Title

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Journal

Medical Care, 54(8)

ISSN

0025-7079

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Publication Date

2016-08-01

DOI

10.1097/mlr.0000000000000561

Peer reviewed

HHS Public Access

Author manuscript

Med Care. Author manuscript; available in PMC 2018 October 05.

Published in final edited form as:

Med Care. 2016 August ; 54(8): 780–788. doi:10.1097/MLR.0000000000000561.

Racial/Ethnic and Socioeconomic Differences in Colorectal and Breast Cancer Treatment Quality:

The Role of Physician-level Variations in Care

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Abstract

Background: Despite a large body of research showing racial/ ethnic and socioeconomic disparities in cancer treatment quality, the relative role of physician-level variations in care is unclear.

Objective: To examine the effect of physicians on disparities in breast and colorectal cancer care.

Subjects: Linked SEER Medicare data were used to identify Medicare beneficiaries diagnosed with colorectal and breast cancer during 1995–2007 and their treating physicians.

Research Design: We identified treating physicians from Medicare claims data. We measured the use of NIH guideline-recommended therapies from SEER and Medicare claims data, and used logistic models to examine the relationship between race/ethnicity, socioeconomic status, and cancer quality of care. We used physician fixed effects to account for between-physician variations in treatment.

Results: Minority and low socioeconomic status beneficiaries with breast and colorectal cancer were less likely to receive any recommended treatments as compared with whites. Overall, between- physician variation explained <20% of the total variation in quality of care. After accounting for between-physician differences, median household income explained 14.3%, 18.4%, and 13.2% of the variation in use of breast-conserving surgery, chemotherapy, and radiation for breast cancer, and 13.7%, 12.9%, and 12.6% of the within-physician variation in use of colorectal surgery, chemotherapy, and radiation for colorectal cancer, whereas race and ethnicity explained <2% of the within-physician variation in cancer care.

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The authors declare no conflict of interest.

The conclusions of this paper are solely the responsibility of the authors and do not necessarily represent the official views of the American Cancer Society or NHLBI.

Conclusions: Between-physician variations partially explain racial disparities in cancer care. Residual within-physician disparities may be due to differences in patient-provider communication, patient preferences and treatment adherence, or unmeasured clinical severity.

Keywords

race; socioeconomic status; disparities; colorectal breast cancer

Breast and colorectal cancer are 2 of the most prevalent cancers in the United States and among the leading causes of death in the general population.[1] Highly effective treatments are available,[2–4] yet evidence shows that these treatments are significantly underused in vulnerable populations, including minority and less affluent groups.[5–18] Minority women with breast cancer are less likely to receive radiation and chemotherapy than white women[5–9,18]; similarly, minority patients are less likely to receive chemotherapy for colon cancer, and radiation therapy for rectal cancer, than white patients.[10,11]

Economic deprivation has also been associated with differences in breast and colorectal cancer quality of care.[12–16] Women with low socioeconomic status (SES) experience lower rates of breast-conserving surgery (BCS), are less likely to receive radiation after BCS,[12] and receive suboptimal chemotherapy.[14,16] Low SES is associated with lower rates of chemotherapy for colorectal cancer and with lower rates of radiation for rectal cancer.[15,17] Although there is no consensus on the relative roles of race/ethnicity and SES, research uniformly shows that disparities persist after adjusting for differences in patient-level characteristics, suggesting that system-level factors may be at play.

System-level factors (eg, local availability of specialist physicians, cancer care networks, and social support) may give rise to “between-physician” differences. White and more affluent patients may receive care from different providers than minority and low SES patients, and physicians who treat vulnerable populations may face barriers to providing care of the highest quality. This hypothesis is supported by research showing that the medical care of minority patients is concentrated within a small number of providers who are less well trained and have lower access to hospitals and diagnostic tools.[19, 20]

In contrast, disparities in cancer care could be due to treatment differences among race/ethnicity and SES groups treated by the same physician (“within-physician” differences), a premise backed by studies showing racial differences in medical decision making (eg, provider bias), and differences in patient preferences for care.[21–23]

Few studies have examined between-physician and within-physician differences as sources of health care disparities. One study[24] demonstrated both between-physician and within-physician differences in rates of cancer screening counseling among racial/ethnic and socioeconomic groups, whereas another analysis[25] found that racial differences in diabetes outcomes were primarily related to within-physician effects. To date, direct evidence about the role of between- physician and within-physician effects in cancer treatment is lacking.

The main objective of this study was to understand whether between-physician and within-physician variations play a role in cancer care disparities among seniors with breast and

colorectal cancer enrolled in a national cancer surveillance program. To assess between-physician and within-physician sources of treatment variation, we used fixed-effects models, which account for the clustering of patients within physician practices and control for all the unobserved, higher-level differences between clusters (eg, physician-level, practice-level, or systems-level factors).

METHODS

Data Sources

We used data from the linked Surveillance, Epidemiology, and End Result (SEER) Medicare files to identify patients with breast and colorectal cancer during 1995–2007. The SEER program collects data on all incident cancer cases from 14 geographic areas selected to be representative of the US population. SEER files, which include information on tumor site, type, and extent, treatments received, and cause of death, are linked to Medicare claims, which contribute information on medical services provided to patients. SEER Medicare files have been extensively used in health services research to study variations in quality of care and disparities faced by cancer patients.[26,27]

We used Medicare physician claims, which contain a unique physician identifier, to link patients to physicians providing care. To identify physician specialty, we used data from the American Medical Association (AMA) Masterfile linked to Medicare claims. The AMA Masterfile is used by the American Society of Clinical Oncology to describe the supply of oncologists in the United States.[28] Linkage of the Medicare-SEER dataset to the AMA Masterfile is very high (98.7%).[29]

Study Sample

We identified all patients with breast and colorectal cancer in the SEER Medicare Patient Entitlement and Diagnosis Summary File using ICD-O codes (C500-C509 for breast, C180–189 for colon, and C199, C209 for rectal cancer). For 1995–2003, cancer stage was based on the modified American Joint Committee on Cancer (AJCC) Manual for Staging Cancer 3rd edition, derived by algorithm from extent of disease data; beginning 2004, staging was based on AJCC 6th edition T, N, M and Stage data. We only included breast cancer patients stage I and II and colorectal cancer patients stages I-III. We excluded patients with incomplete claims (eg, enrolled in health maintenance organization plans); patients with missing diagnosis dates or diagnosed before age 65 as quality measures could not be constructed for these patients; and patients older than 85, those not at first cancer diagnosis, those with male breast cancer, and those with nonadenocarcinoma colon cancer, due to less agreement about treatment. We then identified cancer treatments using Medicare claims and SEER therapy codes based on published methodology.[30]

We identified physicians responsible for care using claims and attributed patients to physicians using previously published algorithms.[31] We chose the physician responsible for care hierarchically, based on the most likely treating specialty (eg, for chemotherapy: medical oncologist, surgeon, subspecialist, primary care). If a patient had > 2 same-specialty physicians submit claims, we chose the physician with most claims. To evaluate

the robustness of findings, we performed sensitivity analyses using different selection criteria (eg, the physician with the most recent claim).

All patients were assigned to a physician responsible for care. The average number of patients assigned to a physician was 20 for breast cancer and 17 for colon cancer. Over 92% of patients-within-physician clusters had at least 10 patients, whereas <5% of patients-within-physician clusters had >200 patients. We excluded clusters with <5 patients because they were too small to be retained in model estimations. The final sample included 69,121 patients with breast cancer and 57,050 patients with colorectal cancer. Figure 1 presents the number of breast and colorectal cancer cases excluded at each step.

Study Variables

The main outcome variables were measures of cancer quality of care. We examined quality using several process measures based on the NIH Consensus Guidelines for the treatment of breast and colorectal cancer, first issued in 1990.

Because early adoption of new cancer treatments is highly variable,[32,33] and because we were concerned that physicians practicing in resource-deprived settings would less likely be early adopters, we selected measures based on recommendations that had been in place for several years before the study period. Thus, our findings may represent a conservative estimate of disparities in cancer care.

We identified the use of guideline-recommended therapies using methods previously employed with SEER Medicare data. We used the NIH Consensus Guidelines,[2–4] NCCN practice guidelines (http://www.nccn.org/professionals/physician_gls/f_guidelines.asp), and prior studies on cancer quality of care[5,18,30,34,35] to define reasonable time periods for the use of each guideline-recommended treatment. Breast cancer measures included: (1) receipt of BCS for stage I and II; (2) use of radiation within 12 months of BCS; and (3) use of chemo therapy for stage II hormone receptor-negative tumors within 12 months of surgery. Colorectal cancer measures included: (1) surgical resection for stage I, II, or III within 6 months of diagnosis; (2) use of chemotherapy within 3 months of surgery for stage III colon cancer, and within 3 months before surgery to 9 months afterward for stage II and III rectal cancer; and (3) use of radiation within 3 months before surgery to 9 months afterward for stage II and III rectal cancer. A summary of measures and sources used is presented in the Appendix.

The key variables of interest were race/ethnicity and SES. We used Medicare and SEER data to create mutually exclusive race/ethnicity categories: Hispanic, and non-His- panic white, black, Asian, and American Indian. Medicare files contain 1 race/ethnicity variable, whereas SEER files contain 2 race/ethnicity variables, one denoting Hispanic ethnicity, and the other denoting race. We first assigned Hispanic ethnicity and then assigned non-Hispanic race based on both SEER and Medicare data, following published methodology.[36] We excluded American Indian patients due to relatively small numbers, and patients for whom race was coded as “Other” or “Unknown.”

We measured SES using patients' zip code median household income, categorized into deciles. SEER files contain several zip code and census tract-level SES variables. Because census tract data are missing for over 30%, whereas zip code data are missing for only 7.5% of cases, we aggregated SES data at the zip code level. Median household income has been reported to be well correlated with self- reported income, regardless of its level of aggregation (ie, zip code vs. census tract).[36]

Additional study variables included demographics (age, sex), number of comorbidities categorized as 0, 1, 2, 3, and ≥ 4,[37] tumor characteristics (eg, presence of estrogen/progesterone receptors), and year of diagnosis.

Data Analysis

As all outcome variables were binary, we used logistic regression models with fixed effects to evaluate the relationship between race/ethnicity, SES, and cancer quality of care. Fixed-effects models control for all higher-level (practice and systems level) variation and, as compared with hierarchical models, still yield unbiased estimates when higher-level variation cannot be assumed to be uncorrelated with the lower-level key variables—race/ethnicity and SES (eg, minority patients might be more likely to live in areas with unobservably worse quality of care).

A first set of models adjusted for patient and tumor characteristics including age, sex, comorbidities, tumor stage and type, and year of diagnosis (model 1). A second set of models accounted for patient variables and introduced physician fixed effects (model 2). We used the estimated coefficients from models 1 and 2, and the recycled predictions method,[38,39] to calculate predicted probabilities for each treatment, and the relative risk (ie, ratio of predicted probabilities) of receiving treatment for each racial/ethnic minority (white as reference) and lower SES group (highest decile as reference). By using the fixed-effects model coefficients, the differences in predicted probabilities of treatment from model 2 reflect only within-physician variation, whereas model 1 probabilities reflect overall variation. This approach enabled us to decompose differences in quality of care into 2 components as follows: the total difference in quality of care (ie, difference in probabilities calculated from model 1) is equal to the difference due to within-physician effects (ie, difference in probabilities calculated from model 2)+the difference due to between-physician effects.

P-values were 2-sided. Statistical significance was defined as $P<0.05$. All analyses were performed using SAS and STATA statistical software. The UCLA institutional review board approved this study. Because we analyzed data from SEER Medicare from the National Cancer Institute (NCI), this paper was also reviewed by NCI, which identified no confidentiality issues.

RESULTS

Sample characteristics are summarized in Table 1. Most patients were white, followed by black and Hispanic. Whites and Asians lived in zip codes with higher household median

incomes ($51,235 and $52,542) than non-Hispanic blacks and Hispanics ($35,714 and $41,948).

In unadjusted analyses of breast cancer patients, blacks, Hispanics, and Asians received less BCS than whites (52%−56% vs. 59%), and blacks and Asians received less radiation than whites and Hispanics (46%−51% vs. 53%), but rates of chemotherapy were similar around 50%. Patients residing in high-income zip codes were more likely to receive treatment than patients residing in low-income zip codes (eg, 69%, 53%, and 65% top decile income patients received BCS, chemotherapy, and radiation vs. 46%, 48%, and 43% bottom decile income patients). For colorectal cancer, blacks, Hispanics, and Asians had lower rates of surgery within 6 months of diagnosis than whites (85%−88% vs. 90%). Blacks also had lower rates of chemotherapy (54% vs. 67%) and radiation (28% vs. 38%) than whites. Receipt of any treatment was also lower for low-income patients than for high-income patients (eg, 85%, 53%, and 27% of bottom decile income patients received surgery, chemotherapy, and radiation vs. 92%, 68%, and 44% of top decile income patients).

Less than 30% of physicians treated over 50% blacks and <25% of physicians treated patients in the lowest income decile (Fig. 2). Physicians treating no black patients had higher rates of adherence to guideline-recommended treatments than physicians treating a majority of blacks (77% vs. 45% for breast cancer; 72% vs. 50% for colon cancer). Similarly, physicians treating high-income patients had higher adherence rates than those treating low-income patients (77% vs. 41% for breast cancer; 78% vs. 48% for colorectal cancer).

In breast cancer models adjusting for patient and tumor characteristics (Table 2), Asian women and women of other races were less likely to receive BCS and radiation therapy, and black women were less likely to receive radiation than white women. Low-income patients were less likely to receive any therapy as compared with high-income patients. In models accounting for physician effects (Table 2), Asian and Hispanic women were less likely to receive BCS, but no other differences by race/ethnicity were significant; differences by income were attenuated but remained significant.

In colorectal cancer models adjusting for patient variables (Table 3), blacks, Hispanics, and other race patients were less likely to receive surgery, blacks and other race patients were less likely to receive chemotherapy, and blacks and Asians were less likely to receive radiation than whites. Living in low-income zip codes was associated with lower rates of chemotherapy but no other disparity. Accounting for physician effects (Table 3) only slightly modified race/ethnicity and income effects with varying results (eg, some coefficients increased, whereas others decreased).

Overall, between-physician differences explained 17.1%, 21.3%, and 15.8% of the variation in use of BCS, chemotherapy, and radiation for breast cancer, and 16.5%, 15.2%, and 14.9% of variance for surgery, chemotherapy, and radiation for colorectal cancer. In contrast, within-physician differences explained 82.9%, 78.7%, and 84.2% of the variation in use of BCS, chemotherapy, and radiation for breast cancer, and 83.5%, 84.8%, and 85.1% of variance for surgery, chemotherapy, and radiation for colorectal cancer. After accounting for between-physician differences, median household income explained 14.3%, 18.4%, and

13.2% of the variation in use of BCS, chemotherapy, and radiation for breast cancer, and 13.7%, 12.9%, and 12.6% of the within-physician variation in use of colorectal surgery, chemotherapy, and radiation for colorectal cancer, whereas race and ethnicity explained <2% of the within-physician variation in cancer care.

DISCUSSION

Among fee-for-service Medicare beneficiaries with breast or colorectal cancer, we found various degrees of disparity in treatment by race/ethnicity and SES. For breast cancer, low income was strongly associated with lower rates of treatment, whereas racial/ethnic treatment differences were small. In contrast, racial/ethnic disparities in colorectal cancer were more substantial but income-based disparities were small. Within-physician variations seemed to explain most of the variation in quality of care; race/ethnicity and SES effects explained only a small fraction of the within- physician variations in treatment receipt.

Our study findings are in line with prior studies showing racial/ethnic and SES disparities in cancer care, suggesting that equitable access to high-quality care may improve cancer outcomes.[5–18] Similar to other studies,[19] we also found that relatively few physicians, who tend to have lower rates of guideline compliance, care for a large share of minority and low-income cancer patients, although it is not possible to determine whether the reasons for lower compliance stem from physician or patient factors (eg, preferences and adherence to treatments).

Prior research has shown that the characteristics of physicians serving white and minority patients differ substantially,[19] but the role of physicians in racial/ethnic and SES health care disparities is incompletely understood. A survey[40] of US adults showed that minority patients perceived their quality of care to be significantly worse than whites, whereas another analysis[41] showed that physician organizations' performance scores are directly associated with the SES of the area where the organizations are located.

Prior studies examining specific physician-level factors on health care quality and disparities are limited by the fact that unmeasured system-level variations may confound the results. The use of physician-level fixed effects allowed us to control for all measured or unmeasured differences that may exist between physicians, including practice, health care system, and social context characteristics (eg, differences in resources, training and knowledge of current treatments, access to cancer care networks, community support). Thus, the advantage of our study design was that it enabled us to determine the extent to which treatment variations were explained by between-physi- cian differences (due to any of the above-mentioned factors), and by remaining within-physician differences.

Our analyses suggest that, for both cancers, between- physician variations explain relatively little (<20%) of the total variation in quality of care received, with most variation occurring within-physician. Between-physician variation also explained relatively little of the race/ethnicity and SES treatment disparities; while accounting for between-physi- cian differences significantly attenuated SES differences in breast cancer treatment, racial/ethnic

differences in breast cancer care, as well as racial/ethnic and SES disparities in colorectal cancer care, were not explained by between- physician variations.

Within-physician variation explained most of the overall variation in quality of care, and various degrees of racial/ethnic and SES disparities in cancer treatment persisted in models controlling for physician effects. However, race/ethnicity and SES accounted for a relatively small proportion of the within-physician variations in treatment receipt. Several explanations for the within-physician differences in cancer quality of care are possible. First, unmeasured differences in clinical presentation and severity are most likely to drive within-physician variations in treatment. Second, the contribution of race/ethnicity and SES to differences in treatment could be the result of differences in patient-provider communication,[42,43] or differences in preferences for care. In that vein, research has shown that white and minority colorectal cancer patients have similar rates of specialty referral, yet lower rates of adjuvant treatments even after appropriate referral.[44] Some vulnerable populations also have high levels of health care system distrust[45] and more often report difficulty with coordination of care,[46] which could lead to treatment refusal or delay.

Several potential study limitations merit further discussion. Analyses were limited to Medicare beneficiaries aged 65 and older, thus findings from this study may not be applicable to other population groups. In addition, the administrative nature of the databases we used has inherent limitations with regard to the level of clinical detail provided, in particular information on unmeasured burden of illness which may have appropriately precluded treatment. Nevertheless, these databases are to date the most comprehensive sources of information on cancer patterns of care and outcomes. Lastly, we assigned treating physicians using a claims-based algorithm, which may not always accurately identify the treating physician. However, sensitivity analyses using different hierarchies produced similar results.

Despite its limitations, the current study provides new information on the complicated interplay between patient and system-level factors in breast and colorectal cancer disparities. As many observational studies do, our study also poses more questions than it provides answers. Exploring the local context for disparities could substantially further our understanding of specific factors tied to cancer care. For example, small area analyses could shed new light on the availability of community services required to facilitate treatments, and to improve recovery and reduce mortality. Understanding the pathways for the differences in quality of care may also entail further research into how physicians treat and communicate with patients of varying racial/SES backgrounds, or how patients from varying backgrounds respond and adhere differently to physician’s recommendations. In turn, such studies will provide targeted actionable information to quality improvement organizations, policy makers, and local health planners to improve resources, training efforts for providers caring for this population, and cultural competence where needed.

Acknowledgments

Supported by award #114115-RSGT-07–231-01-CPHPS from the American Cancer Society. I.P. was supported by R01 HL118410 from the NHLBI.

APPENDIX 1

TABLE 1.

Selected Measures of Quality of Care for Breast and Colorectal Cancer Patients

		References
Breast cancer		
If female patient has breast cancer AND	Then patient should receive	
Stage I-II cancer at diagnosis *	Breast-conserving surgery	2,25
Receives breast-conserving surgery	Radiotherapy within 12 mo of Surgery	3,5,25
Stage II cancer at diagnosis *	Chemotherapy within 12mo of Surgery	3,6,25
Colon cancer		
IF patient has colon cancer AND	Then patient should receive	
Stage I-III cancer at diagnosis *	Surgical resection of the tumor within 6 mo of diagnosis	
Stage III cancer at diagnosis *	Adjuvant chemotherapy within 3 mo of surgery	4,25,26
Rectal cancer		
IF patient has rectal cancer AND	Then patient should receive	
Stage I-III cancer at diagnosis *	Surgical resection of the tumor within 6 mo of diagnosis	
Stage II or III cancer at diagnosis *	Adjuvant chemotherapy from 3 mo before 9 mo after surgery	4,26
Stage II or III cancer at diagnosis *	Adjuvant radiation therapy from 3 mo before 9 mo after surgery	4,25,27

* All cancer staging followed the AJCC Cancer Staging Manual, using SEER variables. During 1995–2003, because SEER did not directly collect TNM and stage data, we used the SEER-modified AJCC 3rd stage variable, derived from extent of disease information (ie, extent and size of primary tumor, presence of metastases, and lymph node involvement) to assign cancer stage. Beginning 2004, TNM and stage variables were available in SEER.

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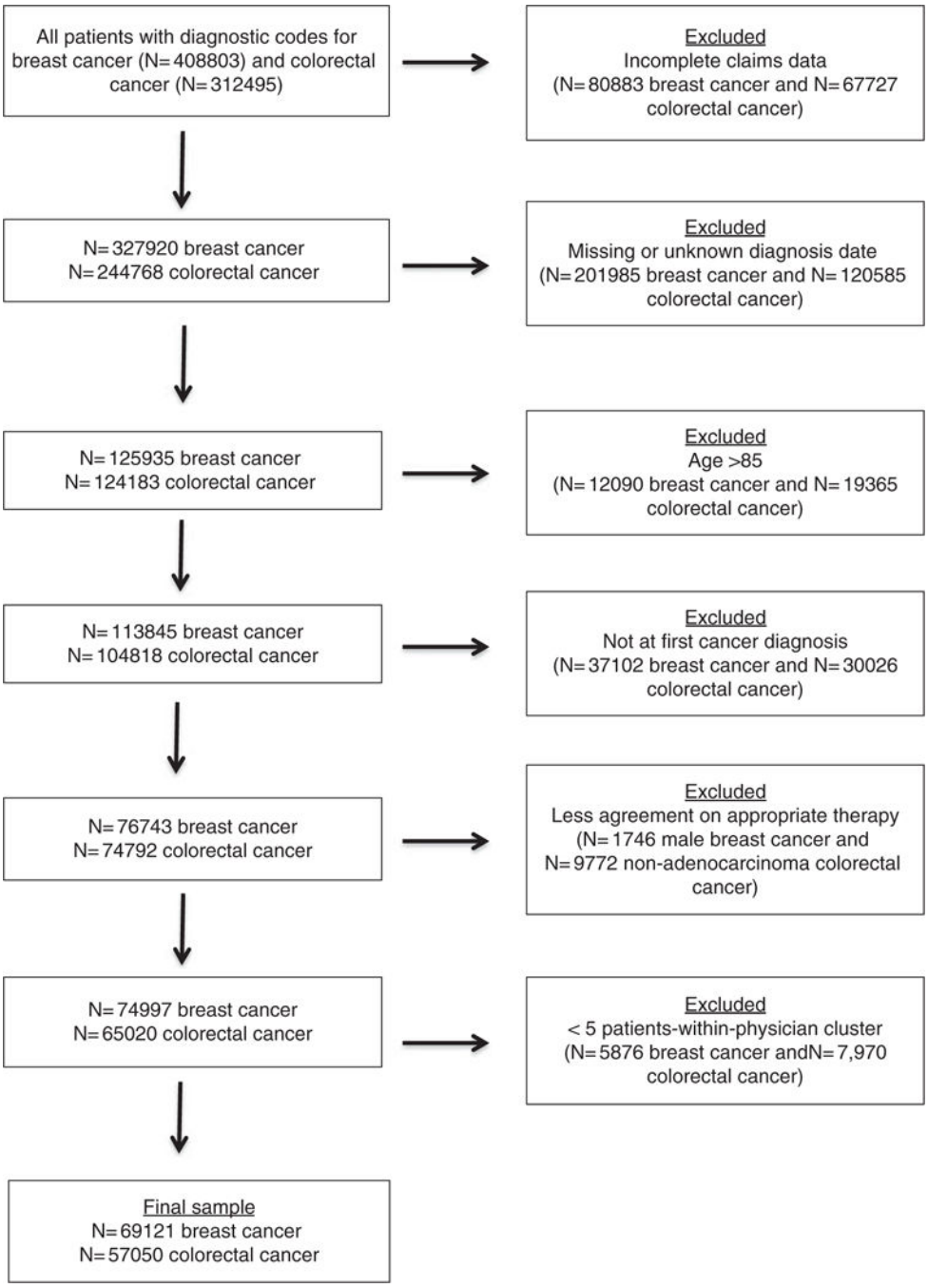

FIGURE 1.
Number of included and excluded cases for breast and colorectal cancer study samples.

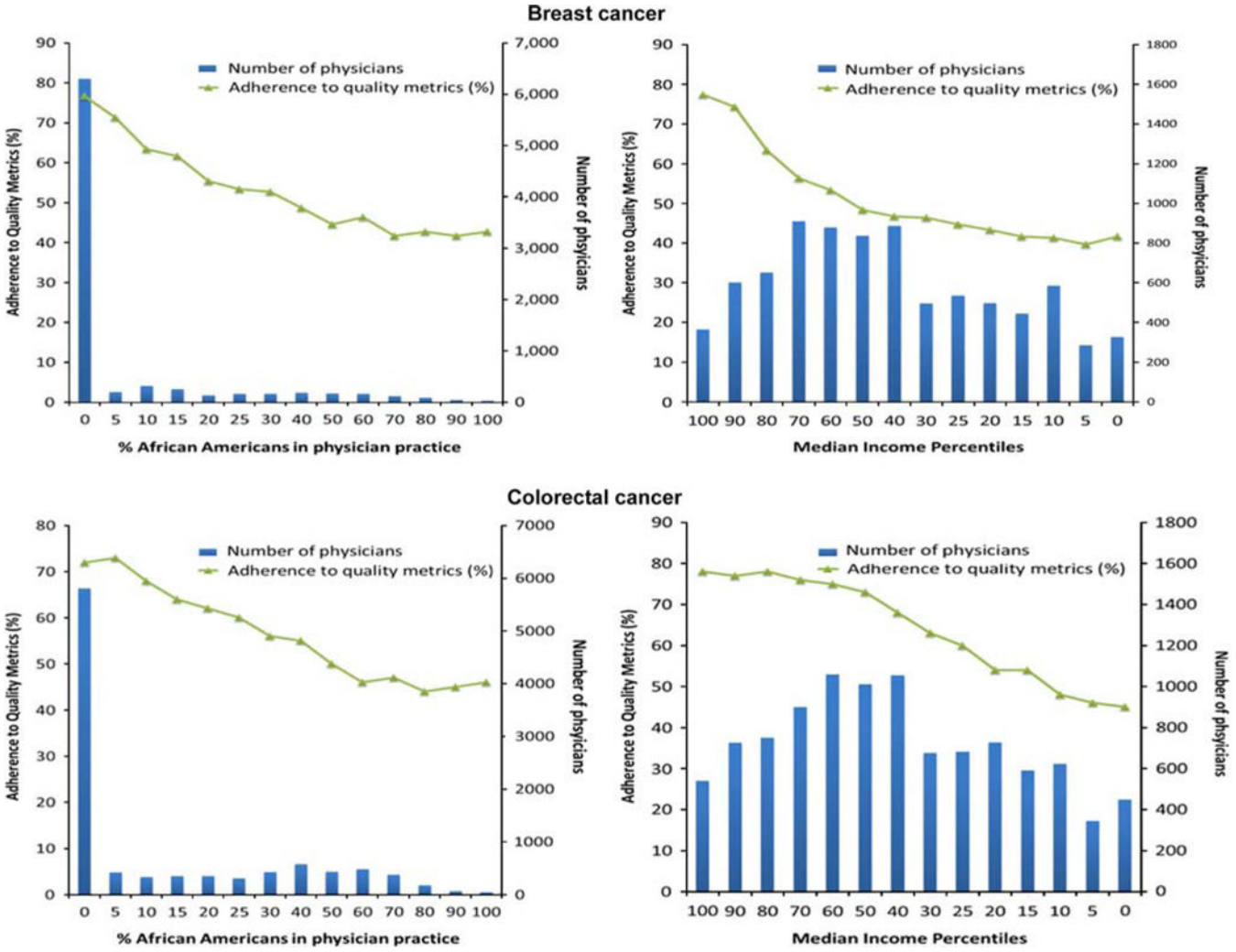

FIGURE 2.

The relationship between the zip code level median household income, percent black patients in physicians' practice, and physician quality of care, as reflected by adherence to quality metrics.

TABLE 1.

Characteristics of Patients With Stage 1 or 2 Breast Cancer, or Stage 1, 2, or 3 Colorectal Cancer Included in the SEER Medicare Database During 1995–2007

	n (%)	
Patient Characteristics	**Breast Cancer Cohort (N = 69,121)**	**Colorectal Cancer Cohort (N = 57,050)**
Race		
White non-Hispanic	60,827 (88.0)	48,378 (84.8)
Black	4078 (5.9)	4108 (7.2)
Hispanic	2281 (3.3)	2510 (4.4)
Asian	1728 (2.5)	1883 (3.3)
Other	207 (0.3)	171 (0.3)
Age group (y)		
65–69	16,313 (23.6)	9984 (17.5)
70–74	19,907 (28.8)	14,947 (26.2)
75–79	19,077 (27.6)	17,001 (29.8)
80–84	13,824 (20.0)	15,118 (26/5)
Sex		
Female	69121 (100)	29,552 (51.8)
Zip code household income (median, IQR)	48,058 (36,948–63,252)	45,904 (35,149–60,490)
Marital status		
Single	4942 (7.2)	4222 (7.4)
Married	33890 (49.0)	32,005 (56.1)
Divorced	5322 (7.7)	3537 (6.2)
Widowed	24967 (36.1)	17,286 (30.3)
Comorbidities		
None	36,911 (53.4)	28,126 (49.3)
1	16,174 (23.4)	12,950 (22.7)
2	7396 (10.7)	6447 (11.3)
3	4562 (6.6)	5020 (8.8)
≥ 4	4078 (5.9)	4507 (7.9)
Peptic ulcer	—	2142 (2.9)
Anemia	—	18,263 (24.5)
Cancer-related variables		
Colon cancer	—	43,073 (75.5)
Rectal cancer	—	13,977 (24.5)
Colorectal cancer stage 1	—	19,283 (33.8)
Colorectal cancer stage 2	—	20,652 (36.2)
Colorectal cancer stage 3	—	17,115 (30.0)
Breast cancer stage 1	43,408 (62.8)	
Breast cancer stage 2	25,713 (37.2)	
Stage I, HR negative	8551 (19.7)	
Stage II, HR negative	6043 (23.5)	

Table 2.

Relative Risks of Receiving Breast Cancer Guideline-recommended Treatments for Minority as Compared With White Patients Registered With the SEER Medicare Database During 1995–2007

	Logistic Regression Models*		Fixed-Effects Models†	
	Relative Risk	95%CI	Relative Risk	95% CI
Receipt of breast-conserving surgery				
White non-Hispanic (reference)				
Black	1.04	0.99, 1.08	0.99	0.96, 1.07
Hispanic	1.03	0.98, 1.07	0.96	0.93, 1.02
Asian	0.89	0.85, 0.94	0.79	0.77, 0.83
Other	0.86	0.71, 0.99	0.85	0.67, 1.04
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	0.95	0.92, 0.97	0.97	0.96. 1.00
> 70th to < 80th percentile	0.92	0.89, 0.94	0.96	0.92, 0.99
> 60th to < 70th percentile	0.91	0.89, 0.93	0.97	0.93. 0.99
> 50th to < 60th percentile	0.86	0.84, 0.88	0.98	0.97. 1.00
> 40th to < 50th percentile	0.83	0.81, 0.85	0.96	0.92. 0.97
> 30th to < 40th percentile	0.78	0.77, 0.81	0.94	0.92. 0.97
> 20th to < 30th percentile	0.79	0.77, 0.82	0.97	0.95, 0.99
> 10th to < 20th percentile	0.75	0.73, 0.77	0.94	0.92, 0.96
0to < 10th percentile	0.68	0.65, 0.71	0.93	0.87, 0.96
Receipt of chemotherapy				
White non-Hispanic (reference)				
Black	1.01	0.92, 1.13	0.95	0.87, 1.02
Hispanic	0.92	0.78, 1.06	0.83	0.72, 0.88
Asian	1.05	0.93, 1.21	0.94	0.83, 1.15
Other	0.70	0.34, 1.35	0.77	0.56, 1.22
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	0.95	0.87, 1.04	1.06	0.96, 1.12
> 70th to < 80th percentile	0.98	0.89, 1.07	1.02	0.90, 1.08
> 60th to < 70th percentile	0.94	0.85, 1.03	1.00	0.96, 1.06
> 50th to < 60th percentile	0.87	0.79, 0.98	0.99	0.98, 1.02
> 40th to < 50th percentile	0.81	0.73, 0.91	0.96	0.83, 0.95
> 30th to < 40th percentile	0.77	0.70, 0.87	0.97	0.89, 0.99
> 20th to < 30th percentile	0.75	0.67, 0.84	0.95	0.85, 0.98
> 10th to <20th percentile	0.79	0.71, 0.86	0.95	0.89, 0.99
>0to < 10th percentile	0.68	0.60, 0.75	0.89	0.79, 0.90
Receipt of radiation therapy				
White non-Hispanic (reference)				
Black	0.97	0.94, 0.99	0.91	0.89, 0.96
Hispanic	1.01	0.96, 1.06	0.94	0.90, 1.02
Asian	0.92	0.87, 0.95	0.83	0.80, 0.85

	Logistic Regression Models*		Fixed-Effects Models†	
	Relative Risk	95%CI	Relative Risk	95% CI
Other	0.80	0.66, 0.96	0.78	0.64, 0.88
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	0.93	0.91, 0.96	0.97	0.94, 0.98
> 70th to < 80th percentile	0.92	0.89, 0.95	0.96	0.94, 0.98
> 60th to < 70th percentile	0.93	0.90, 0.95	0.98	0.94, 0.99
> 50th to < 60th percentile	0.85	0.83, 0.87	0.97	0.95, 0.98
> 40th to < 50th percentile	0.82	0.79, 0.85	0.94	0.91, 0.96
> 30th to < 40th percentile	0.77	0.75, 0.80	0.92	0.87, 0.95
> 20th to < 30th percentile	0.77	0.74, 0.79	0.94	0.91, 0.96
> 10th to <20th percentile	0.74	0.72, 0.77	0.92	0.87, 0.94
>0to < 10th percentile	0.66	0.63, 0.68	0.89	0.87, 0.92

*Models accounted for age, sex, marital status, zip code level median income, year of diagnosis, comorbidities, stage, and tumor histology (presence of hormone receptors).

†Models accounted for the above variables and included fixed effects for physician practices.

CI indicates confidence interval; SEER, Surveillance, Epidemiology, and End Result.

TABLE 3.

Relative Risks of Receiving Colorectal Cancer Guideline-recommended Treatments for Minority as Compared With White Patients Registered With the SEER Medicare Database During 1995–2007

	Logistic Regression Models*		Fixed-Effects Models'†	
	Relative Risk	95%CI	Relative Risk	95%CI
Receipt of surgery				
White non-Hispanic (reference)				
Black	0.95	0.95, 0.99	0.96	0.95, 0.98
Hispanic	0.97	0.95, 0.98	0.97	0.96, 0.98
Asian	0.99	0.98, 1.01	0.99	0.98, 1.01
Other	0.91	0.84, 0.98	0.92	0.91, 0.96
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	0.99	0.98, 1.01	0.99	0.98, 1.02
>70th to <80th percentile	0.97	0.96, 0.99	0.98	0.97, 0.99
> 60th to < 70th percentile	0.99	0.98, 1.01	0.99	0.99, 1.02
>50th to <60th percentile	0.99	0.98, 1.01	0.99	0.99, 1.01
> 40th to < 50th percentile	0.99	0.98, 1.01	0.99	0.99, 1.00
>30th to <40th percentile	0.99	0.98, 1.00	0.99	0.99, 1.00
> 20th to < 30th percentile	1.00	0.99, 1.02	0.99	0.98, 1.00
> 10th to <20th percentile	0.98	0.97, 0.99	0.99	0.98, 1.00
>0to < 10th percentile	0.98	0.97, 0.99	0.97	0.96, 0.99
Receipt of chemotherapy				
White non-Hispanic (reference)				
Black	0.86	0.80, 0.91	0.85	0.75, 0.96
Hispanic	0.99	0.90, 1.08	0.99	0.85, 1.12
Asian	0.96	0.88, 1.02	0.96	0.90, 1.01
Other	0.73	0.52, 0.99	0.74	0.37, 1.02
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	1.01	0.95, 1.08	1.02	0.96, 1.09
> 70th to < 80th percentile	0.99	0.92, 1.06	0.99	0.93, 1.06
> 60th to < 70th percentile	1.01	0.95, 1.09	1.02	0.96, 1.09
> 50th to < 60th percentile	0.98	0.91, 1.05	0.99	0.92, 1.05
> 40th to < 50th percentile	0.94	0.88, 0.99	0.95	0.89, 0.99
> 30th to < 40th percentile	0.93	0.87, 0.99	0.93	0.87, 0.99
> 20th to < 30th percentile	0.96	0.89, 1.02	0.96	0.89, 1.02
> 10th to <20th percentile	0.92	0.86, 0.98	0.93	0.87, 0.98
>0to < 10th percentile	0.91	0.85, 0.98	0.92	0.86, 0.98
Receipt of radiation therapy (rectal cancer)				
White non-Hispanic (reference)				
Black	0.85	0.77, 0.93	0.84	0.80, 0.98
Hispanic	1.11	0.99, 1.22	1.07	0.92, 1.26
Asian	0.88	0.79, 0.97	0.85	0.82, 0.99

	Logistic Regression Models*		Fixed-Effects Models',†	
	Relative Risk	95%CI	Relative Risk	95%CI
Other	0.94	0.63, 1.29	1.14	0.72, 1.47
High-income zip code >90th percentile (reference)				
> 80th to < 90th percentile	1.04	0.94, 1.14	1.03	0.91, 1.29
> 70th to < 80th percentile	0.98	0.88, 1.07	0.96	0.83, 1.02
> 60th to < 70th percentile	0.98	0.89, 1.08	0.95	0.77, 1.11
> 50th to < 60th percentile	0.93	0.83, 1.00	0.94	0.86, 1.12
> 40th to < 50th percentile	0.93	0.84, 1.01	0.91	0.82, 1.02
> 30th to < 40th percentile	0.93	0.83, 1.00	0.94	0.84, 1.10
> 20th to < 30th percentile	0.99	0.92, 1.09	1.00	0.92, 1.15
> 10th to <20th percentile	0.92	0.83, 0.99	0.96	0.94, 0.97
>0to < 10th percentile	0.92	0.83, 0.98	0.93	0.89, 0.93

*Models accounted for age, sex, marital status, zip code level median income, year of diagnosis, comorbidities, stage and type of cancer.

†Models accounted for the above variables and included fixed effects for physician practices.Cl indicates confidence interval; SEER, Surveillance, Epidemiology, and End Result.