Published in final edited form as:

Cancer. 2009 July 01; 115(13): 2999–3008. doi:10.1002/cncr.24363.

Racial and Socioeconomic Disparities in Adjuvant Chemotherapy for Node-Positive Operable Breast Cancer in Older Women

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Abstract

Background: Consistent with findings from clinical trials, a recent population-based study showed that adjuvant chemotherapy for node-positive operable breast cancer is effective at improving survival in older women, specifically those aged 65–69, but no conclusion has been made about relative benefit of chemotherapy for women aged ≥ 70 likely due to small number of cases. However, little is known about racial and socioeconomic disparities in adjuvant chemotherapy for breast cancer among older women.

Methods: The study included 14,177 white and 1,277 black women aged ≥ 65 diagnosed with operable breast cancer (stage II–IIIA) and with positive lymph nodes from 1991–2002, identified from the Surveillance, Epidemiology, and End Results (SEER) and Medicare-linked database. Multivariate logistic regression was used to compute the odds ratios of receiving chemotherapy in blacks compared to whites, and test if **census-tract level** poverty mediated racial disparities by the casual step approach.

Results: Interaction terms analyses indicated that regressions should be stratified by age group. In the 65–69 age group, adjusted odds ratio of receiving chemotherapy were lower for black women than for white women (odds ratio=0.85, 95% CI=0.57–0.97). Poverty mediated the association between chemotherapy and race in this age group. No racial and socioeconomic disparities were found in women aged ≥ 70 .

Conclusions: This study documented racial disparities in adjuvant chemotherapy that was mediated by poverty in women aged 65–69, a group for which there is clear evidence of efficacy, but no disparities in those aged ≥ 70 . It is important to work towards reducing treatment disparities among older women.

Condensed Abstract

We found racial disparities, mediated by **census-tract level** poverty, in adjuvant chemotherapy in women aged 65–69 with node-positive operable breast cancer, a group for which the treatment

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Financial disclosures: There are no financial disclosures from any author.

guidelines recommend the use of adjuvant chemotherapy. No racial and socioeconomic disparities were found in women aged 70 or older.

Keywords

Breast neoplasm; chemotherapy; health care disparities; minority health; SEER-Medicare

Introduction

A disproportionate number of breast cancer deaths occur in racial and ethnic minorities.^{1,2} In particular, African American women have greater breast cancer recurrence and higher mortality than white women.^{3–5} The causes for these disparities include a more advanced stage of disease at diagnosis in African American women, racial differences in tumor characteristics and comorbid conditions,⁴ and racial differences in treatment.^{1–2,5–8} Several studies found that adjusting for tumor characteristics and treatment eliminated or greatly attenuated racial differences in survival,^{2,9,10} but some studies found persistent disadvantage in survival of African American women.¹¹ In addition, several studies have investigated racial differences in breast cancer treatment after controlling for disease severity, prognostic factors, and comorbidities.^{3,5–8} The findings about racial differences in adjuvant therapy in women with early breast cancer are inconsistent, depending on the type of adjuvant therapy and the stage at diagnosis.^{12–15} Several studies have indicated that, even when African American women received chemotherapy, they received suboptimal treatment.^{16–19}

Older women are disproportionately affected by breast cancer. More than half of breast cancer deaths occur in women aged 65 and over and the median age at diagnosis is 61.²⁰ However, older women with breast cancer are more likely to be under-treated. Increasing age is associated with not receiving effective cancer therapies, even after controlling for comorbidity and prognostic factors.^{13, 21–23} Recent research, using population-based observational cohort,²⁴ has shown that adjuvant chemotherapy for node-positive operable breast cancer is effective at improving survival in older women, specifically those aged 65 to 69, but no conclusion has been made about relative benefit of chemotherapy for women aged ≥ 70 likely due to small number of cases. These results are consistent with findings from clinical trials.²⁵ However, very little is known about racial disparities in adjuvant chemotherapy for breast cancer treatment among older women. A number of studies reported breast cancer chemotherapy in older women,^{6,13,21} but few investigate racial disparities.^{12, 22, 26} Mandelblatt and colleagues^{12, 26} found that, among Medicare beneficiaries 67 years or older with local breast carcinoma, African Americans were less likely to receive radiotherapy after breast conservation surgery. In a paper that focused on the relationship between chemotherapy and age among Medicare breast cancer patients for all stages, Du et al²² noticed no racial differences in chemotherapy use. A recent paper also found no racial differences in chemotherapy among breast cancer patients aged 66 to 85.²⁷

Given the recent findings supporting the effectiveness of chemotherapy in the population of older women aged 65–69 with early (stage II and IIIA) breast cancer²⁴ and the persistent disadvantage in breast cancer-specific mortality in older African American women with

early stage breast cancer compared to white women,² it is important to further investigate racial disparities in adjuvant chemotherapy among older women with early stage breast cancer. In this paper, we investigated racial disparities in adjuvant chemotherapy for node-positive operable breast cancer in a much larger and most recent updated population-based cohort of women aged 65 and older in 1991 through 2002 with up to 16 years of follow-up. We studied this population because adjuvant chemotherapy is strongly recommended based on guidelines in node-positive operable breast cancer patients aged 65–69.^{28,29} Guidelines on chemotherapy in women over 70 are less clear.^{28,29} Furthermore, we investigated if racial disparities were mediated by socioeconomic status (SES). We used the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) cancer registry data linked to Medicare data in the 16 areas that account for over 25% of the total U.S. population. Because of the large sample size, we were able to investigate racial differences in adjuvant chemotherapy among subgroups of older women aged 65–69, 70–74, 75–79, and 80.

Methods

Data Sources

This study used the SEER-Medicare linked database, which is supported by the National Cancer Institute and covers the 16 SEER areas. Because of small number of cases, we combined rural Georgia with Atlanta, and combined four registries in California (San Francisco, Los Angeles, San Jose, and the rest of California), making them into 12 geographic areas. The Medicare program provides payment for over 97% of medical care for persons aged over 65 or older.

Study Population and Sample Size Needed

The study population consisted of 15,598 African American and White women aged 65 and older who were diagnosed with operable breast cancer (stage II or IIIA) and also with positive lymph nodes during the period from 1991 to 2002, identified from the 12 SEER areas. Women in the study population had full coverage of both Medicare Part A and Part B and were not with Health Maintenance Organizations in the year of diagnosis. The study population did not include women who had other primary cancer. Women with missing SES variables were excluded, leaving 15,454 women (14,177 White and 1,277 African American) for the final analyses. Based on sample size equation for comparing two proportions,³⁰ 395 subjects will be needed in each racial group in order to have 80% power to detect a prevalence difference of 6% in receiving chemotherapy with $P < 0.05$.

Study variables

Chemotherapy —Chemotherapy received within 6 months of breast cancer diagnosis was obtained from Medicare claims. The identification of chemotherapy through Medicare claims has been previously described and found to be reliable.³¹

Comorbidity index —Comorbidity was ascertained from Medicare claims by identifying diagnoses or procedures made 1 year prior to and 1 month after the diagnosis of breast cancer, including heart disease, diabetes, and dementia but excluding any malignant

tumor. Comorbid diseases within 1 month of diagnosis were included because they are likely to influence the choice of chemotherapy (as discussed in previous studies^{2,5}).

Socioeconomic status —SES was measured by poverty rate at the census tract level from the 1990 and 2000 census available in the SEER-Medicare linked data. Data from the 1990 census were linked to women diagnosed in 1991–1999 and the 2000 census data were linked to women diagnosed in 2000 or later. The **census-tract level** poverty rates defined as the percentage of persons living below the federal poverty line were categorized into quartiles.

Other characteristics —Patient and tumor characteristics such as age, race, marital status, tumor stage, tumor size, tumor grade, hormone receptor status, surgery and radiation, geographic area (12 SEER areas) and year of diagnosis were available from the SEER data. Age was categorized into subgroups: 65–69, 70–74, 75–79, and 80.

Analyses

Differences in the distribution of baseline characteristics between African American and White women were tested using the chi-square statistic. Differences in receiving chemotherapy by race stratified by age group were also tested using the chi-square statistic. The odds ratios of receiving chemotherapy in African American women compared to White women were generated from multivariate logistic regression analyses. Three models with increasing number of covariates were estimated. The first model included only race and age. The second model further adjusted for tumor biological factors and treatment (tumor stage, tumor size, tumor grade, hormone receptor status, surgery and radiation) and other patient characteristics (marital status, comorbidity index, geographic area and year of diagnosis). The third model investigated if poverty mediates the relationship between race and chemotherapy by adding the poverty variable to the covariates in the second model. Mediation was tested using the casual step approach.^{32,33} The test of whether poverty mediated the relationship of race to chemotherapy included three steps: 1. a regression of chemotherapy on race; 2. a regression of chemotherapy on race and poverty and 3. a regression of race on poverty. Poverty was said to mediate the association of race on chemotherapy if: in the 1st regression, race was statistically significant; in the 2nd regression, race was not significant and poverty is significant; in the 3rd regression, poverty was significant.

We tested if the associations between chemotherapy and race varied by age group by examining interactions between race and age. Statistical significance of interaction terms added to the logistic regression of chemotherapy on race and age groups indicated that separate regressions by age group were appropriate. In order to investigate racial disparities in chemotherapy within the different age groups (65–69, 70–74, 75–79, and 80), all multivariate logistic regression analyses were repeated for stratifications by age group. Parameter estimates were obtained using the maximum-likelihood method of estimation and odds ratios (OR), the corresponding 95% confidence limits, and P-values were reported. All tests of significance were two sided; $P < 0.05$ was considered to be statistically significant. All analyses were completed using Stata/IC 10.³⁴

Results

Table 1 compares the use of chemotherapy, tumor biological factors and other patient characteristics in White versus Black women. When tumor, treatment, and patient characteristics were not controlled for, White and Black women had similar rates of chemotherapy. Racial differences were significant for all other characteristics, except year of diagnosis. Compared to White women, Black women were more likely to be younger, less likely to be married, and more likely to live in census tracts with higher poverty rates. They were more likely to be stage IIIA (versus II); had larger tumors, more positive nodes and less favorable tumor grade; were less likely to be hormone receptor positive and to receive BCS with radiation; and had higher comorbidity scores.

To investigate racial differences in chemotherapy by age, Table 2 compares chemotherapy in White and Black women within age groups. Black women were less likely to receive chemotherapy in the 65–69 age group, but there were no racial differences in the older age groups. To further investigate the relationship between race and age in chemotherapy, we estimated a logistic regression of chemotherapy on race and age group. The odds ratios for race (OR=0.85, 95% CI=0.57–0.97, P-value=.02) were statistically significant. Next, we investigated interactions between race and age by adding interaction terms to the regression. Interaction terms were significant (P value for χ^2 test of joint significance = 0.03), indicating that the associations between chemotherapy and race varied by age group. Therefore, we estimated logistic regressions stratified by age group of chemotherapy on race while controlling for tumor, treatment, and patient characteristics (Table 3).

Two models are presented in Table 3. Model-1 presents the odds ratio of receiving chemotherapy in blacks compared to whites while adjusting for patient and tumor characteristics except for socioeconomic status. Model-2 presents the odds ratio of receiving chemotherapy in blacks compared to whites by adding socioeconomic status to the model in addition to other factors in Model-1. Model-2 also presents the effects of other factors on the receipt of chemotherapy. After adjusting for patient and tumor characteristics, Black women were significantly less likely to receive chemotherapy in the 65–69 age group (odds ratio=0.68, 95% confidence interval: 0.52–0.90, P=0.01) and marginally less likely in the 70–74 age group (odds ratio=0.75, 95% confidence interval: 0.56–1.00, P=0.05). There were no racial differences in chemotherapy in women aged 75–79 and in those aged over 80.

However, after additionally adjusting for socioeconomic status (poverty variable) to the model, racial disparity in receiving chemotherapy was no longer significant in patients aged 65–69 years, indicating that poverty possibly explained racial differences in chemotherapy in this age group and was a candidate mediator between chemotherapy and race. Using the casual step approach, we found that poverty indeed mediated the relationship of race to chemotherapy since: 1). race was significant in the regression of chemotherapy on race (Model-1 in Table 3); 2). race was not significant and poverty was significant in the regression of chemotherapy on both race and poverty (Model-2 in Table 3); and 3). poverty was significant in the regression of race on poverty (P value for χ^2 test of significance for poverty quartiles <0.05). In Table 3, among patients ages 70–74, race was no longer marginally significant after adding poverty and poverty was not significant. In patients aged

75–79 and those aged 80 or older, neither race nor poverty was significant. In addition, racial disparity in receiving chemotherapy did not differ significantly in early time period (1991–1997) and in later time period (1998–2002). In both time periods, the odds ratios by race were not significant in patients aged 65–69 (0.85 (0.54–1.32 versus 0.71 (0.47–1.06) and those 70 or older (0.84 (0.60–1.17) versus 0.99 (0.78–1.24), although the magnitude slightly differed with overlapping confidence intervals. However, this stratified analysis by time periods had smaller numbers of cases, making the estimates relatively unstable with wider confidence intervals. Even though the sample size for comparison between blacks and whites on the use of chemotherapy was sufficient overall (395 for each group of blacks and whites are needed), subgroups analyses had smaller numbers and less power to detect the differences. Furthermore, we repeated all analyses with the population of 15,598 women which included women with missing SES variables. The magnitude and direction of the findings were similar.

Model-2 in Table 3 also presented the effect of other factors on the receipt of chemotherapy by age groups. The higher likelihood of receiving chemotherapy was generally associated with married women, higher tumor stage, more positive nodes, poor tumor grade, negative hormone receptor status, and lower comorbidity scores among women aged 65–69 years. In older age groups, the general patterns were similar but the results were less stable because the numbers of cases receiving chemotherapy in older women (particularly those over 80 years old) were small.

Discussion

In women with node-positive operable breast cancer, we found racial differences in adjuvant chemotherapy in women aged 65–69, marginal differences in women aged 70–74 and no differences in women aged over 74. Given the strong evidence about the effectiveness of adjuvant chemotherapy and current treatment guidelines recommending adjuvant chemotherapy in this population of women aged 65–69, our findings of racial differences in this age group are of concern. It is interesting that racial disparities narrowed with age and that no racial differences were found in women aged 75 and over for which the evidence of efficacy and the treatment guidelines are less clear.^{25, 29}

Some previous studies failed to find racial differences in adjuvant chemotherapy in older women.^{12, 22, 27} However, none of those studies specifically investigated adjuvant chemotherapy in the 65–69 age group. Analyzing adjuvant chemotherapy in all women 65 and older can be misleading because evidence of efficacy and treatment guidelines varies by age. Our results indicate that there are interactions between race and age in adjuvant chemotherapy. It is well known that as women age, they are less likely to receive adjuvant chemotherapy.^{13, 21–23} In fact, evidence of efficacy and treatment guidelines are less clear in women 70 and over because of a lack of women in that age group participating in clinical trials.^{25, 29} However, the data in this study indicate that, even though the use of adjuvant chemotherapy decreased with age in this large nationwide and population-based cohort of women with node-positive operable breast cancer, a substantial portion of older women in the population received the treatment (47% in women aged 70–74, 30% of women aged 75–79, and 10% of women aged ≥ 80 , respectively). Therefore there is a need to improve

enrollment of breast cancer patients aged 70 and over in clinical trials investigating the effectiveness of adjuvant chemotherapy in order to develop clearer guidelines for older women.

The relationship between race and treatment may not be fully explored without understanding the role of SES.^{11, 35} Because of the strong correlation between minority status and SES, race is often a surrogate measure for SES in health studies. This leads to inappropriately conclude that there are racial differences in outcomes.² We found that racial differences in adjuvant chemotherapy in the 65–69 age group were mediated by census tract poverty rates. These results demonstrate that socioeconomic factors, such as poverty, that are associated with race, may be one of the reasons responsible for the disparities between African American and White women in adjuvant chemotherapy in this age group. Even in this population of Medicare insured women, poverty can influence treatment decisions through access and cost of care, due to the difficulties for poorer women to pay for out-of-pocket costs and co-payments. Quality of care may also be worse in poorer neighborhoods. Poverty has been associated with limited access to care, limited treatment options, and difficulty with treatment compliance.³⁶ Women living in poorer neighborhoods may also be more likely to have poorer health, more comorbid conditions, worse employment, and different health beliefs. In addition, married women were more likely to receive chemotherapy possibly because of higher motivation for chemotherapy and more family support that includes transportation for visiting outpatient clinics to receive chemotherapy every few weeks for several months. All these factors may impact receiving adjuvant chemotherapy.¹⁵

Limitations of this study include the availability of SES indicators only at the census tract level. While living in disadvantaged neighborhood is an independent predictor of health care behavior, the lack of individual level SES measures may introduce residual confounding. Lack of information on provider characteristics, patient and physician treatment preferences, and hospitals or sites of care is a further limitation. In addition, there was no information on whether the quality of claims for chemotherapy in Medicare data varies by blacks and whites, which could have affected racial differences in the use of chemotherapy. However, this was not supported by our previous study which demonstrated that the quality of Medicare claims for radiation therapy did not vary significantly by blacks and whites.³⁷ Furthermore, although sample size for comparing two proportions of chemotherapy between blacks and whites are sufficient at 80% power with $P < 0.05$ overall or even in stratified analysis by age 65–69 and 70 or older, the sample size became smaller in further stratifications by age 70–74, 75–79 or 80 or above. Therefore, the estimates from these subgroups may be interpreted with caution.

In conclusion, this study documented racial disparities in adjuvant chemotherapy that was mediated by **census-tract level** poverty in women aged 65–69 with node-positive operable breast cancer, a group for which there is clear evidence of efficacy of chemotherapy. There were no racial and socioeconomic disparities in receiving chemotherapy in women aged 70 years or older for which there is no clear evidence of efficacy. Disparities in treatment may explain some of the racial disparities in breast cancer outcomes.² It is important to work towards reducing these treatment disparities, especially in light of evidence that there is no

difference in response to adjuvant chemotherapy in African American and White women.
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Acknowledgments:

We acknowledge the efforts of the National Cancer Institute; Center for Medicare and Medicaid Services; Information Management Services, Inc.; and the SEER Program tumor registries in the creation of this database. The interpretation and reporting of these data are the sole responsibilities of the authors. This study was supported by a grant from the Agency for Healthcare Research and Quality (R01-HS016743). We thank Kavita Sail for providing partial literature review and references, and Luisa Franzini for helpful comments on the early drafts. Alessia Bhargava is an economics major student at Yale and participated in summer research project.

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Table 1:

Comparison of characteristics of White versus Black older women with node-positive operable breast cancer

	All		White		Black		P value χ^2
	N	%	N	%	N	%	
Total	15454	100.0	14177	100.0	1277	100.0	
Chemo							
No chemotherapy	9656	62.5	8845	62.4	811	63.5	
Chemotherapy	5798	37.5	5332	37.6	466	36.5	0.43
Age group							
65–69	3769	24.4	3407	24.0	362	28.3	
70–74	3841	24.9	3539	25.0	302	23.6	
75–79	3638	23.5	3329	23.5	309	24.2	
80	4206	27.2	3902	27.5	304	23.8	<.01
Marital status							
Married	6368	41.2	6049	42.7	319	25.0	
Unmarried	8607	55.7	7701	54.3	906	70.9	
Unknown	479	3.1	427	3.0	52	4.1	<.01
Tumor stage							
Stage II	13826	89.5	12720	89.7	1106	86.6	
Stage IIIA	1628	10.5	1457	10.3	171	13.4	<.01
Tumor size, cm							
<1	801	5.2	753	5.3	48	3.8	
1.0 – <2.0	3811	24.7	3591	25.3	220	17.2	
2.0 – <3.0	4776	30.9	4412	31.1	364	28.5	
3.0 < 4.0	2579	16.7	2339	16.5	240	18.8	
4.0 +	3034	19.6	2670	18.8	364	28.5	
Unknown size	453	2.9	412	2.9	41	3.2	<.01
No. of positive nodes							
1	4912	31.8	4542	32.0	370	29.0	
2 to 3	3258	21.1	2984	21.0	274	21.5	
4 to 9	2674	17.3	2419	17.1	255	20.0	
10 to 51	1516	9.8	1381	9.7	135	10.6	
Unknown but positive	3094	20.0	2851	20.1	243	19.0	0.03
Tumor grade							
Well differentiated	1635	10.6	1550	10.9	85	6.7	
Moderately differentiated	5777	37.4	5370	37.9	407	31.9	
Poorly differentiated	5774	37.4	5188	36.6	586	45.9	
Unknown	2268	14.7	2069	14.6	199	15.6	<.01

	All		White		Black		P value χ^2
	N	%	N	%	N	%	
Hormone receptor status							
Positive	10777	69.7	10059	71.0	718	56.2	
Negative	2138	13.8	1876	13.2	262	20.5	
Unknown	2539	16.4	2242	15.8	297	23.3	<.01
Surgery & radiation							
BCS-only	2338	15.1	2106	14.9	232	18.2	
BCS with radiation	3401	22.0	3177	22.4	224	17.5	
Mastectomy alone	6009	38.9	5519	38.9	490	38.4	
Mastectomy with radiation	3706	24.0	3375	23.8	331	25.9	<.01
Comorbidity score							
0	9953	64.4	9290	65.5	663	51.9	
1	3456	22.4	3126	22.0	330	25.8	
2	2045	13.2	1761	12.4	284	22.2	<.01
SEER area							
Connecticut	1794	11.6	1730	12.2	64	5.0	
Detroit	2225	14.4	1806	12.7	419	32.8	
Hawaii	59	0.4	57	0.4	<5*	0.2	
Iowa	1788	11.6	1767	12.5	21	1.6	
New Mexico	493	3.2	486	3.4	7	0.5	
Seattle	1277	8.3	1260	8.9	17	1.3	
Utah	675	4.4	674	4.8	<5*	0.1	
Atlanta/ Rural Georgia	770	5.0	601	4.2	169	13.2	
Kentucky	572	3.7	536	3.8	36	2.8	
Louisiana	524	3.4	396	2.8	128	10.0	
New Jersey	1106	7.2	1002	7.1	104	8.1	
California	4171	27.0	3862	27.2	309	24.2	<.01
Year of diagnosis							
1991	893	5.8	843	5.9	50	3.9	
1992	1048	6.8	955	6.7	93	7.3	
1993	1004	6.5	926	6.5	78	6.1	
1994	1013	6.6	933	6.6	80	6.3	
1995	1000	6.5	926	6.5	74	5.8	
1996	895	5.8	810	5.7	85	6.7	
1997	977	6.3	898	6.3	79	6.2	
1998	979	6.3	890	6.3	89	7.0	
1999	1055	6.8	961	6.8	94	7.4	
2000	2076	13.4	1883	13.3	193	15.1	

	All		White		Black		P value χ^2
	N	%	N	%	N	%	
2001	2241	14.5	2061	14.5	180	14.1	0.11
2002	2273	14.7	2091	14.7	182	14.3	
Socioeconomic status (SES)							
1 st quartile (<3.9, high SES)	3858	25.0	3793	26.8	65	5.1	<.01
2 nd quartile (3.9–7.4)	3862	25.0	3758	26.5	104	8.1	
3 rd quartile (7.4–13.5)	3869	25.0	3682	26.0	187	14.6	
4 th quartile (>13.5, low SES)	3865	25.0	2944	20.8	921	72.1	

* No actual number of subjects less than 5 was reported as required by the data user agreement.

Table 2:

Comparison of white and black older women with node-positive operable breast cancer who received adjuvant chemotherapy versus those who did not, by age group.

Age group	Race	Total number of patients	Patients receiving chemotherapy		P value χ^2 test
			No. of patients	%	
65–69	White	3407	2244	65.9	<0.01
	Black	362	204	56.4	
	Total	3769	2448	65.0	
70–74	White	3539	1662	47.0	0.40
	Black	302	134	44.4	
	Total	3841	1796	46.8	
74–79	White	3329	1027	30.9	0.75
	Black	309	92	29.8	
	Total	3638	1119	30.8	
80	White	3902	399	10.2	0.38
	Black	304	36	11.8	
	Total	4206	435	10.3	

Multivariate analysis of receiving adjuvant chemotherapy in blacks compared to whites, stratified by age and adjusted for tumor, patient characteristics and socioeconomic status

Table 3.

	Age 65–69 N=3769		Age 70–74 N=3841		Age 75–79 N=3638		Age 80 N=4206	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
MODEL-1 *								
Race								
White	reference		reference		reference		reference	
Black	0.68 (0.52–0.90)	0.01	0.75 (0.56–1.00)	0.05	0.82 (0.60–1.12)	0.21	0.93 (0.61–1.42)	0.75
MODEL-2 *								
Race								
White	reference		reference		reference		reference	
Black	0.78 (0.58–1.04)	0.09	0.84 (0.62–1.15)	0.28	0.79 (0.57–1.09)	0.16	0.93 (0.59–1.44)	0.73
Marital status								
Married	reference		reference		reference		reference	
Unmarried	0.88 (0.75–1.03)	0.12	0.79 (0.68–0.91)	<01	0.86 (0.73–1.02)	0.08	0.65 (0.51–0.83)	<01
Unknown	0.64 (0.41–1.00)	0.05	0.47 (0.28–0.77)	<01	1.26 (0.76–2.09)	0.38	0.63 (0.33–1.21)	0.17
Tumor stage								
II	reference		reference		reference		reference	
III A	1.41 (1.02–1.96)	0.04	0.87 (0.65–1.17)	0.37	1.12 (0.84–1.49)	0.43	0.95 (0.66–1.37)	0.79
Tumor size								
<1.0	reference		reference		reference		reference	
1.0 – <2.0	1.35 (1.00 – 1.81)	0.05	1.04 (0.77–1.41)	0.79	0.82 (0.54–1.22)	0.32	0.79 (0.43–1.46)	0.45
2.0 – <3.0	1.49 (1.10–2.03)	0.01	1.05 (0.77–1.43)	0.77	1.01 (0.67–1.51)	0.98	0.58 (0.32–1.07)	0.08
3.0 – <4.0	1.46 (1.03–2.07)	0.03	1.19 (0.85–1.68)	0.31	0.97 (0.63–1.49)	0.89	0.65 (0.35–1.22)	0.18
4.0 +	1.48 (1.02–2.13)	0.04	1.22 (0.85–1.75)	0.28	1.06 (0.69–1.64)	0.79	0.67 (0.36–1.27)	0.22
Unknown size	1.66 (1.03–2.68)	0.04	1.84 (1.12–3.01)	0.02	1.33 (0.74–2.38)	0.34	1.01 (0.44–2.32)	0.98
Number of positive nodes								
1	reference		reference		reference		reference	

	Age 65–69 N=3769			Age 70–74 N=3841			Age 75–79 N=3638			Age 80 N=4206		
	OR (95% CI)	P		OR (95% CI)	P		OR (95% CI)	P		OR (95% CI)	P	
2–3	1.92 (1.57–2.34)	<.01		1.97 (1.63–2.40)	<.01		1.73 (1.39–2.16)	<.01		0.93 (0.67–1.30)	0.69	
4–9	2.65 (2.09–3.36)	<.01		2.88 (2.31–3.58)	<.01		2.84 (2.24–3.61)	<.01		1.71 (1.25–2.33)	<.01	
10–51	3.99 (2.89–5.50)	<.01		3.70 (2.79–4.91)	<.01		3.50 (2.65–4.64)	<.01		2.36 (1.63–3.43)	<.01	
Unknown but positive	0.31 (0.21–0.45)	<.01		0.28 (0.19–0.41)	<.01		0.27 (0.18–0.39)	<.01		0.33 (0.21–0.50)	<.01	
Tumor grade												
Well differentiated	reference			reference			reference			reference		
Moderately differentiated	0.91 (0.70–1.17)	0.45		1.33 (1.02–1.70)	0.03		1.30 (0.97–1.75)	0.08		1.06 (0.68–1.65)	0.80	
Poorly differentiated	1.19 (0.91–1.57)	0.20		1.87 (1.44–2.42)	<.01		1.74 (1.29–2.36)	<.01		1.41 (0.91–2.21)	0.13	
Unknown	0.90 (0.66–1.23)	0.50		1.53 (1.13–2.07)	0.01		1.39 (0.97–1.98)	0.07		0.87 (0.51–1.47)	0.60	
Hormone receptor status												
Positive	reference			reference			reference			reference		
Negative	3.00 (2.31–3.91)	<.01		3.70 (2.90–4.72)	<.01		3.45 (2.72–4.38)	<.01		3.77 (2.89–4.92)	<.01	
Unknown	1.10 (0.89–1.38)	0.33		1.14 (0.92–1.40)	0.23		0.91 (0.72–1.15)	0.43		1.25 (0.91–1.71)	0.16	
Surgery and radiation												
BCS alone	reference			reference			reference			reference		
BCS with radiation	0.72 (0.54–0.94)	0.02		0.57 (0.43–0.75)	<.01		0.91 (0.67–1.25)	0.57		1.33 (0.87–2.04)	0.19	
Mastectomy alone	0.75 (0.57–0.99)	0.04		0.48 (0.37–0.63)	<.01		0.69 (0.51–0.93)	0.01		0.95 (0.65–1.38)	0.78	
Mastectomy with radiation	1.31 (0.97–1.78)	0.08		0.94 (0.71–1.26)	0.70		1.27 (0.92–1.73)	0.14		2.15 (1.44–3.21)	<.01	
Comorbidity scores												
0	reference			reference			reference			reference		
1	0.77 (0.63–0.94)	0.01		0.72 (0.60–0.87)	<.01		0.82 (0.68–0.99)	0.04		0.87 (0.67–1.13)	0.29	
2	0.31 (0.24–0.41)	<.01		0.44 (0.34–0.57)	<.01		0.42 (0.33–0.55)	<.01		0.63 (0.45–0.88)	0.01	
Socioeconomic status (SES)												
1 st quartile (<3.9, high SES)	reference			reference			reference			reference		
2 nd quartile (3.9–7.4)	0.82 (0.65–1.02)	0.08		0.99 (0.80–1.21)	0.89		1.15 (0.92–1.45)	0.22		0.94 (0.69–1.29)	0.69	
3 rd quartile (7.4–13.5)	0.76 (0.60–0.96)	0.02		0.98 (0.79–1.22)	0.85		1.08 (0.84–1.38)	0.56		0.91 (0.65–1.26)	0.56	
4 th quartile (>13.5, low SES)	0.69 (0.54–0.88)	<.01		0.79 (0.62–1.00)	0.05		1.15 (0.88–1.49)	0.30		0.97 (0.69–1.37)	0.88	
<i>P</i> value for $SES^{\dagger}$		0.02			0.16			0.61			0.94	

Notes:

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* Model-1 adjusted for marital status, tumor stage, tumor size, number of positive nodes, tumor grade, hormone receptor status, surgery and radiation, and comorbidity scores, plus SEER areas and year of diagnosis (not shown). Model-2 additionally adjusted for socioeconomic status (poverty) in addition to factors in Model-1.
† P value for χ^2 trend test of significance for socioeconomic status (**census-tract level poverty**) quartiles 2–4.