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Racial differences and disparities in osteoporosis-related bone-health: Results from the PAADRN randomized controlled trial

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Abstract

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Background—Determining whether observed differences in healthcare can be called disparities requires persistence of differences after adjustment for relevant patient, provider and health system factors. We examined whether providing dual energy x-ray absorptiometry (DXA) test results directly to patients might reduce or eliminate racial differences in osteoporosis-related healthcare.

Design, Subjects, and Measures—We analyzed data from 3,484 White and 1,041 Black women who underwent DXA testing at two health systems participating in the Patient Activation after DXA Result Notification (PAADRN) pragmatic clinical trial (ClinicalTrials.gov NCT-01507662) between February 2012 and August 2014. We examined seven outcomes related to bone health at 12- and 52-weeks post-DXA: (1) whether the patient correctly identified their DXA baseline results; (2) whether the patient was on guideline-concordant osteoporosis pharmacotherapy; (3) osteoporosis-related satisfaction; (4) osteoporosis knowledge; (5 and 6) osteoporosis self-efficacy for exercise and for diet; and, (7) patient activation. We examined whether unadjusted differences in outcomes between Whites and Blacks persisted after adjusting for patient, provider and health system factors.

Results—Mean age was 66.5 years and 29% were Black. At baseline Black women had less education, poorer health status, and were less likely to report a history of osteoporosis ($p < 0.001$ for all). In unadjusted analyses Black women were less likely to correctly identify their actual DXA results, more likely to be on guideline concordant therapy, and had similar patient activation. After adjustment for patient demographics, baseline health status and other factors, Black women were still less likely to know their actual DXA result and less likely to be on guideline-concordant therapy, but Black women had greater patient activation.

Conclusions—Adjustment for patient and provider level factors can change how racial differences are viewed, unmasking new disparities and providing explanations for others.

Trial Registration—ClinicalTrials.gov Identifier: NCT01507662

Keywords

Osteoporosis; Dual Energy X-ray Absorptiometry; Randomized Controlled Trials; Risk Communication

Introduction

Two million osteoporotic fractures occur each year in the United States (U.S.) as a result of low bone mineral density (BMD) and pose a major public health problem.[1] Of these, 310,000 are hip fractures.[2,3] Hip fractures often occur in older women who have osteoporosis (diagnosed or not) and who fall.[4,5] While White women have higher rates of hip fracture, Black women have poorer outcomes including higher morbidity and mortality.[6–8] The primary preventive strategy for reducing fractures in the U.S. is screening for osteoporosis using dual-energy x-ray absorptiometry (DXA).[9]

There are substantial racial differences in DXA screening and osteoporosis diagnosis and treatment rates.[6] For example, Curtis et al. report that among traditional Medicare beneficiaries, 33% of White vs. 5% of Black women had undergone osteoporosis screening. Cheng reported that among traditional Medicare beneficiaries with fractures, osteoporosis

was diagnosed nearly twice-as-often for White women compared to Black women across all age groups.[10] Hamrick reported that while 80% of White women received pharmacotherapy after osteoporosis diagnoses, only 68% of Black women did.[11]

What is not clear is whether these racial differences constitute disparities. In a groundbreaking 2003 U.S. Institute of Medicine (IOM) report, Smedley et al. defined racial disparities as "racial or ethnic differences in the quality of healthcare that are not due to access-related factors or clinical needs, preferences, and appropriateness of intervention."[12] That is, racial differences may be due to patient, provider, and/or institutional factors, and only constitute disparities if they exist after adjustment for these factors. Patient factors include the social determinants of health and health behaviors, provider factors include practice patterns and explicit and implicit biases, and institutional factors include access to and the organization of healthcare. The dearth of detailed information about these patient, provider, and institutional factors in administrative claims and medical records hinder efforts to determine if racial differences are true disparities.

We used data from the Patient Activation after DXA Report Notification (PAADRN) randomized controlled trial (RCT)[21,22] to investigate and differentiate racial differences and disparities in bone health care among White and Black women. PAADRN data are well suited to this task for two reasons. First, PAADRN's intervention focused on engaging patients in their bone health self-care, which has been shown in prior studies to be lower for Blacks than for Whites.[13] Second, PAADRN collected an extensive battery of data about numerous aspects of bone health knowledge, self-efficacy, and behaviors.[14] Accordingly, we use the PAADRN data on White and Black women to explore these issues. Building on the recommendations of the IOM report,[1] we estimate four multivariable models for each of the seven bone health measures. Through successive models, we provide insight into whether racial disparities in bone health can be explained by differences in patient and provider level factors.

Methods

Design and Sample

PAADRN was a pragmatic RCT whose design has been detailed elsewhere.[15,16] PAADRN enrolled 7,749 patients presenting for DXA between February 2012 and August 2014 at the University of Iowa (UI), the University of Alabama at Birmingham (UAB), and Kaiser Permanente of Georgia (KPGA). Exclusion criteria were: (1) age < 50 years; (2) prisoners or patients with overt cognitive disability; (3) patients who did not speak or read English; and, (4) patients who were deaf or lacked access to a telephone. Baseline phone or face-to-face interviews occurred up to 28-days before or 3-days after their baseline DXA, with follow-up telephone interviews occurring at 12- and 52-weeks post-DXA. Because this Brief Report focuses on racial differences and disparities, the sample excludes all patients from UI (where there were not enough Black patients for analytic purposes) and all men from UAB and KPGA (because of the uncertainty about DXA screening in men).[9] Institutional Review Boards at UI, UAB, and KPGA approved the study protocol. Our full protocol is available at https://clinicaltrials.gov/ct2/show/NCT01507662.

Intervention

Intervention patients were notified of their DXA results via a tailored letter accompanied by an educational brochure.[15,17,18] The letter included the clinical impression of each patient's DXA result (normal, low BMD [osteopenia], or osteoporosis), their 10-year fracture risk, and the suggestion that the patient bring the letter to their next physician visit. The brochure explained osteoporosis, reviewed the benefits of proper calcium and vitamin D intake, exercise, fall prevention, smoking cessation, and alcohol moderation, and provided additional osteoporosis resources. Intervention materials were mailed to patients from UI 4-weeks after their baseline DXA. Usual care patients received their DXA results based on the practices of their physicians and healthcare systems.

Outcomes

We examine seven outcomes related to bone health at 12- and 52-weeks post-DXA (Table 1). Measures included: (1) whether the patient correctly identified their baseline DXA results; (2) whether the patient was on guideline-concordant osteoporosis pharmacotherapy;[22] (3) osteoporosis-related satisfaction;[29] (4) osteoporosis knowledge;[30,31] (5 and 6) osteoporosis self-efficacy for exercise and self-efficacy for diet;[26] and, (7) patient activation.[31,32] All but the guideline-concordant care measure are based directly on scales of known reliability and validity, or to a shortened form (patient activation) of such a scale. Receipt of guideline-concordant pharmacotherapy occurred when patients reported taking osteoporosis pharmacotherapy when indicated, or when patients reported not taking osteoporosis pharmacotherapy when it was not indicated by their DXA results and other patient considerations according to National Osteoporosis Foundation (NOF) guidelines.[22]

Covariates

Covariates included patient, provider, and institutional characteristics (Table 2) important for differentiating racial differences and disparities according to the IOM framework.[12] Patient characteristics included sociodemographics (age, sex, race, and education), comorbidities, health habits (smoking, drinking, and exercise), self-reported health, prior bone health, health literacy and numeracy, and study DXA results. Provider characteristics included sex and specialty. Institutional characteristics were limited to DXA site.

Data analyses

Baseline characteristics of White and Black women are compared using bivariable methods. Linear mixed effects models are used to estimate four multivariable models for the seven bone health measures (after standardizing the non-binary measures). The first model only contains only race as a covariate. The second model adjusts for patient, provider, and center factors. The third model further adjusts for receipt (or not) of the mailed letter intervention. The fourth model includes the interaction of the DXA centers with the intervention and is estimated to test for potential heterogeneity of treatment effects (HTEs) based on the site characteristics, including uniform employer-based insurance and practice protocols at KPGA vs. UAB. In sensitivity analyses we restricted the sample to women ≥ 65 years old for whom osteoporosis treatment guidelines are most clearly applicable, and we used inverse probability of treatment weighting (IPTW) to adjust for the higher attrition rates among

Black women. Bonferroni adjustments are used to correct for multiplicity. All p-values are 2-tailed, with those ≤ 0.025 deemed statistically significant. All statistical analyses were performed using *SAS 9.4* (SAS Inc., Cary, NC).

Results

Table 2 reveals significant (all $p < 0.001$) baseline differences between the 3,484 White and 1,041 Black women in most domains including age, education, comorbidity, health habits, self-reported health, health literacy, DXA results, and provider characteristics. Black women are disadvantaged for many of these measures. Table 2 also reveals significant unadjusted differences between Black and White women at 12- and 52-weeks post-DXA on the osteoporosis health measures. Black women are less likely to correctly identify their DXA results and have less osteoporosis-related knowledge than White women ($p < 0.001$). At the same time, Black women are more likely to be on guideline-concordant pharmacotherapy and are more satisfied with their care ($p < 0.001$).

Table 3 contains the multivariable results for the osteoporosis health measures at 12-weeks post-DXA. Even after full adjustment (Model 3), Black women were less likely to correctly identify their DXA results (beta = −0.150, $p < 0.001$) and had lower osteoporosis-related knowledge (beta = −0.473, $p < 0.001$) than White women, suggesting health disparities.

Table 3 also reveals a suppressed disparity (i.e., a disparity that was only observed after adjustment for the covariates) and two suppressed advantages (i.e., advantages that were only observed after adjustment for the covariates) for Black women. The suppressed disparity is that prior to covariate adjustment, Black women are more likely to be on guideline-concordant pharmacotherapy (Model 1, beta = 0.144, $p < 0.001$). After adjusting for the covariates (especially their DXA results), however, Black women are less likely than White women to be on guideline-concordant pharmacotherapy (Model 3, beta = −0.073, $p < 0.001$). The two suppressed advantages for Black women reveal their greater self-efficacy for exercise (Model 3, beta = 0.166, $p < 0.001$) and their greater patient activation (Model 3, beta = 0.114, $p = 0.012$) after adjustment for the covariates, whereas the unadjusted analyses (Model 1) revealed no such advantages.

Table 4 contains the multivariable results for the osteoporosis health measures at 52-weeks post-DXA. Because these are consistent with those reported in Table 3, they are not discussed here. The sensitivity analyses (all Model 4s in Tables 3 and 4) revealed no HTEs for the intervention across the two DXA centers (all $p > 0.025$). The sensitivity analyses restricting our analysis to women age ≥ 65 years old and those using IPTW to adjust for differential attrition were consistent with those shown in Tables 3 and 4 (available on request).

Discussion

The IOM defines racial disparities as “racial or ethnic differences in the quality of healthcare that are not due to access-related factors or clinical needs, preferences, and appropriateness of intervention.”[12] This definition implies that before a difference can be called a disparity

adjustment for patient, provider and health system factors that are difficult to measure must take place.

In an analysis of White and Black women from the PAADRN study we found that a subtle and nuanced story becomes visible after adjustment. For example, without adjustment Black women were less likely to correctly recall their DXA result, and this difference persisted after adjustment fulfilling the IOM definition of a disparity. Alternatively, without adjustment Black women appeared more likely to receive guideline-concordant therapy, but after adjustment Black women were actually less likely to receive guideline-concordant therapy, which we have labeled as a suppressed disparity. Finally, Black and White women had similar levels of patient activation in the unadjusted analyses, but after adjustment Black women actually were more activated than White women, which we have labeled as a suppressed advantage. It is important to note that these suppressed disparities and advantages were seen only after adjustment for critical clinical details—in this case, the baseline DXA results.

We are unaware of any prior studies that have evaluated the impact of educational interventions on racial differences in osteoporosis. More broadly there are relatively few RCTs assessing the impact of educational interventions on racial differences outside of osteoporosis, though a number are currently underway.[22,23] Tully reported that a pilot trial of patient empowerment improved blood pressure control among Black intervention and usual care patients.[24] Thomas found that an educational video reduced White-Black differences in willingness to receive an implantable cardiac defibrillator (ICD).[25]

A number of our other findings warrant brief elaboration. Both this analysis and related publications provide evidence that our mailed DXA result letter had similar effects in Blacks and Whites.[16,19] This finding is important and suggests that despite critical differences in education, health literacy and numeracy, and baseline health status, well-crafted interventions targeting patients can provide similar benefits to both Whites and Blacks.

It is important to discuss future directions. The rise in patient advocacy, in patients being active partners in their own medical care, and in shared decision making makes it incumbent on the healthcare system to find ways to communicate results to diverse patient populations. Our tailored letters are a start, but future research needs to explore communication involving different diagnostic tests and using newer communication modalities (e.g., patient portals and text messaging with embedded YouTube links).[20,21]

Our study has three limitations. The first is whether these results can be applied to newer communication modalities. The second is our focus only on White and Black women at just two health systems. Finally, despite our extensive data collection we were unable to capture certain factors that are likely important in explaining racial differences, such as access to care (e.g., travel distance), provider attitudes and biases, and institutional policies.

In conclusion, using data from the PAADRN study we found that certain unadjusted differences in bone health care between White and Black women appear to be true disparities. After careful risk adjustment, we also identified suppressed disparities and suppressed advantages that were not apparent in our unadjusted analyses. These results

highlight the importance of carefully planning protocols for patient (including key clinical findings), provider, and institutional data collection and subsequent statistical analyses when differentiating racial differences from racial disparities.

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Table 1

Outcomes and their reliability coefficients

Outcome	Number of Items in Scale	Range of Original Scare	Standardized Cronbach Coefficient Alpha
Correctly identified the results of their baseline DXA	1	0 = No, 1 = Yes	--
On guideline concordant pharmacotherapy *	1	0 = No, 1 = Yes	--
Osteoporosis related satisfaction [29]	5	5 – 25	0.764
Osteoporosis specific knowledge [30,31]	10	0 – 10	0.607
Osteoporosis self-efficacy exercise [26]	10	0 – 100	0.969
Osteoporosis self-efficacy diet [26]	11	0 – 100	0.962
Patient activation [31,32]	6	0 – 100	0.719

* Patients with osteoporosis (T-score of femoral neck, hip, or spine ≤−2.5 *or* FRAX ≥20 %), *or* with a self-reported history of low impact fracture, *or* with osteopenia (T-score between −1.0 and −2.5 at the femoral neck, hips, or lumbar spine) *and* a 10-year probability of a major osteoporosis-related fracture ≥20 % who are on osteoporosis pharmacotherapy OR patients who do not have one of the above and are not on osteoporosis pharmacotherapy. [22]

Table 2

Baseline characteristics of White and Black women at the two PAADRN sites.

	White (N=3484)	Black (N=1041)	P-Value
Site			
UAB, number (%)	2159 (62.0)	620 (44.3)	<0.001
KP, number (%)	1325 (38.0)	781 (55.7)	
Socio-demographics			
Age, mean (SD)	66.9 (8.11)	66.38 (7.84)	0.039
Education			
Some high school, number (%)	96 (2.8)	108 (7.8)	<0.001
Completed high school, number (%)	759 (21.9)	327 (23.5)	
Some college, number (%)	1157 (33.3)	579 (41.7)	
Completed college, number (%)	712 (20.5)	220 (15.8)	
Graduate school, number (%)	749 (21.6)	155 (11.2)	
Comorbid Conditions			
COPD, number (%)	208 (6.0)	79 (5.7)	0.667
Depression, number (%)	957 (27.5)	220 (15.7)	<0.001
Breast cancer, number (%)	613 (17.6)	144 (10.3)	<0.001
Health Habits			
Current smoker, number (%)	216 (6.2)	119 (8.5)	0.004
Past smoker, number (%)	1219 (35.0)	420 (30.0)	0.001
Current alcohol user, number (%)	872 (49.2)	225 (31.4)	<0.001
Self-reported Health Status			
Excellent, number (%)	535 (15.4)	83 (5.9)	<0.001
Very good, number (%)	1278 (36.7)	354 (25.3)	
Good, number (%)	1170 (33.6)	612 (43.7)	
Fair, number (%)	393 (11.3)	303 (21.7)	
Poor, number (%)	106 (3.0)	47 (3.4)	
Bone Health			
Prior DXA, number (%)	2903 (83.3)	737 (52.6)	<0.001
History of osteoporosis, number (%)	898 (26.0)	220 (15.9)	
History of osteoporosis treatment, number (%)	1799 (51.6)	319 (22.8)	
Health Literacy, mean (SD)	4.36 (0.81)	4.24 (0.93)	<0.001
Health Numeracy, mean (SD)	4.71 (0.97)	4.12 (1.13)	<0.001
Study DXA Results			
Normal, number (%)	727 (20.9)	626 (44.7)	<0.001
Low BMD, number (%)	2002 (57.5)	613 (43.8)	
Osteoporosis, number (%)	755 (21.7)	162 (11.6)	
Fracture Risk			
Low, number (%)	1181 (33.9)	1310 (93.5)	<0.001

	White (N=3484)	Black (N=1041)	P-Value
Medium, number (%)	1478 (42.4)	87 (6.2)	
High, number (%)	825 (23.7)	4 (0.3)	
Provider Characteristics			
Physician, number (%)	3375 (96.9)	1359 (97)	0.811
Women Provider, number (%)	1886 (54.1)	874 (62.4)	<0.001
Provider Specialty			
Family Medicine, number (%)	512 (14.7)	347 (24.8)	<0.001
General Internal Medicine, number (%)	1783 (51.2)	745 (53.2)	
Rheumatology/Endocrinology, number (%)	419 (12.0)	74 (5.3)	
Other, number (%)	770 (22.1)	235 (16.8)	
Intervention			
Intervention, number (%)	1771 (50.8)	716 (51.1)	0.862
Usual Care, number (%)	1713 (49.2)	685 (48.9)	
Outcomes			
Correctly identified the results of their baseline DXA			
12 weeks, number (%)	2109 (68.2)	615 (55.2)	<0.001
52 weeks, number (%)	1802 (63.1)	477 (50.9)	<0.001
On guideline concordant pharmacotherapy			
12 weeks, number (%)	1934 (62.5)	857 (76.9)	<0.001
52 weeks, number (%)	1778 (62.3)	713 (76.1)	<0.001
Osteoporosis related satisfaction			
12 weeks, mean (SD)	20.91 (3.77)	20.38 (3.94)	<0.001
52 weeks, mean (SD)	21.21 (3.64)	20.45 (4.01)	<0.001
Osteoporosis specific knowledge			
12 weeks, mean (SD)	8.17 (1.42)	7.10 (1.81)	<0.001
52 weeks, mean (SD)	8.11 (1.43)	7.09 (1.87)	<0.001
Osteoporosis self-efficacy exercise			
12 weeks, mean (SD)	7.73 (2.2)	7.75 (2.21)	0.790
52 weeks, mean (SD)	7.82 (2.19)	7.99 (2.04)	0.040
Osteoporosis self-efficacy diet			
12 weeks, mean (SD)	8.51 (1.69)	8.45 (1.87)	0.368
52 weeks, mean (SD)	8.47 (1.76)	8.45 (1.88)	0.812
Patient activation			
12 weeks, mean (SD)	77.34 (17.15)	77.26 (18.48)	0.900
52 weeks, mean (SD)	78.13 (17.28)	77.95 (18.25)	0.788

Table 3

Effect estimates at 12 weeks from linear mixed effect models on the seven outcomes.

Outcome		Effect	Effect Estimate	95% CI	P-value
Correctly identified the results of their baseline DXA	Model 1	Race Black vs. White	−0.145	(−0.178, −0.111)	<0.001
	Model 2	Race Black vs. White	−0.154	(−0.194, −0.113)	<0.001
	Model 3	Race Black vs. White	−0.15	(−0.190, −0.110)	<0.001
		Intervention vs. Control	0.118	(0.087, 0.148)	<0.001
		Site KP vs. UAB	0.088	(0.052, 0.125)	<0.001
	Model 4	Race Black vs. White	−0.151	(−0.191, −0.111)	<0.001
		Intervention vs. Control	0.141	(0.100, 0.181)	<0.001
		Site KP vs. UAB	0.115	(0.067, 0.163)	<0.001
		Site (KP) * Intervention	−0.051	(−0.112, 0.01)	0.099
On guideline concordant pharmacotherapy	Model 1	Race Black vs. White	0.144	(0.112, 0.176)	<0.001
	Model 2	Race Black vs. White	−0.073	(−0.111, −0.034)	<0.001
	Model 3	Race Black vs. White	−0.073	(−0.112, −0.035)	<0.001
		Intervention vs. Control	−0.016	(−0.043, 0.01)	0.233
		Site KP vs. UAB	−0.005	(−0.035, 0.025)	0.737
	Model 4	Race Black vs. White	−0.073	(−0.111, −0.034)	<0.001
		Intervention vs. Control	−0.028	(−0.063, 0.006)	0.110
		Site KP vs. UAB	−0.020	(−0.061, 0.021)	0.335
		Site (KP) * Intervention	0.029	(−0.025, 0.083)	0.289
Osteoporosis related satisfaction	Model 1	Race Black vs. White	−0.127	(−0.201, −0.053)	0.001
	Model 2	Race Black vs. White	−0.053	(−0.145, 0.039)	0.256
	Model 3	Race Black vs. White	−0.046	(−0.137, 0.046)	0.328
		Intervention vs. Control	0.266	(0.194, 0.338)	<0.001
		Site KP vs. UAB	0.041	(−0.05, 0.132)	0.378
	Model 4	Race Black vs. White	−0.046	(−0.138, 0.045)	0.323
		Intervention vs. Control	0.282	(0.185, 0.38)	<0.001
		Site KP vs. UAB	0.060	(−0.059, 0.178)	0.322
		Site (KP) * Intervention	−0.036	(−0.180, 0.109)	0.628

Outcome		Effect	Effect Estimate	95% CI	P-value
Osteoporosis specific knowledge	Model 1	Race Black vs. White	−0.656	(−0.724, −0.588)	<0.001
	Model 2	Race Black vs. White	−0.474	(−0.556, −0.392)	<0.001
	Model 3	Race Black vs. White	−0.473	(−0.555, −0.391)	<0.001
		Intervention vs. Control	0.021	(−0.036, 0.079)	0.463
		Site KP vs. UAB	0.023	(−0.042, 0.088)	0.482
	Model 4	Race Black vs. White	−0.472	(−0.554, −0.39)	<0.001
		Intervention vs. Control	−0.007	(−0.082, 0.068)	0.856
		Site KP vs. UAB	−0.011	(−0.100, 0.077)	0.801
		Site (KP) * Intervention	0.067	(−0.048, 0.183)	0.253
Osteoporosis self-efficacy exercise	Model 1	Race Black vs. White	0.006	(−0.066, 0.077)	0.873
	Model 2	Race Black vs. White	0.166	(0.082, 0.250)	<0.001
	Model 3	Race Black vs. White	0.166	(0.082, 0.250)	<0.001
		Intervention vs. Control	−0.010	(−0.068, 0.048)	0.734
		Site KP vs. UAB	0.066	(0.000, 0.132)	0.050
	Model 4	Race Black vs. White	0.166	(0.082, 0.250)	<0.001
		Intervention vs. Control	−0.013	(−0.090, 0.063)	0.729
		Site KP vs. UAB	0.062	(−0.028, 0.152)	0.177
		Site (KP) * Intervention	0.008	(−0.109, 0.125)	0.892
Osteoporosis self-efficacy diet	Model 1	Race Black vs. White	−0.032	(−0.102, 0.038)	0.368
	Model 2	Race Black vs. White	0.082	(−0.006, 0.17)	0.067
	Model 3	Race Black vs. White	0.082	(−0.006, 0.17)	0.069
		Intervention vs. Control	−0.018	(−0.079, 0.044)	0.574
		Site KP vs. UAB	0.045	(−0.024, 0.114)	0.203
	Model 4	Race Black vs. White	0.081	(−0.007, 0.169)	0.071
		Intervention vs. Control	0.006	(−0.074, 0.086)	0.877
		Site KP vs. UAB	0.074	(−0.020, 0.168)	0.121
		Site (KP) * Intervention	−0.057	(−0.180, 0.066)	0.365
Patient activation	Model 1	Race Black vs. White	−0.009	(−0.080, 0.062)	0.796
	Model 2	Race Black vs. White	0.112	(0.024, 0.201)	0.013

Outcome		Effect	Effect Estimate	95% CI	P-value
	Model 3	Race Black vs. White	0.114	(0.025, 0.202)	0.012
		Intervention vs. Control	0.05	(−0.016, 0.116)	0.141
		Site KP vs. UAB	0.029	(−0.049, 0.107)	0.467
	Model 4	Race Black vs. White	0.114	(0.026, 0.203)	0.012
		Intervention vs. Control	0.033	(−0.055, 0.122)	0.463
		Site KP vs. UAB	0.01	(−0.094, 0.114)	0.850
		Site (KP) * Intervention	0.037	(−0.095, 0.169)	0.584

Model 1 includes race only (Black vs. White)

Model 2 includes race and covariates measured at baseline

Model 3 includes race, intervention, plus covariates measured at baseline

Model 4 includes race, intervention, interaction between intervention and site (KP vs. UAB), plus covariates measured at baseline

Baseline covariates include, site (KP vs. UAB), age (continuous), education, comorbidity (COPD, depression and breast cancer), self-assessed health status (using self-reported health status, continuous), heath habits (current smoker, former smoker and drinker), bone health (history of DXA, history of fracture and history of osteoporosis treatment), health literacy (continuous), health numeracy (continuous), study DXA, fracture risk, gender of provider, physician, and provider specialty.

Table 4

Effect estimates at 52 weeks from linear mixed effect models on the eight outcomes.

Outcome		Effect	Effect Estimate	95% CI	P-value
Correctly identified the results of their baseline DXA	Model 1	Race Black vs. White	−0.128	(−0.165, −0.091)	<0.001
	Model 2	Race Black vs. White	−0.149	(−0.193, −0.105)	<0.001
	Model 3	Race Black vs. White	−0.147	(−0.191, −0.103)	<0.001
		Intervention vs. Control	0.065	(0.034, 0.096)	<0.001
		Site KP vs. UAB	0.105	(0.068, 0.141)	<0.001
	Model 4	Race Black vs. White	−0.147	(−0.191, −0.103)	<0.001
		Intervention vs. Control	0.069	(0.027, 0.11)	0.001
		Site KP vs. UAB	0.109	(0.060, 0.158)	<0.001
		Site (KP) * Intervention	−0.008	(−0.072, 0.055)	0.798
On guideline concordant pharmacotherapy	Model 1	Race Black vs. White	0.138	(0.104, 0.173)	<0.001
	Model 2	Race Black vs. White	−0.107	(−0.148, −0.066)	<0.001
	Model 3	Race Black vs. White	−0.107	(−0.148, −0.066)	<0.001
		Intervention vs. Control	0.003	(−0.025, 0.031)	0.838
		Site KP vs. UAB	−0.006	(−0.038, 0.026)	0.729
	Model 4	Race Black vs. White	−0.107	(−0.148, −0.066)	<0.001
		Intervention vs. Control	0.004	(−0.032, 0.041)	0.818
		Site KP vs. UAB	−0.004	(−0.047, 0.039)	0.859
		Site (KP) * Intervention	−0.003	(−0.06, 0.054)	0.909
Osteoporosis related satisfaction	Model 1	Race Black vs. White	−0.183	(−0.263, −0.102)	<0.001
	Model 2	Race Black vs. White	−0.085	(−0.184, 0.014)	0.094
	Model 3	Race Black vs. White	−0.079	(−0.177, 0.02)	0.117
		Intervention vs. Control	0.2	(0.127, 0.274)	<0.001
		Site KP vs. UAB	0.046	(−0.043, 0.135)	0.309
	Model 4	Race Black vs. White	−0.078	(−0.177, 0.021)	0.121
		Intervention vs. Control	0.177	(0.078, 0.276)	<0.001
		Site KP vs. UAB	0.019	(−0.099, 0.136)	0.756
		Site (KP) * Intervention	0.053	(−0.095, 0.201)	0.485

Outcome		Effect	Effect Estimate	95% CI	P-value
Osteoporosis specific knowledge	Model 1	Race Black vs. White	−0.625	(−0.698, −0.553)	<0.001
	Model 2	Race Black vs. White	−0.439	(−0.527, −0.35)	<0.001
	Model 3	Race Black vs. White	−0.437	(−0.525, −0.348)	<0.001
		Intervention vs. Control	0.058	(−0.003, 0.12)	0.063
		Site KP vs. UAB	0.012	(−0.058, 0.082)	0.741
	Model 4	Race Black vs. White	−0.436	(−0.525, −0.347)	<0.001
		Intervention vs. Control	0.029	(−0.05, 0.109)	0.470
		Site KP vs. UAB	−0.024	(−0.118, 0.071)	0.623
		Site (KP) * Intervention	0.069	(−0.055, 0.192)	0.276
Osteoporosis self-efficacy exercise	Model 1	Race Black vs. White	0.083	(0.006, 0.16)	0.036
	Model 2	Race Black vs. White	0.214	(0.125, 0.304)	<0.001
	Model 3	Race Black vs. White	0.213	(0.124, 0.303)	<0.001
		Intervention vs. Control	−0.028	(−0.09, 0.034)	0.38
		Site KP vs. UAB	0.059	(−0.012, 0.13)	0.102
	Model 4	Race Black vs. White	0.214	(0.124, 0.304)	<0.001
		Intervention vs. Control	−0.061	(−0.142, 0.02)	0.142
		Site KP vs. UAB	0.019	(−0.077, 0.115)	0.696
		Site (KP) * Intervention	0.077	(−0.048, 0.203)	0.225
Osteoporosis self-efficacy diet	Model 1	Race Black vs. White	−0.01	(−0.086, 0.067)	0.806
	Model 2	Race Black vs. White	0.091	(−0.003, 0.185)	0.057
	Model 3	Race Black vs. White	0.090	(−0.004, 0.184)	0.06
		Intervention vs. Control	−0.031	(−0.097, 0.035)	0.364
		Site KP vs. UAB	0.071	(−0.005, 0.146)	0.066
	Model 4	Race Black vs. White	0.091	(−0.003, 0.185)	0.057
		Intervention vs. Control	−0.064	(−0.149, 0.022)	0.145
		Site KP vs. UAB	0.032	(−0.069, 0.133)	0.538
		Site (KP) * Intervention	0.076	(−0.056, 0.208)	0.258
Patient activation	Model 1	Race Black vs. White	−0.002	(−0.077, 0.073)	0.960
	Model 2	Race Black vs. White	0.117	(0.023, 0.211)	0.014

Outcome		Effect	Effect Estimate	95% CI	P-value
	Model 3	Race Black vs. White	0.117	(0.024, 0.211)	0.014
		Intervention vs. Control	0.008	(−0.058, 0.075)	0.804
		Site KP vs. UAB	0.002	(−0.074, 0.079)	0.950
	Model 4	Race Black vs. White	0.118	(0.024, 0.211)	0.014
		Intervention vs. Control	−0.024	(−0.111, 0.063)	0.596
		Site KP vs. UAB	−0.036	(−0.139, 0.066)	0.487
		Site (KP) * Intervention	0.074	(−0.059, 0.208)	0.274

Model 1 includes race only (Black vs. White)

Model 2 includes race and covariates measured at baseline

Model 3 includes race, intervention, plus covariates measured at baseline

Model 4 includes race, intervention, interaction between intervention and site (KP vs. UAB), plus covariates measured at baseline

Baseline covariates include, site (KP vs. UAB), age (continuous), education, comorbidity (COPD, depression and breast cancer), self-assessed health status (using self-reported health status, continuous), heath habits (current smoker, former smoker and drinker), bone health (history of DXA, history of fracture and history of osteoporosis treatment), health literacy (continuous), health numeracy (continuous), study DXA, fracture risk, gender of provider, physician, and provider specialty.