inc., Cary, NC). Additional sensitivity analyses further adjusted for extensor strength and excluded 1) Hispanic participants to confirm that results held in a non-Hispanic African-American sample, and 2) persons who underwent total knee replacement during the study, a potential confounding factor.

RESULTS

Of 4796 OAI participants, we excluded participants who had a knee replacement or did not belong to either the progression or incidence cohorts (n = 185), were without baseline BMI or baseline and 48-month WOMAC data (n = 587), were without baseline covariate data (n = 244). Of this group, we further excluded those who were neither African-American nor Caucasian (n = 85), leaving 3695 persons in the WOMAC outcome analysis sample. An additional 357 and 409 persons were missing 48-month chair stand and 20 meter walk time performance data respectively, yielding 3338 persons in the chair stand outcome analysis sample and 3286 in the 20 meter walk outcome analysis sample.

Characteristics of the overall WOMAC outcome analysis sample (16.1% African-American) and strata based on BMI, race, and gender are shown in Table 2. Table 3 shows sample characteristics for strata based on waist circumference, race, and gender. The frequency of poor outcome by each function measure for the overall sample and within strata is shown in Table 4. In comparison with the overall sample, persons who were not included due to missing baseline or follow-up data were similar in age [mean 61.0 years ± 9.5 (SD)], BMI (mean 29.5 kg/m^2 ± 5.2), waist circumference (mean 103.2 cm ± 13.3), and disease severity (maximal joint space grade 0, 1, 2, and 3 of 41.5%, 27.6%, 24.0%, and 6.9%), but were on average less active (mean 147 ± 86.6), reported more pain (mean 4.8 ± 4.3), and had a higher frequency of African-Americans (33.1%), college graduates (43.7%), income exceeding $50,000 (46.5%), comorbidity (34.1%), and depressive symptoms (16.0%).

In the full analysis sample (n = 3695 for WOMAC outcome), high BMI (vs. BMI < 25 kg/m^2 as reference) was associated with an increased risk of poor WOMAC outcome by 48 months, adjusting for age, race, gender, education, income, comorbidity, depressive symptoms, physical activity, knee pain, and disease severity [adjusted OR 1.27, 95% CI (1.06, 1.52)]. This was also the case when BMI was evaluated as a continuous variable [adjusted OR 1.04/1 kg/m^2, 95% CI (1.02, 1.06)]. Results were similar: with the 20 meter walk outcome for high BMI [adjusted OR 1.57, 95% CI (1.30, 1.90)] and for BMI as a continuous variable [adjusted OR 1.06/ 1 kg/m^2, 95% CI (1.04, 1.07)]; and with the chair stand outcome for high BMI [adjusted OR 1.57, 95% CI (1.30, 1.90)] and for BMI as a continuous variable [adjusted OR 1.05/1 kg/m^2, 95% CI (1.03, 1.07)]. Similarly, large waist

circumference (defined by gender-specific cut-points noted above, vs. low waist circumference as reference) was associated with an increased risk of poor 4-year WOMAC outcome [adjusted OR 1.49, 95% CI (1.25, 1.77)], 20 meter walk outcome [adjusted OR 1.60, 95% CI (1.34, 1.93)], and chair stand outcome [adjusted OR 1.82, 95% CI (1.51, 2.19)].

To test our hypotheses, we focused first on individuals with high BMI and second on individuals with large waist circumference. Tables 5 and 6 present the results for women and men, respectively: unadjusted; adjusted for age, education, and income; and fully adjusted. For all models, the covariates significantly associated with the outcome are provided in the table captions. As shown in Table 5, among African-American and Caucasian women with high BMI in the OAI cohort, being African-American was associated with an elevated OR for every outcome measure, adjusting for age, education, and income; in the fully adjusted models, the association remained significant for chair stand outcome and was borderline for WOMAC and 20 meter walk outcomes. The pattern of findings was similar to this for the association between race and outcome (but differed slightly for the covariates) among women with large waist circumference (see Table 5).

As shown in Table 6, among African-American and Caucasian men with high BMI, being African-American was associated with poor outcome by 20 meter walk and chair stand outcomes after adjusting for age, education, and income; in the fully adjusted models, the association remained significant for 20 meter walk outcome. The pattern of findings was similar to this for the association between race and WOMAC and 20 meter walk outcomes (but differed slightly for the covariates) among men with large waist circumference (see Table 6).

Results of models shown in Tables 5 and 6 were minimally altered by the addition of extensor strength as a covariate and strength itself was not associated with outcome (data not shown). In sensitivity analyses, we excluded individuals from our analysis sample who reported that they were “Hispanic or Latino” (n = 23) or who underwent knee replacement during the study (n = 93) and re-ran the models of Tables 5 and 6; results were minimally altered (data not shown).

DISCUSSION

In women and men with or at elevated risk for symptomatic radiographic knee OA, greater BMI and large waist circumference were each associated with an increased risk of poor 4-year function outcome. Among women with high BMI and among women with large waist circumference, African-Americans were at greater risk than Caucasians for poor 4-year function outcome by each measure evaluated, in analyses adjusting for age, education, and income. From the fully adjusted models, factors that may in part explain these findings in women include income, comorbidity, depressive symptoms, knee pain, and disease severity for WOMAC and 20 meter walk outcomes; the factors we analyzed did not explain the chair stand outcome in women. The findings were less consistent for men, emerging (in analyses adjusting for age, education, and income) among men with high BMI only for the 20 meter walk and chair stand outcomes and among men with large waist circumference only for the 20 meter walk outcome. Factors that may partially explain these findings in men include age and knee pain for chair stand outcome; the factors we analyzed did not explain the 20 meter walk outcome in men.

Although there is an abundant literature dealing with body weight and function in OA, we were unable to identify a prior report evaluating the effect of race within elevated BMI or waist circumference strata in persons with or at high risk for knee OA. However, several

lines of research are relevant to the focus of this report. In persons with any arthritis in the Health and Retirement Study, Song et al found a significantly greater demographic-adjusted ADL disability hazard ratio in African-Americans compared with Caucasians (27). Adjustment for health factors (comorbid chronic conditions, depressive symptoms, function limitations, and health behaviors) reduced estimated excess hazard ratios by 55%, with a 12% further reduction by additional control for education, wealth, income, and health insurance. Cross-sectional studies of knee OA have shown worse function in African-Americans than Caucasians (28–31). In the Johnston County Osteoarthritis Project, this finding was explained by pain, female gender, BMI, and depressive symptoms (28). Using baseline data from a trial of phone-based self-management in veterans with knee OA, Allen et al found that worse function scores in African-Americans were explained by self-efficacy, affect, emotion-focused coping, pain, and self-rated health (29). Notably, in a merged sample of older adults with knee OA from the Fitness Arthritis in Seniors Trial and the Arthritis, Diet, and Activity Promotion Trial, race was associated with performance-based and self-reported function in adjusted analyses, but this finding was not significant after 18 months of exercise therapy, suggesting a role for physical activity in reducing health disparities (32).

Measurement of function outcome over time in studies of knee OA is necessary to better understand the impact of the disease. However, the best way to evaluate this outcome in knee OA has not been established. As we previously described (6), a focus on change ignores those with persistently high or low function, effectively lumping them into the same group, and reducing the ability to detect the effects of factors responsible for an individual's state of function. In a disease that is slow to evolve, such as knee OA, factors related to persistent low- or high-function states are particularly important. We (6,11) and others (18) have used the outcome approach of the current manuscript to address this issue. It is possible that the outcome definition may have led to classification of some persons with a small decline in function (who started near a cut-point) as having poor outcome, when the observed decline was solely or partially due to measurement variability/error. Misclassification resulting from use of the quintile approach may have reduced our ability to identify only clinically meaningful changes in function. Given this, it is possible that our findings underestimate the true situation. However, we believe the strengths of the outcome definition outweigh this limitation in our study. We evaluated both self-reported and performance-based function outcome. While objective, performance measures may not mirror activities considered important to individuals or the range of activities experienced during daily life (33). Self-report measures may better capture wider aspects of functioning and better define change in function over time at the individual level (33).

The OAI provided an excellent setting in which to examine the questions we posed. The OAI sample is effectively enriched for elevated body weight, provided both self-report and performance measures of function, provided not only body weight and height but also waist circumference, and the opportunity to evaluate outcome over 4 years. This study has limitations that must be acknowledged. We were unable to undertake evaluation of other ethnic groups or of subgroups with BMI < 25 kg/m^2 due to their small numbers in the OAI. The findings cannot be generalized to groups who had been excluded from the OAI: persons with bilateral, severe knee OA; men over 285 lbs and women over 250 lbs; persons using certain ambulatory aids over 50% of the time; or comorbidity that would preclude participation in a study. Persons who were not included in the analysis sample (but would have been eligible) differed in a number of ways from the analysis sample and it is unclear how their inclusion would have affected the findings. The mean BMI differed between some subgroups of interest; we sought to address this by adjusting for BMI in multivariable analyses. Self-reported estimates of physical activity may not be accurate, and a better understanding of the role of physical activity may require objective measures.

The current findings identify subsets of individuals who are at greater risk for poor outcome, which is of value in both clinical and public health settings. Our findings suggest some explanatory factors; future studies should delve further into the factors contributing to this finding. Such factors include not only those we identified and are particularly relevant to knee OA but also individual socioeconomic status measures, other lifestyle factors, and social and physical environments.

In conclusion, in persons with or at higher risk for knee OA, greater BMI and large waist circumference were each associated with an increased risk of poor 4-year function outcome. Among women with high BMI and among women with large waist circumference, African-Americans were at greater risk than Caucasians for poor 4-year function outcome by each measure evaluated, adjusting for age, education, and income. Modifiable factors that may in part explain these findings in women in the OAI include comorbidity, depressive symptoms, and knee pain. Targeting such factors, while supporting weight loss, may help to lessen the outcome disparity between African-American and Caucasian women.

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Significance and Innovation

- To our knowledge, this is the first demonstration that greater waist circumference is associated with a greater risk for poor long-term function outcome in persons with or at higher risk for knee osteoarthritis (OA).
- To our knowledge, this is the first confirmation that, among overweight women with or at higher risk for knee OA, African-Americans are at greater risk for poor long-term outcome than Caucasians.
- In addition to identifying this risk group, we report the results of exploration of potential explanatory factors. Ultimately, targeting such factors, while supporting weight loss, may improve strategies to prevent poor outcome.

TABLE 1

Definition of Poor WOMAC Function Outcome

The table illustrates how poor outcome was defined in terms of the WOMAC function measure. Quintile groups were defined by the cut-off values of the baseline WOMAC function score quintiles. The baseline-to-48-month outcome was “poor” when a participant moved into a worse function group or remained within the same low functioning group (the two worst function groups).

	WOMAC Quintile Group at 48-month Follow-Up				
WOMAC Quintile (Q) at Baseline	**Q1 (worst)**	**Q2**	**Q3**	**Q4**	**Q5 (best)**
Q1 (worst) (>20.19)					
Q2 (>10.00, ≤20.19)					
Q3 (>3.40, ≤10.00)					
Q4 (>0, ≤ 3.40)					
Q5 (best) (0)					

Table 2

Baseline Characteristics of Sample for Strata Defined by Gender and BMI

Variables	Overall sample (n = 3695)	Women with low BMI (< 25 kg/m^2)		Women with high BMI (≥ 25 kg/m^2)		Men with low BMI (< 25 kg/m^2)		Men with high BMI (≥ 25 kg/m^2)	
		AA (n = 43)	C (n = 569)	AA (n = 382)	C (n = 1149)	AA (n = 11)	C (n = 253)	AA (n = 159)	C (n = 1129)
Age, years, mean (SD)	61.3 (9.1)	60.7 (9.5)	62.4 (9.1)	59.2 (7.9)	62.3 (8.9)	59.0 (11.8)	60.7 (9.9)	59.2 (8.9)	60.9 (9.3)
BMI, kg/m^2, mean (SD)	28.5 (4.7)	22.9 (1.6)	22.5 (1.6)	32.2 (4.2)	30.3 (4.1)	24.1 (1.0)	23.4 (1.2)	30.8 (3.8)	29.8 (3.4)
Waist circumference, cm, mean (SD)	102.5 (12.7)	85.7 (10.5)	89.4 (8.4)	105.3 (11.9)	107.5 (11.7)	86.5 (6.5)	89.9 (5.5)	105.2 (10.7)	106.2 (10.0)
Education, college graduate, %	22.1%	14.0%	22.7%	13.9%	19.9%	36.4%	24.1%	11.4%	27.9%
Income, ≥ $50,000/year, %	63.1%	34.2%	65.3%	41.8%	54.5%	50.0%	78.5%	45.6%	77.4%
Comorbidity Index score > 0, %	22.7%	20.9%	16.9%	32.2%	22.9%	36.4%	15.8%	37.1%	21.7%
Depressive symptoms (CESD), score ≥ 16, %	9.0%	14.0%	8.6%	16.2%	8.6%	18.2%	6.7%	15.1%	6.4%
Physical activity (PASE) score, mean (SD)	163.5 (81.1)	150.5 (65.9)	160.2 (73.4)	139.9 (76.5)	152.9 (75.2)	205.2 (99.9)	188.0 (87.1)	175.2 (95.1)	176.9 (85.0)
WOMAC knee pain score*, mean (SD)	3.3 (3.5)	5.0 (3.8)	2.2 (2.7)	5.8 (4.5)	3.3 (3.5)	5.3 (4.9)	2.0 (2.5)	5.4 (4.3)	2.9 (3.1)
Joint space grade**, %: 0	45.9%	62.8%	61.0%	40.6%	44.0%	54.6%	56.9%	40.9%	39.6%
1	27.7%	18.6%	23.0%	33.8%	29.4%	36.4%	25.7%	23.9%	27.5%
2	19.7%	11.6%	12.5%	21.2%	21.3%	9.1%	12.3%	27.7%	22.1%
3	6.7%	7.0%	3.5%	4.5%	5.2%	0.0%	5.1%	7.6%	10.9%

Abbreviations: AA, African-American; C, Caucasian; BMI, body mass index; SD, standard deviation; CESD, Center for Epidemiologic Studies Depression Scale; PASE, Physical Activity Scale for the Elderly; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index

*Worse of the two knees

**Highest (worst) joint space narrowing grade among the medial and lateral tibiofemoral compartments of both knees

Table 3

Baseline Characteristics of Sample for Strata Defined by Gender and Waist Circumference

Variables	Overall sample (n = 3695)	Women with small waist circumference (≤ 88 cm)		Women with large waist circumference (> 88 cm)		Men with small waist circumference (≤ 102 cm)		Men with large waist circumference (> 102 cm)	
		AA (n = 42)	C (n = 279)	AA (n = 383)	C (n = 1439)	AA (n = 81)	C (n = 656)	AA (n = 89)	C (n = 726)
Age, years, mean (SD)	61.3 (9.1)	57.6 (8.4)	59.4 (8.8)	59.6 (8.1)	62.9 (8.9)	60.0 (9.6)	60.0 (9.7)	58.5 (8.7)	61.7 (9.0)
BMI, kg/m^2, mean (SD)	28.5 (4.7)	24.5 (3.1)	22.5 (2.4)	32.0 (4.4)	28.7 (4.8)	27.8 (2.6)	25.7 (2.4)	32.8 (3.7)	31.2 (3.3)
Waist circumference, cm, Mean (SD)	102.5 (12.7)	80.7 (6.2)	81.5 (5.3)	105.8 (11.2)	105.4 (11.2)	94.7 (6.1)	93.7 (5.7)	112.5 (8.2)	111.8 (7.7)
Education, college graduate, %	22.1%	11.9%	22.9%	14.1%	20.4%	12.4%	25.6%	13.6%	28.7%
Income, ≥ $50,000/year, %	63.1%	42.5%	70.3%	40.9%	55.7%	50.0%	79.4%	42.0%	76.1%
Comorbidity Index score > 0, %	22.7%	21.4%	14.3%	32.1%	22.2%	32.1%	16.2%	41.6%	24.7%
Depressive symptoms (CESD), score ≥ 16, %	9.0%	14.3%	8.2%	16.2%	8.7%	11.1%	7.0%	19.1%	5.9%
Physical activity (PASE) score, mean (SD)	163.5 (81.1)	174.2 (67.3)	176.3 (78.2)	137.3 (75.6)	151.2 (73.3)	178.3 (97.1)	186.7 (83.5)	176.2 (94.4)	171.9 (84.8)
WOMAC knee pain score *, mean (SD)	3.3 (3.5)	5.2 (4.4)	2.3 (3.1)	5.8 (4.5)	3.0 (3.3)	5.0 (4.2)	2.3 (2.9)	5.7 (4.5)	3.1 (3.1)
Joint space grade **, %: 0	45.9%	71.4%	64.5%	39.7%	46.8%	40.7%	48.2%	42.7%	37.9%
1	27.7%	14.3%	19.7%	34.2%	28.8%	25.9%	27.4%	23.6%	26.9%
2	19.7%	11.9%	11.5%	21.2%	19.7%	23.5%	16.3%	29.2%	23.8%
3	6.7%	2.4%	4.3%	5.0%	4.7%	9.9%	8.1%	4.5%	11.4%

Abbreviations: AA, African-American; C, Caucasian; BMI, body mass index; SD, standard deviation; CESD, Center for Epidemiologic Studies Depression Scale; PASE, Physical Activity Scale for the Elderly; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index

*Worse of the two knees

**Highest (worst) joint space narrowing grade among the medial and lateral tibiofemoral compartments of both knees

Table 4

Frequency of Poor Outcome in the Overall Sample and in Strata Based on Race, Gender, BMI, and Waist Circumference

	Poor WOMAC outcome	Poor 20 meter walk outcome	Poor chair stand outcome
Overall sample	1446/3695 (39.1%)	1556/3286 (47.4%)	1339/3338 (40.1%)
AA women with low BMI	15/43 (34.9%)	21/34 (61.8%)	12/35 (34.3%)
C women with low BMI	181/569 (31.8%)	190/493 (38.5%)	164/503 (32.6%)
AA women with high BMI	206/382 (53.9%)	206/327 (63.0%)	185/332 (55.7%)
C women with high BMI	461/1149 (40.1%)	571/1022 (55.9%)	439/1036 (42.4%)
AA women with small waist circumference	18/42 (42.9%)	18/33 (54.6%)	7/34 (20.6%)
C women with small waist circumference	81/279 (29.0%)	78/244 (32.0%)	58/247 (23.5%)
AA women with large waist circumference	203/383 (53.0%)	209/328 (63.7%)	190/333 (57.1%)
C women with large waist circumference	561/1439 (39.0%)	683/1271 (53.7%)	545/1292 (42.2%)
AA men with low BMI	4/11 (36.4%)	3/10 (30.0%)	3/10 (30.0%)
C men with low BMI	74/253 (29.3%)	75/228 (32.9%)	62/237 (26.2%)
AA men with high BMI	77/159 (48.4%)	86/154 (55.8%)	77/155 (49.7%)
C men with high BMI	428/1129 (37.9%)	404/1018 (39.7%)	397/1030 (38.5%)
AA men with small waist circumference	30/81 (37.0%)	36/76 (47.4%)	37/77 (48.1%)
C men with small waist circumference	197/656 (30.0%)	191/599 (31.9%)	172/610 (28.2%)
AA men with large waist circumference	51/89 (57.3%)	53/88 (60.2%)	43/88 (48.9%)
C men with large waist circumference	305/726 (42.0%)	288/647 (44.5%)	287/657 (43.7%)

Abbreviations: AA, African-American; C, Caucasian

Percent given is the % of individuals of that row who had poor outcome. High and low BMI were defined as ≥ 25 kg/m^2 and < 25 kg/m^2 respectively. High and low waist circumference were defined as > 88 cm and ≤ 88 cm for women and > 102 cm and ≤ 102 cm for men.

Table 5

Odds of Poor Outcome Associated with Race among Women with High BMI and among Women with Large Waist Circumference

The table shows results for African-American (AA) and Caucasian (C) women with high BMI and women with large waist circumference, presented as odds ratios (OR) and 95% confidence intervals (CIs) associated with being African-American (vs. Caucasian) for poor baseline-to-4-year function outcome (dependent variable). The crude ORs are shown first, followed by the ORs adjusted for age, education, and income, followed by the ORs from fully adjusted models (adjusted for age, education, income, BMI, comorbidity, depressive symptoms, physical activity, knee pain, disease severity).

		Women with High BMI (≥ 25 kg/m^2)			**Women with Large Waist Circumference (> 88 cm)**		
		Poor WOMAC outcome OR (95% CI)	**Poor 20 meter walk outcome OR (95% CI)**	**Poor chair stand outcome OR (95% CI)**	**Poor WOMAC outcome OR (95% CI)**	**Poor 20 meter walk outcome OR (95% CI)**	**Poor chair stand outcome OR (95% CI)**
# (%) with poor outcome	AA	206/382 (53.9%)	206/327 (63.0%)	185/332 (55.7%)	203/383 (53.0%)	209/328 (63.7%)	190/333 (57.1%)
	C	461/1149 (40.1%)	571/1022 (55.9%)	439/1036 (42.4%)	561/1439 (39.0%)	683/1271 (53.7%)	545/1292 (42.2%)
AA vs. C (unadjusted)		***1.75 (1.38, 2.21)***	***1.35 (1.04, 1.74)***	***1.71 (1.33, 2.20)***	***1.77 (1.41, 2.22)***	***1.51 (1.18, 1.94)***	***1.82 (1.43, 2.32)***
AA vs. C (adjusted for age, education, income)		***1.54 (1.19, 1.98)***	***1.43 (1.07, 1.91)***	***1.81 (1.37, 2.39)***	***1.55 (1.21, 1.99)***	***1.57 (1.18, 2.07)***	***2.02 (1.54, 2.65)***
AA vs. C (fully adjusted)		1.29 (0.99, 1.68)[a]	1.29 (0.96, 1.75)[b]	***1.63 (1.22, 2.17)***[c]	1.22 (0.94, 1.60)[d]	1.35 (1.00, 1.81)[e]	***1.68 (1.26, 2.24)***[f]

[a] Covariates significantly associated with outcome: pain [1.06 (1.03, 1.10)]; disease severity [1.24 (1.09, 1.41)]; depressive symptoms [1.65 (1.13, 2.40)]; income [0.87 (0.77, 0.99)]

[b] Covariates significantly associated with outcome: age [1.06 (1.05, 1.08)]; disease severity [1.18 (1.02, 1.36)]; comorbidity [1.29 (1.07, 1.55)]; income [0.86, (0.75, 0.99)]

[c] Covariates significantly associated with outcome: age [1.04 (1.02, 1.05)]; income [0.86 (0.75, 0.98)]; BMI [1.04 (1.01, 1.08)]

[d] Covariates significantly associated with outcome:pain [1.07 (1.03, 1.10)]; disease severity [1.29 (1.15, 1.46)]; depressive symptoms [1.54 (1.10, 2.18)]; comorbidity [1.18 (1.01, 1.37)]

[e] Covariates significantly associated with outcome: age [1.06 (1.04, 1.07)]; disease severity [1.20 (1.05, 1.37)]; comorbidity [1.22 (1.02, 1.46)]; income [0.83 (0.73, 0.95)]; BMI [1.05 (1.02, 1.08)]

[f] Covariates significantly associated with outcome: age [1.04 (1.02, 1.05)]; BMI [1.04 (1.01, 1.06)]

Table 6

Odds of Poor Outcome Associated with Race among Men with High BMI and among Men with Large Waist Circumference

The table shows results for African-American (AA) and Caucasian (C) men with high BMI and men with large waist circumference, presented as odds ratios (OR) and 95% confidence intervals (CIs) associated with being African-American (vs. Caucasian) for poor baseline-to-4-year function outcome (dependent variable). The crude ORs are shown first, followed by the ORs adjusted for age, education, and income, followed by the ORs from fully adjusted models (adjusted for age, education, income, BMI, comorbidity, depressive symptoms, physical activity, knee pain, disease severity).

		Men with High BMI (≥ 25 kg/m^2)			**Men with Large Waist Circumference (> 102 cm)**		
		Poor WOMAC outcome OR (95% CI)	**Poor 20 meter walk outcome OR (95% CI)**	**Poor chair stand outcome OR (95% CI)**	**Poor WOMAC outcome OR (95% CI)**	**Poor 20 meter walk outcome OR (95% CI)**	**Poor chair stand outcome OR (95% CI)**
# (%) with poor outcome	AA	77/159 (48.4%)	86/154 (55.8%)	77/155 (49.7%)	51/89 (57.3%)	53/88 (60.2%)	43/88 (48.9%)
	C	428/1129 (37.9%)	404/1018 (39.7%)	397/1030 (38.5%)	305/726 (42.0%)	288/647 (44.5%)	287/657 (43.7%)
AA vs. C (unadjusted)		***1.54 (1.10, 2.15)***	***1.92 (1.37, 2.71)***	***1.57 (1.12, 2.21)***	***1.85 (1.19, 2.89)***	***1.89 (1.20, 2.97)***	1.23 (0.79, 1.92)
AA vs. C (adjusted for age, education, income)		1.26 (0.87, 1.81)	***1.94 (1.31, 2.87)***	***1.56 (1.07, 2.28)***	1.53 (0.93, 2.52)	***2.24 (1.30, 3.85)***	1.34 (0.80, 2.23)
AA vs. C (fully adjusted)		0.99 (0.67, 1.45)[a]	***1.66 (1.11, 2.48)***[b]	1.25 (0.84, 1.85)[c]	1.23 (0.73, 2.09)[d]	***1.91 (1.09, 3.34)***[e]	1.10 (0.65, 1.86)[f]

[a] Covariates significantly associated with outcome: pain [1.08 (1.04, 1.12)]; disease severity [1.23 (1.09, 1.39)]; comorbidity [1.26 (1.07, 1.48)]; income [0.84 (0.73, 0.96)]; BMI [1.08 (1.04, 1.12)]

[b] Covariates significantly associated with outcome: age [1.06 (1.04, 1.07)]; income [0.80 (0.69, 0.93)]; BMI [1.06 (1.02, 1.10)]

[c] Covariates significantly associated with outcome: age [1.04 (1.02, 1.05)]; pain [1.09 (1.05, 1.14)]

[d] Covariates significantly associated with outcome: pain [1.10 (1.05, 1.16)]; disease severity [1.32 (1.13, 1.54)]; comorbidities [1.30 (1.07, 1.58)]; BMI [1.07 (1.02, 1.12)]

[e] Covariates significantly associated with outcome: age [1.07 (1.04, 1.09)]; income [0.77 (0.63, 0.92)]

[f] Covariates significantly associated with outcome: age [1.05 (1.02, 1.07)]; pain [1.10 (1.04, 1.16)]