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ORIGINAL REPORT

Health Care Segregation, Physician Recommendation, and Racial Disparities in *BRCA1/2* Testing Among Women With Breast Cancer

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ABSTRACT

Purpose

Racial disparities in *BRCA1/2* testing have been documented, but causes of these disparities are poorly understood. The study objective was to investigate whether the distribution of black and white patients across cancer providers contributes to disparities in *BRCA1/2* testing.

Patients and Methods

We conducted a population-based study of women in Pennsylvania and Florida who were 18 to 64 years old and diagnosed with invasive breast cancer between 2007 and 2009, linking cancer registry data, the American Medical Association Physician Masterfile, and patient and physician surveys. The study included 3,016 women (69% white, 31% black), 808 medical oncologists, and 732 surgeons.

Results

Black women were less likely to undergo *BRCA1/2* testing than white women (odds ratio [OR], 0.40; 95% CI, 0.34 to 0.48; $P < .001$). This difference was attenuated but not eliminated by adjustment for mutation risk, clinical factors, sociodemographic characteristics, and attitudes about testing (OR, 0.66; 95% CI, 0.53 to 0.81; $P < .001$). The care of black and white women was highly segregated across surgeons and oncologists (index of dissimilarity 64.1 and 61.9, respectively), but adjusting for clustering within physician or physician characteristics did not change the size of the testing disparity. Black women were less likely to report that they had received physician recommendation for *BRCA1/2* testing even after adjusting for mutation risk (OR, 0.66; 95% CI, 0.54 to 0.82; $P < .001$). Adjusting for physician recommendation further attenuated the testing disparity (OR, 0.76; 95% CI, 0.57 to 1.02; $P = .06$).

Conclusion

Although black and white patients with breast cancer tend to see different surgeons and oncologists, this distribution does not contribute to disparities in *BRCA1/2* testing. Instead, residual racial differences in testing after accounting for patient and physician characteristics are largely attributable to differences in physician recommendations. Efforts to address these disparities should focus on ensuring equity in testing recommendations.

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INTRODUCTION

Testing for mutations in *BRCA1* and *BRCA2* can reduce breast and ovarian cancer risk by targeting preventive interventions to women found to carry a mutation and enabling the assessment of cancer risk among family members.[1] Multiple advisory groups recommend consideration of *BRCA1/2* testing among women who are at increased risk for carrying a *BRCA1/2* mutation, including women with breast cancer who meet specific criteria.[1-3] Although the probability of carrying a *BRCA1/2* mutation is similar for black and white women in the United States,[4-12] several studies have demonstrated that rates of *BRCA1/2* testing are substantially lower among black than white women.[6,13-15] The causes of testing disparities are poorly understood, with prior studies being unable to explain differences in testing on the basis of differences in mutation risk, attitudes about *BRCA1/2* testing, or insurance and socioeconomic status.[13,14,16]

Another potential cause of health care disparities is the segregation of racial groups across health care facilities and physicians.[17-20] Racial

residential segregation refers to the uneven distribution of racial groups across small geographic areas within a larger area and has been well described for most US cities, particularly for black and white residents. Racial residential segregation (most commonly measured by the index of dissimilarity) has been linked to a variety of health outcomes. However, there is relatively little information about the level of racial segregation within health care itself or the connections between an uneven distribution of racial groups across health care providers and health care utilization or outcomes.

A few studies have demonstrated that black and white patients in the United States tend to be treated at different hospitals and by different doctors, and that providers with greater proportions of black patients may have different characteristics and outcomes; however, studies examining the effect of this clustering on disparities in recommended care for specific conditions are limited.[21-28] Although the uptake of genetic testing has been shown to differ across physicians,[29] it is unknown whether segregation of black and white patients across breast cancer physicians contributes to racial disparities in *BRCA1/2* testing.

Given this background, we conducted a large, population-based study of women with recently diagnosed breast cancer to investigate whether black and white patients with breast cancer were unevenly distributed across physicians, and whether that clustering explained racial disparities in *BRCA1/2* testing.

PATIENTS AND METHODS

The study population included women 18 to 64 years old, who were diagnosed with localized or regional-stage invasive breast cancer in Pennsylvania and Florida between January 1, 2007 and December 31, 2009. These states were included because of the size and diversity of their populations and the ability to directly contact patients from cancer registry files. We included all black women, an equal random sample of white women, and all women diagnosed before the age of 40 to facilitate comparisons by race and to enrich for women who would be candidates for genetic testing. Women were sampled on the basis of race as recorded in the cancer registry. Thirty women were excluded because they reported a different race when surveyed. A small proportion of participants reported Hispanic ethnicity (2% of black and 7% of white women).

Women were surveyed by mail 24 to 36 months after cancer diagnosis, with additional telephone recruitment efforts made for black nonresponders up to 48 months after diagnosis. The overall response rate was 61%[30] (62% among white women and 58% among black women). Patients provided the name and address of their surgeon and medical oncologist. This information was linked to the American Medical Association Physician Masterfile, and physicians were surveyed using mailed and/or online surveys. The physician response rate was 29%.[30] The University of Pennsylvania Institutional Review Board approved the study and considered completion of a questionnaire as implicit informed consent.

The use of *BRCA1/2* testing was measured with a pretested single item with a sensitivity of 95% and a specificity of 92% compared with medical records among the 95 patients who received care through Penn Medicine. *BRCA1/2* mutation risk was categorized into mutually exclusive categories (high, moderate, and low) using age at diagnosis, family history, and Ashkenazi Jewish heritage (Fig 1) on the basis of the 2007 National Comprehensive Cancer Network guidelines[31] because participants were diagnosed between 2007 and 2009. Attitudes toward *BRCA1/2* testing were measured using a scale that included four items about potential benefits and three items about potential adverse effects of testing (Cronbach's alpha = 0.75). We independently analyzed a single item about the cost of testing.

Physician demographic and practice characteristics were obtained from the American Medical Association Physician Masterfile. Physician innovativeness was assessed because innovativeness has been associated

High risk – Women were categorized as high mutation risk if they met any of the five criteria below:

1. Diagnosed ≤ 40 years
2. Diagnosed ≤ 50 years and:
   First- or second-degree female relative diagnosed with breast cancer ≤ 50 years or first- or second-degree relative with ovarian cancer
3. First- or second-degree male relative with breast cancer
4. Two relatives with breast or ovarian cancer at any age in the same lineage
5. Ashkenazi Jewish ancestry

Moderate risk – Women were categorized as moderate mutation risk if they did not meet high-risk criteria and met either of the two criteria below:

1. Diagnosed 41 to 49 years and:
   A relative with breast cancer diagnosed > 50 years or no family history of cancer
2. Diagnosed ≥ 50 years and:
   Any family history of breast or ovarian cancer

Low risk – Women were categorized as low mutation risk if they did not meet criteria for high or moderate risk, ie:

1. Diagnosed ≥ 50 years and no family history of breast or ovarian cancer

Fig 1. *BRCA1/2* mutation risk categories.

with the adoption of new medical technologies.[32-36] Physician innovativeness was measured using five items adapted from an established scale[37-41] (Cronbach's alpha = 0.65). Perceptions of barriers included items about whether *BRCA1/2* testing is too expensive, too difficult to arrange, and usually covered by their patients' insurance. Given that it is the most commonly used metric of racial residential segregation, we used the index of dissimilarity to assess segregation of black and white patients. It ranges from 0 to 100 and represents the proportion of patients who would have to be treated by a different physician for black and white patients to be evenly distributed across physicians.[42] For racial residential segregation, an index of dissimilarity > 30 is considered moderate segregation and > 60 high segregation.[43]

Statistical Analyses

Characteristics of respondents and nonrespondents for both physician and patient surveys were compared using χ^2 tests. χ^2 tests and *t* tests were used to compare characteristics of black and white women and characteristics of physicians who treated a greater number of black patients in our cohort (top quintile) versus physicians who treated fewer black patients (bottom four quintiles). The association of race with physician recommendation was assessed using logistic regression adjusted for patient characteristics including age at diagnosis, risk group, stage at diagnosis,[44] estrogen/progesterone receptor status, education, income, insurance type, state, *BRCA* attitude scale, and *BRCA* cost. Missing covariate data were handled by including a missing indicator variable.

The effect of patient and physician characteristics on the racial disparity in *BRCA* testing was assessed with sequential logistic regression models adjusted for patient and physician characteristics. We included physician as a clustering variable in multilevel models and adjusted for physician characteristics (age, sex, US medical education, employment, and medical school graduation year). Additionally, we included physician variables for the proportion of black patients and the number of black patients treated.

Finally, we adjusted the multilevel model for physician recommendation for *BRCA1/2* testing. In a subanalysis among patients with physician survey data, we also adjusted for physician-perceived barriers to testing, ability to access genetic counseling, and physician innovation. All statistical tests were two sided with a significance level of < .05. Analyses were performed using STATA/IC version 14 (College Station, TX). More details of the methods are provided in the Data Supplement.

RESULTS

Of the 3,016 study participants, 2,071 were white and 945 were black. A comparison of respondents and nonrespondents is provided in the Data Supplement. Among respondents, black women were older; were more likely to have higher-stage, hormone receptor–negative disease; and had lower levels of education and income (Table 1). Black women were less likely to report any relative with breast or ovarian cancer, but were more likely to report a first-degree relative with breast or ovarian cancer (Table 1 and Data Supplement). After aggregating risk factors, *BRCA1/2* mutation risk was lower among black women, with 30% of black women and 52% of white women meeting high-risk criteria.

Black women were slightly less likely to report positive attitudes about *BRCA1/2* testing and slightly more likely to report negative attitudes, except for higher concerns about the effect of testing on health or life insurance among white women (Table 1 and Data Supplement). There was no difference in belief that *BRCA1/2* testing is too expensive between black and white women (Table 1). Among women who underwent *BRCA1/2* testing, black women were less likely to be categorized high risk than white women. The majority of women (> 80%) identified their surgeon and medical oncologist, although black women were less likely to identify their physicians than white women (Data Supplement).

The care of black and white women was highly segregated across surgeons and medical oncologists, with indices of dissimilarity of 64.1 and 61.9, respectively. The characteristics of the surgeons and medical oncologists caring for study patients are reported in Table 2. Among oncologists, those in the quintile who cared for the most black patients were younger ($P = .01$) and more likely to be female ($P < .001$). Among surgeons, those in the quintile who cared for the most black patients were younger ($P = .03$), more likely to be female ($P < .001$), used in group practice ($P = .002$), and a graduate of a US medical school ($P = .02$).

Among the 210 oncologists and 208 surgeons who completed the survey, physicians who took care of more black women did not differ in innovativeness or attitudes toward *BRCA1/2* testing compared with physicians who took care of fewer black women. Black women were less likely to have their surgeon or oncologist recommend *BRCA1/2* testing, as shown in univariate analyses (odds ratio [OR], 0.38; 95% CI, 0.32 to 0.45; $P < .001$); this difference persisted after adjustment for mutation risk, clinical factors, sociodemographic characteristics, and attitudes about testing (Table 3; OR, 0.66; 95% CI, 0.54 to 0.82; $P < .001$). Accounting for physician and physician characteristics (age, sex, US trainee, employment type, and medical school graduation year) in a multilevel model did not change the observed association between race and physician recommendations (Data Supplement).

Overall, 26.7% of black women underwent *BRCA1/2* testing compared with 47.5% of white women (OR, 0.40; 95% CI, 0.34 to 0.48; $P < .001$). This difference was attenuated by adjustment for mutation risk, clinical factors, sociodemographic characteristics, and attitudes about testing (Table 4 [Model 2]). In addition to the association with patient race, *BRCA1/2* testing was more common among women at higher mutation risk, with estrogen/progesterone receptor–negative cancers, with higher levels of education and income, who were younger, with more positive attitudes about testing, and who believed testing is affordable.

In the multilevel model (Table 4 [Model 3]), adjustment for the treating physician explained 7% of the variance in testing use ($P = .003$), and having a female physician was associated with higher odds of testing. However, accounting for clustering within physician and adjusting for physician characteristics had no effect on the size of the racial difference in testing. Additionally, neither the proportion of black patients seen by physicians nor the number of black patients seen by physicians (highest quintile *v* remaining quintiles) were statistically significantly associated with testing, nor did they alter the OR for the association of race with *BRCA* testing (data not shown). Similarly, among patients whose physician completed the survey (n = 1,540; physician respondent and nonrespondent characteristics are given in the Data Supplement), adjustment for perceived barriers to testing, access to genetic counseling, or physician innovation did not alter the size of the racial difference in *BRCA1/2* testing. However, a physician recommendation for *BRCA1/2* testing was strongly associated with the use of *BRCA1/2* testing, and adjustment for physician recommendation narrowed the racial difference in testing so that it was no longer statistically significant (Table 4 [Model 4]).

Table 1. Characteristics of Patients by Race (N = 3,016)

	Black		White		
	No.	%	No.	%	*P*
Total no. of patients	945	100	2,071	100	
State					
Florida	523	55.3	1,046	50.5	.01
Pennsylvania	422	44.7	1,025	49.5	
Age, years					
< 40	77	8.2	590	28.5	< .001
40-44	105	11.1	270	13.0	
45-49	181	19.2	247	11.9	
50-54	192	20.3	277	13.4	
55-59	220	23.3	307	14.8	
60-64	170	18.0	380	18.4	
Stage					
I	454	48.0	1,141	55.1	< .001
II	491	52.0	930	44.9	
ER/PR status					
Negative	281	29.7	385	18.6	< .001
Positive	607	64.2	1,559	75.3	
Unknown	57	6.0	127	6.1	
Education					
≤ High school	321	34.0	510	24.6	< .001
Any college	476	50.4	1,071	51.7	
Graduate school	132	14.0	472	22.8	
Unknown	16	1.7	18	0.9	
Income, $ thousands					
< 30	375	39.7	379	18.3	< .001
30-70	300	31.8	664	32.1	
> 70	173	18.3	919	44.4	
Missing	97	10.3	109	5.3	
Insurance					
Employer based	368	38.9	1,134	54.8	< .001
Medicaid	117	12.4	82	4.0	
Medicare	151	16.0	236	11.4	
Self-pay	159	16.8	441	21.3	
Other/missing	150	15.9	178	8.6	
Medonc reported	708	74.9	1,837	88.7	< .001
Surgeon reported	737	78.0	1,902	91.8	< .001
Family history of breast or ovarian cancer*	466	49.3	1,108	53.5	.03
Mutation risk					
High	279	29.5	1,075	51.9	< .001
Moderate	359	38	577	27.9	
Low	307	32.5	419	20.2	
Ashkenazi ancestry	10	1.1	160	7.7	< .001
Surgeon recommended *BRCA1/2* testing	155	16.4	656	31.7	< .001
Oncologist recommended *BRCA1/2* testing	188	19.9	770	37.2	< .001
BRCA attitudes scale, mean (standard deviation)†	26.5 (3.9)		27.1 (4.3)		< .001
BRCA1/2 testing is too expensive for me to afford	291	30.8	607	29.3	.41
No. of patients who underwent *BRCA1/2* testing (%)	252 (100)		984 (100)		
High risk	124 (49.2)		739 (75.1)		< .001
Moderate risk	88 (34.9)		192 (19.5)		
Low risk	40 (15.9)		53 (5.4)		

Abbreviations: ER, estrogen receptor; Medonc, medical oncologist; PR, progesterone receptor.
*Additional family history characteristics and *BRCA* attitudes items can be found in the Data Supplement.
†A higher score indicates a more positive view of *BRCA1/2* testing.

DISCUSSION

The potential for genomic information to improve treatment and prevention decisions continues to expand as the number of clinically useful genomic tests grows.[45,46] At the same time, enthusiasm for this potential effect is increasingly tempered by concern about inequities in the delivery of genomic applications.[47] *BRCA1*/2 mutation testing was one of the first genetic tests for the risk of common disease to become clinically available, and it offers an important model for understanding factors driving disparities in the use of genomic applications. Our study offers several insights that can inform strategies to address disparities in precision medicine.

First, more than 15 years after *BRCA1/2* testing became available, racial disparities in *BRCA1/2* testing among women with

Table 2. Physician Characteristics by Number of Black Patients in Study Population

AMA Physician Masterfile Data	No. of Black Patients Seen: Medical Oncologists, Top Quintile,* n = 121	Medical Oncologists, Bottom Quintiles, n = 687	*P*	Surgeons, Top Quintile,* n = 134	Surgeons, Bottom Quintiles, n = 598	*P*
Age in years, %						
25-39	18.2	12.5	.01	6.7	5.4	.03
40-49	34.7	24.3		29.9	30.4	
50-59	21.5	30.4		40.3	30.1	
≥ 60	19.8	21.4		19.4	22.7	
Missing	5.8	11.4		3.7	11.4	
Female, %	43.9	21.8	< .001	34.3	17.1	< .001
US trained, %	67.8	72.3	.31	92.5	82.9	.02
Employment, %						
Solo practice	8.3	8.8	.22	20.2	29.8	.002
Group practice	64.5	63.1		52.2	42.3	
Other setting	21.5	16.8		23.9	16.7	
Missing	5.8	11.4		3.7	11.2	
Year of medical school graduation, %						
< 1975	13.2	16.9	.06	11.2	17.1	.01
1975-1984	22.3	26.6		38.8	28.6	
1985-1994	29.8	24.9		29.1	27.8	
≥ 1995	28.9	20.2		17.2	15.4	
Missing	5.8	11.4		3.7	11.2	
Survey data						
No. of respondents	34	176		47	161	
Perceived barriers to testing, % agree						
BRCA1/2 testing usually covered by insurance	61.8	74.4	.13	72.3	62.1	.20
BRCA1/2 testing too expensive	61.8	57.4	.64	59.6	50.9	.30
BRCA1/2 testing too difficult to schedule	20.6	11.9	.17	17.0	13.0	.49
Innovation scale, mean (standard deviation)	17.4 (3.4)	17.0 (3.3)	.45	15.5 (3.7)	16.4 (3.3)	.13

Abbreviation: AMA, American Medical Association.
*Because of the patient distribution, the top quintile represents 16.5% of medical oncologists and 18.9% of surgeons. Physicians in the top quintile treated at least two black patients.

breast cancer remain large, with black women nearly half as likely as white women to undergo testing. As seen in an earlier study of a primary care population, this disparity is only partially explained by differences in the risk of carrying a mutation, tumor characteristics, and sociodemographic characteristics, or attitudes about testing.[13] Our study demonstrates that the disparity in testing is not explained by differences in the doctors that black and white women see for their cancer treatment. Rather, it is driven, in part, by differences in the recommendations that are given to black versus those given to white women, with both oncologists and surgeons being less likely to recommend *BRCA1/2* testing to black women than they are to white women even after adjusting for the predicted risk of a mutation.

The reasons for this difference in physician recommendation are uncertain. Several studies suggest that family history information may be less complete among black women than white women, either because of less awareness of family members' cancer diagnoses or because physicians are less likely to ask about family history.[48,49] In our study, reporting of first-degree family history was similar by race, whereas second-degree family history was more likely to be incomplete for black women. One small study of oncologists suggests that doctors may be more concerned about cost and the challenges of insurance coverage of *BRCA1/2* testing among black patients.[50] In addition, physicians may have misconceptions about the level of interest in testing among black women, the rate of mutations, or the rates of variants of unknown significance, which have declined significantly in recent years, even among women of African ancestry.[4-12,51] Given the importance of physician recommendation for testing use, interventions to address this large disparity in recommendation rates should be a priority.

Second, despite evidence that mutation rates are similar among black and white women with breast cancer, application of the 2007 *BRCA* risk assessment guidelines led to a lower proportion of black women being classified as high risk (approximately 30%) than white women (approximately 52%). Although this difference may reflect in part the specific characteristics of our sample, it emphasizes the importance of continually improving risk algorithms to ensure accurate identification of women at high risk across racial and ethnic groups. Since 2007, guidelines for testing have been revised to include women diagnosed with breast cancer before the age of 45 (*v* the age of 40 previously), and with triple-negative breast cancer before the age of 60.[52] Given that black women are more likely to be diagnosed with triple-negative cancers and at younger ages, these changes will likely improve equity in risk assessment.[11,53]

Third, as assessed by a commonly used metric of racial residential segregation, the care of black and white patients with breast

Table 3. Logistic Regression of Physician Recommendation for *BRCA1/2* Testing (N = 3,016)

	Odds Ratio	95% CI	*P*
Race			
Black (*v* white)	0.66	0.54 to 0.82	< .001
Risk group			
Low	Ref		
Moderate	1.86	1.37 to 2.53	< .001
High	4.03	2.94 to 5.51	< .001
Stage			
I	Ref		
II	1.02	0.84 to 1.22	.87
ER/PR			
Positive (*v* negative)	0.87	0.70 to 1.09	.22
Age, years			
60-64	Ref		
< 40	6.65	4.50 to 9.85	< .001
40-44	5.27	3.55 to 7.82	< .001
45-49	2.44	1.66 to 3.59	< .001
50-54	1.98	1.37 to 2.88	< .001
55-59	1.43	0.98 to 2.07	.06
Education			
≤ High school or GED	Ref		
College	1.44	1.15 to 1.81	.002
≥ Graduate school	1.66	1.24 to 2.23	.001
Income, $ thousands			
< 30	Ref		
30-70	1.70	1.29 to 2.24	< .001
> 70	1.78	1.32 to 2.40	< .001
Insurance type			
Employer based	Ref		
Medicaid	0.71	0.45 to 1.12	.14
Medicare	1.11	0.77 to 1.60	.58
Self-pay	1.06	0.84 to 1.35	.62
State			
Florida	Ref		
Pennsylvania	0.81	0.67 to 0.97	.02
Attitudes			
BRCA attitude scale	1.14	1.12 to 1.17	< .001
BRCA cost	0.78	0.63 to 0.95	.01

NOTE. Physician recommendation includes patient report of recommendation from oncologist or surgeon. Models also included stage at diagnosis, which was not associated with testing use.
Abbreviations: ER, estrogen receptor; GED, General Educational Development; PR, progesterone receptor; Ref, reference.

cancer is highly segregated in this study, similar to previous studies of primary care and other cancer care.[26-28,54] Surgeons and medical oncologists who deliver most of their care to black women differ in terms of age and sex from physicians who care for relatively few black women. However, those physician characteristics are not traditionally associated with differences in quality. Furthermore, characteristics such as level of innovativeness or attitudes toward testing that may have contributed to differences in testing recommendations did not differ substantially across these groups of physicians. These findings add to the growing literature about the uneven distribution of racial groups across health care providers,[18,55-58] providing an additional example where clustering exists but does not explain a large racial difference in care.[59-61]

Fourth, racial differences in attitudes about *BRCA1/2* testing were relatively small and had little impact on testing use. Although efforts to prevent discrimination based on genetic information remain important, concerns about employment or insurance discrimination did not drive racial disparities in *BRCA1/2* testing in this sample.[62] Although more research about the prevalence and impact of these concerns is needed across different settings and different populations,[63-66] these results suggest that physicians should not assume that black women have negative attitudes about testing and are unlikely to pursue testing if it is offered.[50]

This study has several strengths. To our knowledge, it is the only study to examine the patient- and physician-level correlates of *BRCA1/2* testing in a large, population-based sample of racially diverse patients with breast cancer, a key target for the use of this test. Furthermore, by including patient surveys, physician surveys, and cancer registry records, it included a wide range of potential explanations for the disparity in testing, including family history, which is critical to determine testing eligibility and is not available in administrative data.

However, this study also has several limitations. The patient survey had a reasonable response rate, but respondents and nonrespondents differed in terms of age, race, and year of diagnosis. In addition, black women were less likely than white women to provide physician data. Whereas demographic and some practice information was available for all of the physicians, only 29% of physicians responded to the survey, making analyses of those measures possible in only 50% of the overall patient sample.

We were unable to compare academic versus nonacademic centers, and additional work should examine educational and genetic counseling strategies to increase the use of testing among black women. Although we found that self-reported use of *BRCA1/2* testing has relatively high positive and negative predictive value (91% and 96%, respectively), testing status may have been misclassified for some women, and it is possible that misclassification would be larger among black women. Also, we relied on patient self-reports of physician recommendations for *BRCA1/2* testing, and women who undergo testing may be more likely to recall their physician's recommendation. However, it is unlikely that this tendency would differ between black and white women and, to the degree that it resulted in nondifferential misclassification, it would make it more difficult to find a difference by race.

Patients with breast cancer may receive care from other types of doctors in addition to surgeons and medical oncologists. However, our pilot testing and clinical experience found that few patients with breast cancer reported having received testing recommendations from other types of physicians. Finally, although Florida and Pennsylvania comprise large, diverse populations, it is possible that the patterns observed in these states are not generalizable to other areas of the country.

In summary, racial disparities in *BRCA1/2* testing among women with breast cancer are large and are not fully explained by differences in risk factors for carrying a mutation. Although black and white women tend to see different surgeons and oncologists for their cancer care, this segregation does not explain disparities in *BRCA1/2* testing. Instead, differences in physician recommendations for testing are associated with disparities in testing. Efforts to address these disparities should focus on ensuring equity in testing recommendations.

Table 4. Logistic Regression Models Assessing Predictors of *BRCA1/2* Testing Use (N = 3,016)

Variables	Model 1: Mutation Risk			Model 2: Mutation Risk, Clinical Factors, Sociodemographic Characteristics, Attitudes About *BRCA1/2* Testing*			Model 3: Model 2 With Inclusion of Physician Random Effect and Characteristics*			Model 4: Model 3 With Inclusion of Physician Recommendation for *BRCA1/2* Testing*		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Patient factors												
Race												
Black *v* white	0.54	0.45 to 0.64	< .001	0.66	0.53 to 0.81	< .001	0.64	0.51 to 0.81	< .001	0.76	0.57 to 1.02	.06
Risk group (*v* low)												
Moderate	2.88	2.22 to 3.74	< .001	1.72	1.27 to 2.34	< .001	1.75	1.27 to 2.40	.001	1.36	0.91 to 2.03	.13
High	10.9	8.52 to 13.9	< .001	3.79	2.78 to 5.17	< .001	3.92	2.82 to 5.44	< .001	2.18	1.44 to 3.29	< .001
Age, years (*v* 60-64)												
< 40				6.71	4.53 to 9.93	< .001	7.35	4.83 to 11.19	< .001	3.22	1.90 to 5.46	< .001
40-44				5.44	3.66 to 8.09	< .001	5.93	3.89 to 9.04	< .001	3.00	1.76 to 5.09	< .001
45-49				2.74	1.86 to 4.02	< .001	2.91	1.93 to 4.37	< .001	2.19	1.31 to 3.65	.003
50-54				1.92	1.33 to 2.77	.001	1.99	1.35 to 2.93	.001	1.53	0.94 to 2.49	.09
55-59				1.29	0.89 to 1.86	.18	1.31	0.89 to 1.93	.17	1.06	0.66 to 1.71	.81
ER/PR status												
Positive *v* negative				0.73	0.58 to 0.91	.005	0.71	0.56 to 0.90	.004	0.68	0.50 to 0.91	.01
Education (*v* HS/GED)												
College				1.32	1.05 to 1.66	.02	1.31	1.03 to 1.66	.03	1.04	0.77 to 1.41	.79
Graduate school				1.93	1.43 to 2.58	< .001	1.91	1.40 to 2.60	< .001	1.73	1.17 to 2.56	.06
Income, $ thousands (*v* < 30)												
30-70				1.18	0.90 to 1.56	.23	1.12	0.84 to 1.50	.44	0.74	0.51 to 1.07	.11
> 70				1.40	1.04 to 1.89	.03	1.32	0.97 to 1.81	.08	0.95	0.64 to 1.43	.82
Insurance type (*v* employer based)												
Medicaid				0.60	0.38 to 0.94	.03	0.62	0.39 to 1.00	.05	0.67	0.38 to 1.20	.18
Medicare				1.13	0.79 to 1.63	.50	1.09	0.75 to 1.60	.65	1.12	0.70 to 1.80	.64
Self-pay				0.97	0.76 to 1.23	.80	0.95	0.74 to 1.23	.72	0.88	0.64 to 1.23	.46
Other				0.75	0.54 to 1.05	.10	0.74	0.52 to 1.05	.10	0.82	0.52 to 1.28	.38
State												
Pennsylvania *v* Florida				0.69	0.57 to 0.83	< .001	0.63	0.50 to 0.79	< .001	0.63	0.48 to 0.83	.001
Attitudes												
BRCA attitude scale				1.18	1.15 to 1.21	< .001	1.19	1.16 to 1.22	< .001	1.15	1.12 to 1.19	< .001
BRCA cost				0.55	0.45 to 0.68	< .001	0.54	0.43 to 0.67	< .001	0.49	0.37 to 0.64	< .001
Physician recommendation for testing										36.69	26.89 to 50.06	< .001
Physician characteristics												
Age of physician, years												
40-49 *v* 25-39							1.27	0.81 to 1.99	.30	1.43	0.83 to 2.49	.20
50-59 *v* 25-39							1.19	0.64 to 2.21	.59	1.23	0.58 to 2.62	.60
≥ 60 *v* 25-39							1.22	0.58 to 2.55	.61	1.38	0.56 to 3.42	.49
Sex of physician												
Female *v* male							1.44	1.14 to 1.82	.002	1.12	0.84 to 1.50	.45
Physician trained in United States												
No *v* yes							1.05	0.81 to 1.36	.73	1.02	0.74 to 1.40	.91
Employment												
Group *v* solo practice							1.07	0.74 to 1.57	.71	0.93	0.59 to 1.46	.74
Other *v* solo practice							1.08	0.70 to 1.66	.74	1.11	0.66 to 1.87	.69
Year of medical school graduation												
1975-1984 *v* < 1975							1.11	0.67 to 1.86	.68	1.06	0.57 to 1.99	.85
1985-1994 *v* < 1975							0.86	0.46 to 1.60	.63	0.76	0.36 to 1.64	.49
≥ 1995 *v* < 1975							0.90	0.43 to 1.90	.78	0.72	0.29 to 1.80	.49
Physician random effect†							Rho: 0.071	0.028 to 0.169	.003	Rho: 0.051	0.009 to 0.238	.09

Abbreviations: ER, estrogen receptor; GED, General Educational Development; HS, high school; OR, odds ratio; PR, progesterone receptor.
*Models also included stage at diagnosis, which was not associated with testing use.
†Rho indicates the proportion of variation in *BRCA1/2* testing explained by treating physician.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Health Care Segregation, Physician Recommendation, and Racial Disparities in *BRCA1/2* Testing Among Women With Breast Cancer

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