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Racial disparities in the development of breast cancer metastases among older women: A multi-level study

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Abstract

Background—Distant metastases are the most common and lethal type of breast cancer relapse. We examined whether older African American breast cancer survivors were more likely to develop metastases compared with older white women. We also examined the extent to which five mediating pathways explained racial disparities in the development of metastases.

Methods—We used 1992−1999 Surveillance Epidemiology and End Results (SEER) data with 1991−1999 Medicare data. We used Medicare's ICD-9-CM codes to identify metastases of respiratory and digestive systems, brain, bone, or of other unspecified sites. The five mediating pathways consisted of patient characteristics, tumor characteristics, type of treatment received, access to medical care, surveillance mammography use, and area-level characteristics (poverty rate and percent African American) and were obtained from the SEER or Medicare data.

Results—Of the 35,937 women, 10.5% developed metastases. In univariate analysis, African American women were 1.61 (95% CI: 1.54−1.83) more likely to develop metastasis as white women. In multivariable analysis, tumor grade, stage at diagnosis, and census-tract percent African American explained why African American women were more likely to develop metastases as white women (HR: 1.13; 95% CI: 0.93−1.40).

Conclusions—Interventions to reduce late-stage breast cancer among African Americans also may reduce racial disparities in subsequent increased risk of developing metastasis. African Americans diagnosed with high-grade breast cancer could be targeted to reduce their risk of metastasis. Future studies should identify specific reasons why the racial distribution in census tracts was associated with racial disparities in the risk of breast cancer metastases.

Keywords

racial disparity; community factors; neighborhood; breast neoplasms

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Introduction

Racial disparities in breast cancer diagnosis, treatment, and survival are well established. African American women are less likely to develop breast cancer, but when they do, they are more likely to be diagnosed with late-stage breast cancer1 and have a decreased survival compared with white women.2, 3 Explanations for these disparities are likely complex and may include socioeconomic, cultural, and biological factors.4-7

Distant metastases are the most common and lethal type of breast cancer relapse, but less is known about racial disparities in risk of distant disease relapse. Reducing any racial disparities in relapse may also reduce racial disparities in breast cancer mortality. Since racial disparities in breast cancer mortality have been increasing over time,8, 9 identifying reasons for disparities in development of metastases may help reverse this trend.

Differences in breast cancer tumor biology have been examined as an explanation for racial disparities in breast cancer prognosis. Recently, gene expression profiling of tumors has demonstrated that there is a difference in prevalent in cancer subtypes among African Americans and whites, with a higher prevalence of poor-prognosis basal-like breast cancers in African American women.5, 10 Tumor characteristics such as higher tumor grade, estrogen and progesterone receptor status also increase the risk of metastasis development.2 Some of these biological characteristics also vary by race.11

Besides tumor characteristics, there may be several other mediating pathways that could explain why African Americans are more likely to develop metastases. First, at the time of diagnosis, African American women may differ from white women in terms of specific patient characteristics, e.g., older age and more comorbidity, which might convey increased vulnerability to the development of metastases.12 Second, different type and extent of treatment received may affect the development of metastases. African American women are less likely to receive indicated radiotherapy and later-generation chemotherapeutic agents than white women.13 Third, lack of access to care and contact with the medical system may result in delayed detection of metastases, and African American women typically have lower access to medical care than white women.14 Fourth, surveillance mammography after diagnosis reduces the risk of death among older women with breast cancer,15 but surveillance mammography is underutilized by older African American women.16 Fifth, African Americans are more likely to live in areas with increased poverty rates and segregated from white women. Residents of these areas may have reduced access to local resources, such as grocery stores selling fresh fruits and vegetables,17 which may lead to increased consumption of dietary fat intake, which, in turn, is associated with development of metastases.18 Residents of these areas also may experience increased psychosocial stress, which may indirectly influence development of metastases through increased stress hormones and reduced immune function.19, 20

We sought to determine if older African American breast cancer survivors were more likely to develop metastases compared with older white women using a retrospective cohort design. We also examined the extent to which the abovementioned pathways of patient characteristics, tumor characteristics, type of treatment received, access to medical care, surveillance mammography use, and area-level characteristics (poverty rate and racial distribution) mediated any observed associations between race and development of metastases.

Methods

Sample Selection

The sample for this study was obtained from a database that links data from the 1992−1999 National Cancer Institute's SEER program with 1991−1999 Medicare claims files from the Centers for Medicare and Medicaid (CMS).21 Inclusion of study data about breast cancer occurrence started in 1992 in order to obtain patients' comorbidity data at least one year prior to their diagnosis. Ninety-four percent of cancer patients age 65 or older who were reported to SEER were successfully matched to the Medicare data.21 We limited the study population to women age 66 or older with a first primary, stage I-III breast cancer from 1992 to 1999 (n=54,818). We excluded women with in situ breast cancer, which has a very low risk of metastases, as well as women who already had metastatic breast cancer (TNM stage IV) at diagnosis. We excluded women who were age 65 at diagnosis, in order to be able to obtain comorbidity data from Medicare. Of the 54,818 women, we excluded 19,010 women who 1) were enrolled in a health maintenance organization (HMO) at any point during the 1991−1999 study period, since claims data would not be available; 2) were not covered by Medicare Parts A and B during the time between diagnosis and study end point (date of death or December 31, 1999); and 3) were identified by death certificate only, since survival time cannot be calculated. This left 35,808 patients age 66 or older at time of diagnosis available for the remainder of the study. Approval was obtained from Washington University's Institutional Review Board.

Measurement of metastases and time at risk

We used Medicare's ICD-9-CM codes (197.0−198.1, 198.3−198.7, 198.82−198.89) to identify metastases of respiratory and digestive systems, brain, bone, or of other unspecified sites.22, 23 Medicare claims are able to accurately identify secondary malignancies.23 To maximize the potential to identify new metastases and discriminate these from the initial breast cancer diagnosis, we started identifying metastases at least seven months after breast cancer diagnosis. Thus, time at-risk for developing metastases started at seven months post diagnosis. Identifying metastases starting at two months after diagnosis showed similar results.

Patients who did not develop metastases were censored in the statistical analysis. SEER registries ascertain annual vital status through a number of approaches, including contact with physicians and patients, review of death certificates and local obituaries, and matching against the National Death Index and Medicare enrollment data. Patients were classified as lost to follow-up after the last date at which vital status was positively established. For this study, the follow-up cutoff date was December 31, 1999.

Individual-level variables

The individual-level variables were categorized into five mediating pathways: 1) patient factors (age, marital status, and comorbidity), 2) type of treatment received (type of surgery, radiation therapy, and chemotherapy), 3) tumor characteristics (stage at diagnosis, histology, estrogen receptor status, progesterone receptor status, and tumor grade), 4) access to primary care (ambulatory-care-sensitive hospitalizations [ACSH], which are considered preventable by high-quality primary care), and 5) surveillance mammography use.

From SEER, we obtained data about TNM stage at diagnosis, tumor grade, estrogen receptor (ER) and progesterone receptor (PR) status, histology, first-course type of surgery, first-course receipt of radiation therapy, race, and marital status. From Medicare, we obtained information about comorbidity, chemotherapy, and ACSH. We used the Deyo adaptation of the Charlson comorbidity index to measure comorbidity.24, 25 We searched all available

ICD-9 CM codes in the Medicare files (inpatient, outpatient, physician claims) to identify claims of women from 365 days before to 120 days after their breast cancer diagnosis. Women who had no Medicare claims during this period were categorized as having unknown comorbidity.

Chemotherapy was obtained from the Medicare claims data, which are of adequate validity and completeness.26 We used ICD-9-CM procedure, revenue center and V codes to define chemotherapy.27 Women were considered to have received chemotherapy for breast cancer if there was at least one claim present after the date of diagnosis; other women were coded as not having received chemotherapy.

Similar to other studies, we used Medicare claims data to identify ACSH, as an indicator of adequate, timely, efficient, and high-quality ambulatory care.28 The ICD-9-CM codes reported as a first or primary diagnosis for each hospitalization were used to determine if a hospitalization could be classified as ACSH.29 Women who had one or more ACSH at any time following their breast cancer diagnosis were considered to have less adequate, timely, efficient, or high-quality ambulatory care. This group of women was compared with women who did not have any ACSH following their breast cancer diagnosis. Only those ACSH that occurred prior to the date of diagnosis of any metastases, if any, were considered for inclusion in the analysis.

Mammograms were identified from the Medicare data by the CPT-4 codes of 76090, 76091, and 76092 starting at seven months after diagnosis. Since the procedure codes distinguish poorly between screening and diagnostic mammograms,30 we counted two mammograms within one month of each other as one screening mammogram. For claims with a screening mammography code (76092), there had to be a screening diagnosis code (V10.3, V15.89, V16.3, V72.5, or V76.1) in the physician's claim.31, 32 There is high concordance between claims data and medical record data for mammography use among breast cancer survivors. 33 We determined whether or not women had received one or more mammograms during each 14-month time period starting seven months after diagnosis. Women who had a mammogram during each of the 14-month time periods were considered to have received annual mammography. These women were contrasted with women who had mammograms during some but not all time periods and with women who did not have any mammograms.

Area-level variables

The study was conceptualized in terms of two-level models in which breast cancer survivors (level 1) were nested within census tracts (level 2). Area-level variables consisted of poverty rate and racial distribution (percent African American) at the census-tract level. Addresses of residence of breast cancer patients were address matched to obtain the census-tract variables using the 1990 census data. Poverty rate is a measure that is robust across various diseases and levels of geography and has possible implications for policy recommendations. 34 The racial distribution of each census tract was based on the percentage of all residents in the census tract who were African American. This overall reflected the predominant minority group in the census tracts. Percentage of African American in a given census tract is an indicator of minority residential segregation; a high percentage of African American per tract population corresponds to greater minority segregation. Other racial/ethnic minorities may be present within census tracts; however, African Americans may experience higher levels of residential segregation and more hypersegregation (i.e., segregation in socio-environmental dimensions, such as recreational activities, church, and other social gatherings).35

Statistical analysis

Our two-level survival models (time until metastasis, if any) used restricted iterative generalized least squares36 and second-order penalized quasi-likelihood estimation. Time consisted of the number of months between the date of diagnosis plus six months and until first claim for a metastasis (if any), death, or end of the study period (December, 1999). Women who died or reached the end of the study period without metastasis were censored at that time. Women who had a metastasis were compared to women who were censored.

Mediation of the various pathways between race and development of metastases was tested using the approach described by Krull and McKinnon.37 Univariate associations were performed to describe the relationship between each of the mediating variables, development of metastasis, and race. Hazard ratios and 95% confidence intervals were calculated for each comparison. Multivariable, multilevel survival models were constructed to evaluate the influence of the mediating pathway variables on development of metastasis. Each of these groups of variables was added separately to the multilevel survival model to examine their effect on the hazard ratio for patient race. Changes in hazard ratios for patient race were considered evidence for the mediating effects of these groups of variables. It was recognized that, because a variety of variables were tested simultaneously, certain variables might have a stronger mediating effect than others, and some variables might not have a mediating effect at all.

Models were developed and fitted using MLwiN, Version 2.0.2.38 Parameters in the fixed part and the random part of the survival models were tested with the Wald test.

Results

For 35,808 women in the study population, median and mean duration of follow-up were 32.5 months and 36.5 months, respectively. A total of 6,846 census tracts, with an average of 5.3 women per tract (range: 1−62), were included in the analysis. During the study period, 3,757 (10.5%) women developed metastases at least seven months after their breast cancer diagnosis. Median and mean time until metastasis were 18.2 month and 22.7 months, respectively. Of 2,101 African American women, 347 (16.5%) developed metastases. Of 32,387 white women, 3,295 (10.2%) developed metastases. Of 1,320 women of other races, 115 (8.7%) developed metastases. The most common first site of metastasis was to bone (42.3%), followed by lung (22.6%), and liver (13.4%). The site of first metastasis did not vary significantly by race (p=0.2847) as shown in Table 1.

Overall, African American women were more likely to be younger and to have comorbidities (Table 2). African Americans also were more likely to be diagnosed with more advanced disease and with ER negative and PR negative breast cancers (although a higher percentage of African Americans had unknown ER and PR status). African American women were less likely to have surgery and more likely to have an ACSH than white women. Table 2 also shows that average poverty rate for whites and African Americans were 9.8 percent and 28.2 percent, respectively. African American women lived in census tracts with significantly higher average census-tract percent African American compared with white women and women of other races. The correlations between census-tract poverty rate and percent African American was 0.55 ($p<0.001$). Among African American breast cancer patients, 11.1 percent lived in census tracts where African Americans constituted less than 10 percent of the population and 38.1 percent lived in census tracts where African Americans constituted at least 90 percent of the population. By comparison, among white breast cancer patients, 91.2 percent lived in census tracts where African Americans constituted less than 10 percent of the population and 0.2 percent lived in census tracts where African Americans constituted at least 90 percent of the population.

Table 2 also shows that women who were diagnosed with stage II-III tumors, and had moderately, poorly, or undifferentiated tumors, a mastectomy; and ER negative and PR negative tumors were more likely to develop metastases than their respective comparison groups. Women who were 70 years of age or older and women who had received radiotherapy were less likely to develop metastases than their respective comparison groups. Women were ten percent more likely to develop metastases for every ten percent increase in census-tract poverty rate. For every ten percent increase in census-tract percent African American, women were six percent more likely to develop metastases.

In univariate analysis, African American women were 1.61 (95% CI: 1.54−1.83) as likely and women of other races were 0.81 (95% CI: 0.66−0.99) as likely to develop metastasis regardless of type of metastasis as white women (Table 3, Model 1). We added the groups of potentially mediating variables separately to the multilevel survival model to examine their respective effects on the hazard ratio for patient race. When adding all tumor characteristics to the univariate Model 1, the hazard ratio for African Americans versus whites was reduced to 1.28 (95% CI: 1.12−1.46) as shown in Model 3. Of the four tumor characteristics, the largest reduction in hazard ratio for patient race was seen for tumor grade (Model 3a) and stage at diagnosis (Model 3d), although African American women remained more likely to develop metastases than white women when each of these variables were included in the model. When adding census-tract percent African American (Model 8) to Model 1, the hazard ratio for African American women from Model 1 was reduced to 1.30 (95% CI: 1.07−1.59). When adding stage at diagnosis, tumor grade, and census-tract percent African American to the univariate Model 1, African American breast cancer patients (HR: 1.13; 95% CI: 0.93−1.40) and women of other races were equally likely (HR: 0.84; 95% CI: 0.68−1.03) as white women to develop metastases (Model 9), suggesting that these three factors explained why African American women were more likely to develop metastases than white women. Sensitivity analysis showed that using census-tract percent African American or census-tract poverty rate as categorical variables did not alter the findings. Patient characteristics (Model 2), treatment factors (Model 4), access to primary care (Model 5), use of surveillance mammography after diagnosis (Model 6), and census-tract poverty rate (Model 7) did not influence the hazard ratio appreciably for African American relative to white women, suggesting that they did not mediate the association between race and development of metastases.

Discussion

Racial disparities in metastases following breast cancer diagnosis play an important role in racial disparities in breast cancer survival. Our results show that racial distribution at the census-tract level, tumor grade, and stage at diagnosis combined were able to explain why African American women were at increased risk of developing metastases relative to white women. Any differences in patient characteristics, type of treatment received, access to primary care, surveillance mammography use after diagnosis, and census-tract poverty rate between African American and white women were not able to explain racial disparities in the risk of metastases.

Racial distribution at the census-tract level partly explained why African American women were at increased risk for metastases. Racial residential segregation may increase the risk of developing metastases through increased psychosocial stress and indirectly influence development of metastases through increased stress hormones and reduced immune function.[19, 20, 39, 40] In addition to the direct effects of stress on physiological functioning, individuals who are stressed are more likely to have health behaviors that put them at greater risk, including greater propensity for alcohol abuse, poorer nutrition, and less physical activity – health behaviors that have immunological and endocrinological consequences.[41]

Reducing the effect of psychological stress through provision of social support, including the presence of a social network or psychological intervention, has been shown to be associated with decreased rate of metastasis.19, 20, 42 There is evidence linking stress and subsequent behavioral response patterns to cancer progression.43 Older African American women diagnosed with stage I-III breast cancer who live in predominantly African American communities should be encouraged to participate in support groups and/or health behaviors, such as physical activity and a diet low in fat and high in fruit and vegetable consumption in an effort to reduce their risk of developing metastases.

African Americans who live in segregated, predominantly African American communities also may be more likely to seek treatment for their breast cancer at smaller hospitals, and the physicians they see may have less experience with diagnosis and treatment of breast cancer. Lower hospital volume (annual number of breast cancer surgeries) has been associated with increased risk of adverse breast cancer outcomes.44 Additional studies are needed to provide insight into why African American breast cancer survivors living in predominantly African American census tracts are particularly vulnerable to the development of breast cancer metastases.

Stage at diagnosis also partly explained racial differences in the risk of metastases. This may be due to delayed diagnosis or differences in tumor cell biology.2 Inadequate mammographic screening may result in the development of more advanced cancers in African American women. In an analysis of more than one million women, inadequate mammographic screening explained the observed differences in advanced cancer rates in African American women.45 Interventions to reduce late-stage breast cancer among African Americans thus may also reduce subsequent occurrence of metastasis.

Tumor grade also partly explained racial differences in the risk of metastases. African American women were more likely to be diagnosed with tumors of a higher grade.2 Tumor grade among older African American women may be considered a marker for a population segment that may especially benefit from interventions aimed at reducing the risk of metastasis.

This study was limited in several respects due to our use of the linked SEER-Medicare data. Our study was limited to women aged 66 or older diagnosed with stage I-III breast cancer during 1992−1999, who did not have managed care insurance as part of the Medicare program, who had part B Medicare coverage, and who resided in one of the SEER program areas. Our findings cannot be generalized to women age 65 or younger, who resided elsewhere, who were enrolled in a health maintenance organization, and who only had Medicare part A coverage.

Also, using administrative claims data precluded us from examining some factors that were not available and that also might explain the racial disparity in risk of metastasis, such as proliferation markers, smoking status, and household income.2, 46 Additionally, the length of follow-up restricted our analysis predominantly to the detection of early recurrences (within three year), but it cannot be generalized to late recurrences (>5 year). However, the combined factors of tumor grade, stage at diagnosis, census-tract percent African American entirely explained racial differences in development of metastasis, suggesting that the unmeasured factors would only be able to explain our findings if they were strongly associated with tumor grade, stage at diagnosis, and census-tract percent African American. This is unlikely to be the case. Additionally, we did not have information about possible migration of the study population into different areas after diagnosis, and therefore could not determine whether patients who moved to different areas were more or less likely to develop metastases compared with patients who did not move. Strengths of this study include the use

of the population-based SEER-Medicare, the prospective multilevel design, and our focus on this rapidly growing population of older breast cancer survivors.

In summary, stage at diagnosis, tumor grade and racial distribution at the census-tract level explained racial disparities in the development of breast cancer metastases. Interventions to reduce late-stage breast cancer among African Americans also may reduce racial disparities in subsequent increased risk of developing metastasis. African Americans diagnosed with high-grade breast cancer could be targeted to reduce their risk of metastasis. Reasons why the racial distribution in census tracts is associated with racial disparities in the risk of breast cancer metastases may include greater likelihood of psychosocial stress leading to increased stress hormones and reduced immune function, of engagement in health behaviors, or of environmental factors that might put them at greater risk for metastases. Further research is recommended to analyze the relative impact of these potential risk factors on development of breast cancer metastases.

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Table 1

Percent of first metastasis by type and race among patients with stage I-III breast cancer, 1992−1999.

Type of first metastasis	White (n=3,295)	African American (n=347)	Other (n=115)	Total (n=3,757)
Bone	42.9	39.5	33.9	42.3
Lung	22.4	22.7	27.8	22.6
Liver	13.0	16.4	14.8	13.4
Brain	6.5	9.2	8.7	6.8
Gastrointestinal*	5.6	4.6	6.1	5.5
Other	9.6	7.6	8.7	9.4

* Includes small intestine/duodenum, large intestine/rectum, retroperitoneum/peritoneum, other digestive organs/spleen

Table 2

Selected characteristics (percent) of the study population by race and univariate associations (hazard ratio, 95% confidence interval) with risk of development of metastasis at least seven months after first diagnosis among patients with stages I-III breast cancer, 1992−1999.

	White (n=32,387)	African American (n=2,101)	Other race (n=1,320)	Unadjusted association with development of metastases
Patient factors				
Age group*				
66−69	20.9	23.9	30.2	1.00
70−74	28.4	29.5	33.6	0.87 (0.79−0.96)
75−79	23.9	24.1	21.2	0.79 (0.71−0.88)
80−84	15.9	13.2	10.2	0.69 (0.61−0.78)
85+	10.9	9.3	4.8	0.51 (0.44−0.59)
Comorbidity*				
None	53.9	39.0	54.4	1.00
One	27.0	27.6	25.8	1.07 (0.98−1.16)
Two or more	17.7	31.3	17.1	1.00 (0.91−1.10)
No claims	1.4	2.1	2.7	0.45 (0.29−0.68)
Tumor factors				
TNM stage*				
I	57.9	46.5	60.3	1.00
IIA	25.2	26.4	23.4	1.85 (1.69−2.02)
IIB	10.0	15.5	9.9	3.03 (2.73−3.36)
II (unknown)	0.8	0.8	0.4	4.13 (3.04−5.61)
IIIA	2.9	4.9	2.5	4.35 (3.72−5.09)
IIIB	3.3	6.0	3.5	3.63 (3.14−4.22)
Morphologic grade*				
Well differentiated (I)	16.7	11.6	16.4	1.00
Moderately differentiated (II)	37.0	30.3	40.2	1.97 (1.71−2.27)
Poorly differentiated (III)	24.6	30.0	24.1	3.82 (3.32−4.39)
Undifferentiated (IV)	2.1	1.4	1.8	4.01 (3.12−5.16)
Unknown	19.6	26.7	17.5	3.92 (3.38−4.54)
Estrogen receptor*				
Positive	68.2	54.2	69.0	1.00
Negative	12.6	18.5	15.2	1.87 (1.71−2.06)
Unknown	19.3	27.4	15.8	1.23 (1.12−1.35)
Progesterone receptor*				
Positive	55.9	44.4	58.0	1.00
Negative	22.5	26.3	25.2	1.57 (1.44−1.70)
Unknown	21.6	29.4	16.9	1.25 (1.15−1.37)
Type of treatment				

	White (n=32,387)	African American (n=2,101)	Other race (n=1,320)	Unadjusted association with development of metastases
Surgery*				
Breast conserving	47.7	47.0	42.7	1.00
Mastectomy	51.6	51.2	57.0	2.04 (1.90−2.20)
None	0.6	1.7	0.1	1.66 (1.15−2.39)
Unknown	0.1	0.1	0.2	2.03 (0.74−5.61)
Radiotherapy*				
No	36.9	33.8	38.4	1.00
Yes	61.8	63.5	59.7	0.80 (0.74−0.86)
Unknown	1.3	2.7	1.9	1.07 (0.81−1.40)
Lack of access to primary care				
No	87.5	83.1	91.3	1.00
Yes*	12.6	16.9	8.8	0.97 (0.86−1.08)
Census-tract level	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	
Poverty rate*	9.8 (9.0)	28.2 (16.1)	12.6 (11.5)	1.10 (1.06−1.08)**
Percent African American*	5.1 (12.0)	65.4 (31.4)	7.0 (14.4)	1.06 (1.04−1.08)**

s.d.: standard deviation

* $p<0.01$ for differences by race

** per 10% increase

Table 3

Hazard ratios (HR) and 95% confidence intervals (CI) measuring likelihood of African American and Other race compared with white breast cancer patients to develop metastases at least seven months after first diagnosis, by controlling for various mediating variables for women aged 66 or older with stages I-III breast cancer, 1992−1999.

		HR (95% CI)	
Model	**Adjustment variables**	**African Americans**	**Other race**
1	None (univariate)	1.61 (1.54−1.83)	0.81 (0.66 −0.99)
2	Patient characteristics	1.56 (1.37−1.78)	0.76 (0.62−0.94)
3	Tumor characteristics	1.28 (1.12−1.46)	0.81 (0.66−1.00)
3a	Grade	1.45 (1.27−1.65)	0.82 (0.67−1.01)
3b	Histology	1.60 (1.41−1.83)	0.80 (0.65−0.98)
3c	Estrogen & progesterone receptor status	1.52 (1.33−1.74)	0.80 (0.65−0.98)
3d	Stage at diagnosis	1.42 (1.24−1.62)	0.82 (0.67−1.01)
4	Type of treatment received	1.65 (1.44−1.89)	0.76 (0.61−0.94)
5	Lack of access to primary care	1.61 (1.41−1.84)	0.78 (0.63−0.96)
6	Surveillance mammography after diagnosis	1.63 (1.43−1.86)	0.79 (0.65−0.97)
7	Census-tract poverty rate	1.51 (1.31−1.75)	0.80 (0.65−0.98)
8	Census-tract percent African American	1.30 (1.07−1.59)	0.80 (0.66−0.99)
9	Tumor grade, stage at diagnosis, Census-tract percent African American	1.13 (0.93−1.40)	0.84 (0.68−1.03)
10	All variables	1.20 (0.96−1.50)	0.71 (0.57−0.95)

Patient characteristics: age, marital status, and comorbidity

Tumor characteristics: stage at diagnosis, histology, estrogen receptor status, progesterone receptor status, and tumor grade

Type of treatment received: type of surgery, radiation therapy, and chemotherapy

Lack of access to primary care: ambulatory-care-sensitive hospitalizations