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Racial and Ethnic disparity in symptomatic breast cancer awareness despite a recent screen: the role of tumor biology and mammography facility characteristics

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Abstract

BACKGROUND—In a racially and ethnically diverse sample of recently diagnosed urban breast cancer patients, we examined associations of patient, tumor biology and mammography facility characteristics on the probability of symptomatic discovery of their breast cancer despite a recent prior screening mammogram.

METHODS—In the Breast Cancer Care in Chicago study, self-reports at interview were used to define patients as having a screen-detected breast cancer or having symptomatic awareness despite a recent screening mammogram (SADRS), in the past one or two years. Patients with symptomatic breast cancer who did not report a recent prior screen were excluded from these analyses. Characteristics associated with more aggressive disease (estrogen and progesterone receptor negative status and higher tumor grade) were abstracted from medical records. Mammogram facility characteristics that might indicate aspects of screening quality were defined and controlled for in some analyses.

RESULTS—SADRS was more common among nH Black and Hispanic than nH White patients (36% and 42% vs. 25%, respectively, p=0.0004). SADRS was associated with ER/PR negative and higher grade disease. Patients screened at sites that relied on dedicated radiologists, and sites that were breast imaging centers of excellence were less likely to report SADRS. Tumor and facility factors together accounted for two-thirds of the disparity in SADRS (proportion mediated=70%, p=0.02).

CONCLUSION—Facility resources and tumor aggressiveness explain much of the racial/ethnic disparity in symptomatic breast cancer among recently screened patients. IMPACT: A more equitable distribution of high quality screening would ameliorate but not eliminate this disparity.

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Keywords

breast cancer; screening; mammography; healthcare quality; disparities

INTRODUCTION

Mammography screening is effective in the early detection of breast cancer and the balance of the evidence suggests that it improves survival and reduces mortality from breast cancer (1–4). Early detection enables breast cancer to be diagnosed at an early stage when treatment is most effective (1,4,5). Despite reportedly similar mammography utilization rates among racial and ethnic groups in the United States (6), non-Hispanic (nH) Black women both nationally (7,8) and in Chicago die from breast cancer at a higher rate than nH Whites (9). Symptomatic tumors tend to display characteristics of more aggressive disease (10–14). Additional research in Chicago suggests that there exist disparities in access to high quality mammography that may contribute to disparities in breast cancer outcomes in Chicago. In one study, minority women and those without private insurance were found to be less likely than nH White women and women with private insurance to obtain screening mammography at facilities with characteristics suggesting high quality screening (15). These characteristics included whether a facility was an academic medical center, relied exclusively on breast imaging specialists to read mammograms, and used digital mammography. Another study found that the probability of potentially missed detection (defined as an actionable lesion identified upon expert mammogram review in the same breast and quadrant as the subsequently diagnosed breast cancer) was greater among minority and socioeconomically disadvantaged women compared to nH white women and those from socioeconomically advantaged backgrounds (16). Taken together, these findings suggest that the disparity in breast cancer mortality might relate to a combination of differences in patient, tumor biology, and healthcare quality factors.

In this study, symptomatic awareness despite a recent screen (SADRS) is defined as a patient reported symptomatic awareness despite reporting a recent screening mammogram in the past one or two years. We examined associations of patient, tumor biology, and healthcare quality factors on SADRS and the extent to which tumor biology and healthcare quality factors might account for racial/ethnic disparities in SADRS.

MATERIALS AND METHODS

Patients for this study participated in the “Breast Cancer Care in Chicago (BCCC)” study of newly diagnosed female patients between 30 and 79 years of age at diagnosis, who resided in Chicago, had a first primary in situ or invasive breast cancer, were diagnosed between March 1, 2005 and February 31, 2008, and self-identified as either nH White, nH Black, or Hispanic (17,18). The study was approved by the Institutional Review Board at the University of Illinois at Chicago. All diagnosing facilities in the greater Chicago area (N=56) were visited on a monthly basis and all eligible newly diagnosed cases were ascertained by review of pathology and tumor registry records at each hospital. Patients were further screened for eligibility and scheduled for interviews if eligible and interested.

The 90-minute interview was administered either in English or Spanish as appropriate using computer-assisted personal interview (CAPI) procedures. The final interview response rate was 56% representing 989 completed interviews among eligible patients (397 nH White, 411 nH Black, 181 Hispanic, response rates 51%, 59% and 66%, respectively). Of patients who were interviewed, 86% (n = 849) consented to medical record reviews to obtain information on aspects of diagnosis and treatment. More details of the BCCC study have previously been reported (17,18).

Symptomatic Awareness Despite a Recent Screen (SADRS)

Breast cancer mode of detection was based on the response to the question: "How was the problem noticed for the very first time?" with possible response categories being: 1) I found something, 2) My partner/spouse found something, 3) A doctor or nurse found something during a physical exam, 4) mammogram, 5) ultrasound, 6) MRI, and 7) lung/chest x- ray. The method of detection was defined as *symptomatic* if the woman reported that she or her spouse/partner found something or that a healthcare provider found something during physical exam, and as *screen-detected* if the disease was detected through a mammogram in the absence of symptoms (no patients in the analysis sample reported discovery through an ultrasound, MRI, or chest x-ray). All of the women were asked to report when their last mammogram had occurred prior to awareness of the problem later diagnosed as breast cancer. Patients were defined as having a screen-detected breast cancer or having SADRS in the past one or two years. Patients with symptomatic breast cancer in the absence of a recent prior screen were excluded from these analyses. The final sample size was 750 with respect to SADRS in the past two years, and 674 with respect to SADRS in the past one year (76 patients reporting a screen more than one but less than two years prior to detection were excluded from this latter definition).

Analysis variables

Race/ethnicity—Patients were categorized as 1) White, non-Hispanic, 2) Black, non-Hispanic, and 3) Hispanic or Latino. Ethnicity was defined through separate self-identification of Hispanic ethnicity and race. Ethnicity was defined as Hispanic if the patient self-identified as Hispanic, reported a Latin American country of origin, or reported a Latin American country of origin for both biological parents.

Socioeconomic factors—Socioeconomic position (SEP) was defined by four variables. At the individual level, attained education was reported in years and annual household income was reported in categories of below $20,000, between $20,000–$50,000, and greater than $50,000. At the census tract level for the individual's home address, concentrated disadvantage was defined using variables from the 2000 US Census on the percentage of families in the census tract with incomes below the poverty line, percentage of families receiving public assistance, percentage of persons unemployed, and percentage of female-headed households with children. Concentrated affluence was defined based on the percentage of families with incomes of $75,000 or more, percentage of adults with a college education or more, and percentage of the civilian labor force in professional and managerial occupations. For each measure an equally weighted sum across the relevant variables was calculated and then standardized to have a mean of zero and a standard deviation of one.

Tumor aggressiveness factors and breast density—Breast density, hormone receptor status, histologic grade and stage at diagnosis were abstracted from patient medical records. Breast density was abstracted from mammography reports and defined using the BIRADS categories of fatty, scattered fibro-glandular, heterogeneously dense, and extremely dense. Hormone receptor status was defined as positive if the tumor contained either estrogen or progesterone receptors, or negative if negative for both receptor types. Histologic grade was defined as low, intermediate and high. Stage at diagnosis was categorized into AJCC categories of 0, 1, 2, and 3 and 4 combined. For descriptive analyses, stage was dichotomized as late (stage 2,3,4) vs. early (stage 0,1). In-situ tumors (stage 0) were excluded from some analyses.

Facility characteristics—We used data from a mammography facility survey conducted in 2007 to define facility characteristics potentially associated with quality of mammography. With respect to the mammogram facility that detected the breast cancer (screen-detected) or the prior screening mammogram facility (symptomatic awareness), we defined facility reliance on dedicated breast imagers as none, partial or sole reliance (15). We also characterized facilities in terms of their designation as an American College of Radiology Breast Imaging Center of Excellence (19). The Disproportionate Share (DSH) program in state Medicaid programs provides supplemental payments to facilities with high levels of uninsured and Medicaid patients (20). We defined facilities as disproportionate share (DSH) facilities if they were located within hospitals that were classified as such by the state of or if they were non-hospital sites that were public health facilities.

Statistical analyses

We tabulated the distribution of patient, tumor biological, and facility characteristics by race/ethnicity (Table 1) and the prevalence of SADRS by patient, tumor biological, and facility characteristics (Table 2), and reported associated p-values from Pearson Chi-Squared tests. Next, we estimated a series of nested logistic regression models and conducted likelihood ratio tests for the inclusion of variables representing either biological or healthcare quality domains in the models (Table 3). For type 1 analysis, we started with a baseline model of SADRS containing age and race/ethnicity as covariates, then added either tumor biological or healthcare facility covariates, and conducted likelihood ratio tests to compare these models to the baseline model. For type 3 analyses we began with a full model containing age, race/ethnicity, tumor biological and healthcare facility covariates, then removed either the tumor biological or healthcare facility covariates as a group and conducted likelihood ratio tests. P-values from likelihood ratio tests <0.05 were interpreted as indicating that a specific domain contributed to the prediction of SADRS. We ran separate analysis for two definitions of SADRS: SADRS within one year and within two years.

To assess potential mediation of ethnic disparities in SADRS by socioeconomic, tumor biological or healthcare facility characteristics, we compared rescaled coefficients for these selected domains of interest using the method described by Karlson and Holm (Table 4)(21). In order to model variation in quality across facilities in a more granular fashion, we modeled individual facilities as fixed effects, after collapsing several facilities with small

numbers of breast cancers into a single group, resulting in a variable with 39 groups. All analyses were conducted using SAS version 9 (SAS Institute, Cary NC) and Stata statistical software, version 13 (Stata Corp, College Station, TX), and all tests were two-sided with a threshold for significance of 0.05.

RESULTS

Distribution of Patient Characteristics

The final sample for analysis included 750 patients with data on SADRS within 2 years, and a subset of 674 patients had data with respect to SADRS within one year.

Stage at diagnosis and SADRS among recently screened patients

As expected, patients reporting SADRS in the past one or two years were 43 and 42 percentage points more likely to be diagnosed at a later stage than screen-detected patients, respectively ($p<0.0001$). After excluding in-situ breast cancers, patients reporting SADRS in the past one or two years were 41 and 40 percentage points more likely to be diagnosed at a later stage than screen-detected patients, respectively ($p<0.0001$).

Racial/ethnic differences in patient, facility and tumor aggressiveness factors

Compared to nH White patients, nH Black and Hispanic patients were more likely to be of lower socioeconomic status (less likely to be privately insured, less income and education, and more likely to live in more disadvantaged and less affluent census tracts (Table 1). Racial and ethnic minorities were also more likely to be screened at disproportionate share and public facilities and less likely to be screened at breast imaging centers of excellence, university-based facilities or at facilities with dedicated breast radiologists. Racial and ethnic minorities were also more likely to be diagnosed with more aggressive-appearing ER/PR negative and higher grade tumors (Table 1). Breast density was available from medical records for 475 patients, and there were no differences in the distribution of breast density by race/ethnicity ($p=0.944$).

Patient, facility and tumor aggressiveness factors as predictors of SADRS

There were significant differences in SADRS by race/ethnicity, age, tumor biology, and facility characteristics (Table 2). We discuss results relative to SADRS within the past 2 years but the trends were similar with respect to SADRS within the past year. In this population of recently screened patients, nH Black and Hispanic patients were more likely than nH Whites to report SADRS (36% and 42% vs. 25%, respectively, $p=0.0004$). Greater breast density was positively associated with SADRS, and earlier age at diagnosis, ER/PR negative and higher grade disease were each positively associated with SADRS. Women screened in lower resourced institutions (disproportionate share, non-university-based, not designated as a breast imaging center of excellence, or facilities without dedicated breast radiologists) were more likely to report SADRS compared to women seen in higher resourced institutions. Patients with higher incomes were less likely to report SADRS, but education and health insurance were not associated with SADRS (Table 2).

Multivariable Nested Models of SADRS

In type 1 and 3 analyses, we grouped the socioeconomic, tumor aggressiveness and facility characteristics into separate domains and conducted likelihood ratio tests for nested models. The tumor aggressiveness domain was retained as a significant predictor of SADRS in both type 1 and type 3 analyses for SADRS within the past one or two years. The facility characteristics domain was retained in both type 1 and type 3 analyses for SADRS within the past 2 years. For SADRS within the past one year the facility characteristics domain was retained in type 1 analysis (p=0.0498) and marginally retained in type 3 analysis (p= 0.0606) (Table 3).

Proportionate reduction in the racial and racial/ethnic disparity in SADRS

In age-adjusted models of the racial/ethnic disparity in SADRS within the past one or two years, inclusion of socioeconomic variables did not affect the estimated disparity. Inclusion of facility characteristics marginally accounted for nearly one fourth (22% and 24%) of the disparity in SADRS within the past one or two years, respectively (Table 4). When we replaced facility characteristics with indicator variables for each separate facility, facility differences accounted for 42% (p=0.199) and 55% (p=0.048) of the disparity, respectively. Inclusion of tumor aggressiveness factors (ER/PR status and grade) significantly reduced the disparity by 26% (p=0.005) and 18% (p=0.02), respectively. Inclusion of both facility characteristics and tumor aggressiveness factors reduced the racial/ethnic disparity by 45% and 39% (p=0.01 for both). When we replaced facility characteristics with indicator variables for each separate facility, facility differences and tumor aggressiveness factors reduced the racial/ethnic disparity by 61% (p=0.09) and 70% (p=0.02), respectively (Table 4).

DISCUSSION

In a sample of breast cancer patients who received a screening mammogram within one or two years of their breast cancer detection, nH Black and Hispanic women were more likely than nH Whites to report symptomatic awareness which prompted the detection of their breast cancer. Both tumor biological factors and healthcare facility characteristics were associated with SADRS, and tumor biological factors and healthcare facility characteristics together accounted for nearly half of the racial/ethnic disparity in SADRS. The definition of SADRS used here is similar to the definition of interval breast cancer except that our results are based on patient self-reports, whereas interval breast cancer is typically defined from medical records or other sources of documentation. Here, patients reported how they came to discover their breast cancer and their mammography use prior to becoming aware of the problem later diagnosed as breast cancer. In addition to a missed finding on a screening mammogram, SADRS could be the result of an abnormal screening mammogram finding in a woman who did not receive appropriate diagnostic follow-up and which subsequently evolved into a symptomatic breast cancer. This second possibility distinguishes SADRS from interval breast cancer: the definition of SADRS used in the present study is broader and encompasses both interval breast cancer and symptomatic breast cancer developing as a result of delayed diagnostic follow-up.

Prior comparisons of symptomatic versus screen-detected breast cancers have often included both women with a recent prior screening history and women without a recent prior history, and these studies are not directly comparable to ours (10–12,22–27). Several studies have examined the disparities with respect to interval breast cancer as an outcome on either tumor biological factors or health care quality factors (13,14,28–32), but none of these studies provided a comprehensive picture of the multiple factors contributing to the disparity in symptomatic detection. These studies used a more rigorous definition of interval breast cancer, based on documented screening mammogram dates and results, than our definition of SADRS that relied on patient reported mode of detection and timing of prior screening imaging. Therefore, we need to carefully consider the potential impact of self-report biases/errors on our associations with SADRS.

Breast cancer that is diagnosed in younger women tends to be more aggressive and more likely to evade detection with screening mammography than in older women (14,30). In our sample of recently screened patients, as expected, SADRS was more likely in younger women. Likewise, tumor characteristics associated with aggressiveness of disease appeared to influence mode of detection in our study. Patients with ER/PR negative or high-grade tumors were more likely to report SADRS than patients with ER/PR positive and lower grade tumors. Similarly, patients in our study with heterogeneously or extremely dense breasts were more likely to report SADRS than patients with fatty or scattered fibro-glandular breasts. This finding is consistent with what has been previously reported in other studies examining the role of breast density on cancers occurring between screens (interval cancer) (32–34).

We also found that factors associated with quality of screening appear to influence mode of detection among screened patients. Prior studies have found associations between radiologist characteristics, practice characteristics, image characteristics, patient characteristics, and likelihood of interval cancer/mammography accuracy (5,28,35–39). Screening performance can depend on whether facilities offer screening alone vs. screening and diagnostic mammograms or multimodality screening and diagnosis, the extent to which facilities rely on breast imaging specialists, and frequency of audit reviews (35–39).

We used four variables to model healthcare quality associated with SADRS, and these were each associated with SADRS in the expected direction. Patients screened at sites that relied on dedicated radiologists, that were breast imaging centers of excellence, and that were not disproportionate share facilities were each less likely to report SADRS. Together these variables accounted for about one-fourth of the racial/ethnic disparity ion SADRS. When we modeled variation in healthcare quality in a more detailed manner by using individual facility indicators, facility variation appeared to account for about half of the racial/ethnic disparity in SADRS.

Prior studies conducted in Chicago suggest the existence of a differential access to quality mammography services between minority women and nH White women. In a study assessing the distribution of mammography services by race/ethnicity and health insurance in Chicago, minority women were less likely than nH Whites to obtain mammograms at university-based facilities, at facilities that relied exclusively on breast imaging specialists,

and at facilities where digital mammography was available (15). Previous analyses of a small subsample of patients from the current study found that nearly half of prior screening mammogram images that were originally interpreted as normal showed some evidence of a potentially missed cancer, that is, an actionable lesion in the same breast and quadrant as the subsequently diagnosed breast cancer (16). Our results are consistent with these findings and could offer some insight into the outcome disparities in breast cancer in Chicago.

Method of detection and timing of the most recent prior mammogram were both self-reported. We went to great lengths to get accurate self-reports of method of detection through careful design of the question based on prior cognitive interviews and by allowing for a range of possibilities for how a patient might become aware of the problem later diagnosed as breast cancer. We attempted to limit any tendency for over-reporting of screen-detection due to socially desirable reasons by asking first about whether the problem was discovered by the patient, her partner, or her doctor via clinical breast exam, before mentioning potential discovery through mammography or other imaging modalities. The definition of a recent prior screening mammogram was also based on self-reports; thus, forward-telescoping of the date of most recent screening examination likely caused some women without a recent prior mammogram to be included in the definition of SADRS. If this process were non-differential with respect to characteristics examined it would tend to attenuate associations observed. However, if, as prior research suggests, ethnic minorities were more likely than nH Whites to forward telescope prior mammography (40–42), then any estimated disparity would tend to be inflated. However, the apparent mediation of the disparity in SADRS by tumor aggressiveness variables (abstracted from medical records) and facility characteristics suggest that at least part of the disparity is real and is due to differences in these domains.

To our knowledge this is the first study to examine socioeconomic status, facility characteristics and tumor biology and their potential role in mediating a racial and ethnic disparity in screen-detection of breast cancer. Our results implicate both facility resources and tumor aggressiveness in SADRS in explaining the racial/ethnic disparity in SADRS in this study. Results suggest that elimination of inequities in access to high quality mammography screening would reduce the racial/ethnic disparity in symptomatic breast cancer among screened women by as much as half.

Regular, high-quality mammography is even more important for patients at risk for more aggressive forms of breast cancer, e.g., racial/ethnic minorities, since tumors in these women are harder to detect and more likely to arise as interval breast cancer or SADRS. Racial/ethnic minorities are also more likely to be screened at lower-resource facilities that may be associated with increased SADRS. Factors potentially amenable to improvement are largely those related to quality of mammography and they include encouraging facilities to recruit breast imaging specialists and breast focused radiologists, requiring rigorous auditing as part of the Mammography Quality Standards Act, and mammography focused continuing education for mammography technologists and radiologists. MQSA inspects mammogram images only once every three years and only a small sample of images that are hand- picked in advance by the facility. Lower-performing institutions might be able to pass image quality inspection regardless of actual practice, and these might serve a disproportionate share of

ethnic minority patients. Illinois recently became the first state in the nation to implement a statewide mammography quality surveillance program tied to increased Medicaid reimbursement, with the goal of improving the quality of mammography and timeliness of follow-up (43).

Differences in facility characteristics accounted for much of the disparity in symptomatic breast cancer among recently screened patients, and a more equitable distribution of high quality screening would reduce this disparity. At the same time, the tendency for more aggressive breast cancer in nH Black and Hispanic patients resulted in a roughly equal contribution to explaining the disparity. Our results suggest that even if a more equitable distribution of high quality screening were available, a substantial disparity would remain in symptomatic breast cancer among recently screened patients.

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Table 1

Racial/ethnic differences in patient, facility and tumor characteristics among breast cancer patients with a recent screen prior to their diagnosis in the Breast Cancer Care in Chicago study (2005–2008).

	N	nH White (N=314) %	nH Black (N=304) %	Hispanic (N=132) %	P-Value
SADRS[a]					0.0004
No	507	75	64	58	
Yes	243	25	36	42	
Stage at diagnosis					<0.0001
Stage 0,1	423	75	60	54	
Stage 2,3,4	227	25	40	46	
Age					0.2848
25–49	169	24	20	26	
50–59	246	32	33	34	
60–79	335	44	47	40	
Breast Density					0.9437
Fatty	33	7	6	9	
Scattered fibroglandular	208	45	46	36	
Heterogeneously dense	171	34	36	42	
Extremely dense	63	14	13	13	
Socioeconomic factors					
Health insurance[a]					<0.0001
None	71	2	13	20	
Public	117	5	23	23	
Private	562	93	64	57	
Education					<0.0001
<12	135	4	21	44	
12	133	13	21	20	
>12	479	82	57	36	
Income					<0.0001
<20K	181	10	35	35	
20–50K	343	41	51	52	

	N	nH White (N=314) %	nH Black (N=304) %	Hispanic (N=132) %	P-Value
>50K	203	49	13	13	
Disadvantage					<0.0001
>1 SD below mean	113	32	1	8	
Within 1 SD of the mean	493	67	56	85	
>1 SD above mean	142	1	43	8	
Affluence					<0.0001
>1 SD below mean	49	0	11	11	
Within 1 SD of the mean	542	59	82	84	
>1 SD above mean	157	41	7	5	
Facility characteristics					
Designation					<0.0001
Not Disproportionate Share	547	92	66	54	
Disproportionate Share	187	8	34	46	
Designation					0.0220
Not a Breast Center of Excellence	480	59	69	69	
Breast Center of Excellence	257	41	31	31	
University-Based					<0.0001
No	545	59	78	92	
Yes	205	41	22	8	
Reliance on dedicated radiologists					0.0180
None	137	14	19	27	
Partial	475	66	65	54	
Sole reliance	138	20	16	20	
Tumor aggressiveness factors					
ER/PR status					<0.0001
Either or both positive	461	91	75	82	
Double negative	96	9	25	18	
Histologic Grade (1,2,3)					0.0085
Low	129	30	19	12	
Moderate	237	36	43	48	

	N	nH White (N=314) %	nH Black (N=304) %	Hispanic (N=132) %	P-Value
High	209	33	38	40	

[a] P-values for these 2 variables and for all binary variables are from a general Chi-Squared test, whereas p-values for the remaining ordered variables are from a test for trend via nominal logistic regression with race/ethnicity as a dependent variable. P-values >0.15 are suppressed.

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Table 2

Patient, facility and tumor aggressiveness factors and symptomatic awareness despite a recent screen in the Breast Cancer Care in Chicago study (2005–2008).

	Symptomatic breast cancer awareness despite a recent screen					
	Within the past year			Within the past 2 years		
	N	%	P-Value	N	%	P-Value
Ethnicity[a]			0.0004			0.0004
nH White	288	18		314	25	
nH Black	267	27		304	36	
Hispanic	119	36		132	42	
Age			0.0036			0.0002
25–49	147	30		169	39	
50–59	215	30		246	39	
60–79	312	19		335	24	
Breast Density			0.0005			0.0016
Fatty	29	14		33	24	
Scattered fibroglandular	190	18		208	25	
Heterogeneously dense	154	32		171	39	
Extremely dense	56	34		63	41	
Socioeconomic factors						
Health insurance[a]			0.7550			0.6840
None	63	29		71	37	
Public	104	25		117	33	
Private	507	24		562	32	
Education			0.4806			0.4000
<12	121	26		135	34	
12	117	26		133	35	
>12	433	24		479	31	
Income			0.095			0.0976
<20K	164	28		181	35	
20–50K	302	26		343	35	

	Symptomatic breast cancer awareness despite a recent screen					
	Within the past year			Within the past 2 years		
	N	%	P-Value	N	%	P-Value
>50K	186	20		203	27	
Disadvantage			0.2316			0.1172
>1 SD below mean	106	21		113	26	
Within 1 SD of the mean	439	25		493	33	
>1 SD above mean	127	28		142	35	
Affluence			0.1124			0.0464
>1 SD below mean	45	29		49	35	
Within 1 SD of the mean	480	26		542	34	
>1 SD above mean	147	20		157	25	
Facility characteristics						
Designation			0.1076			0.0500
Not Disproportionate Share	496	24		547	31	
Disproportionate Share	164	30		187	39	
Designation			0.0104			0.0536
Not a Breast Center of Excellence	433	28		480	35	
Breast Center of Excellence	228	19		257	28	
University-Based			0.0188			0.0069
No	485	27		545	35	
Yes	189	19		205	25	
Reliance on dedicated radiologists			0.0026			0.0017
None	122	35		137	42	
Partial	248	24		475	32	
Sole reliance	128	19		138	25	
Tumor aggressiveness factors						
ER/PR status			0.00006			0.0011
Either or both positive	413	22		461	30	
Double negative	88	42		96	47	
Histologic Grade (1,2,3)			0.0018			0.0020

	Symptomatic breast cancer awareness despite a recent screen					
	Within the past year			Within the past 2 years		
	N	%	P-Value	N	%	P-Value
Low	119	17		129	23	
Moderate	212	21		237	30	
High	187	32		209	39	

[a]P-values for these 2 variables and for all binary variables are from a general Chi-Squared test, whereas p-values for the remaining ordered variables are from a test for trend via logistic regression. P-values >0.15 are suppressed.

Table 3

Comparison of nested multivariable models of Symptomatic awareness despite a recent screen in the Breast Cancer Care in Chicago study (2005–2008).

	Symptomatic breast cancer awareness despite a recent screen			
	Within the past year		Within the past 2 years	
	N	P-Value[a]	N	P-Value[a]
Type 1 analysis				
Add socioeconomic factors[b]	453	0.9671	503	0.9262
Add facility characteristics[c]	453	0.0498	503	0.0147
Add tumor aggressiveness factors[d]	453	0.0001	503	0.0003
Type 3 analysis				
Remove socioeconomic factors	453	0.9270	503	0.8776
Remove facility characteristics	453	0.0606	503	0.0116
Remove tumor aggressiveness factors	453	0.0002	503	0.0005

[a] From a Chi-Squared likelihood ratio test comparing two nested models. P-values >0.15 are suppressed.

[b] Individual level income and education, and census tract disadvantage and affluence.

[c] Status as Disproportionate Share and as a Breast Imaging Center of Excellence, reliance on dedicated breast radiologists.

[d] tumor grade and ER/PR status.

Table 4

Proportionate reduction in the racial/ethnic disparity in symptomatic awareness despite a recent screen.

	Symptomatic awareness despite a recent screen			
	Within the past year (N=453)		Within the past 2 years (N=503)	
Domains	**Pr[a]**	**P-Value[b]**	**Pr[a]**	**P-Value[b]**
Domains modeled one at a time				
Socioeconomic Status	4%	0.837	–2%	0.719
Facility characteristics	22%	0.15	24%	0.09
Individual Facility[c]	42%	0.199	55%	0.05
Tumor aggressiveness	26%	0.005	18%	0.02
Domains modeled together	45%	0.01	39%	0.01
Facility characteristics	21%		23%	
Tumor aggressiveness	24%		16%	
Domains modeled together	61%	0.09	70%	0.02
Individual Facility[c]	31%		50%	
Tumor aggressiveness	30%		20%	

[a] Proportionate reduction in the ethnic disparity in symptomatic awareness despite a recent screen, based on the method of rescaled coefficients.

[b] P-value from a test of difference between the reduced model and the full model containing all mediators of interest. P-values>0.15 are suppressed.

[c] Indicator variables for individual mammogram facilities.