

The Influence of Race, Ethnicity, and Individual Socioeconomic Factors on Breast Cancer Stage at Diagnosis

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Racial and ethnic differences in breast cancer incidence, stage at diagnosis, and mortality have been observed for decades in the United States.^{1–3} White women have a higher age-adjusted incidence of breast cancer than do Black women, Hispanic women, and other ethnic groups for whom data are available.^{1,4} Despite having the highest incidence of breast cancer, White women do not have the highest mortality. The 1998 to 2002 breast cancer mortality rate per 100 000 was 26.2 for non-Hispanic White women, 34.7 for Black women, and 16.7 for Hispanic women.⁵ This suggests that, despite their much lower incidence, Black women are more likely to die from breast cancer than are White women.^{2–8} Of additional concern is that the breast cancer mortality rate for Black women actually rose in the late 1990s, at the same time it was declining overall and for White women in particular.^{1,6–8}

Women of color are significantly more likely to be diagnosed with breast cancer at a late stage in the United States.^{3,5,9,10} Li et al. reported that Black, American Indian, and Hawaiian women and Hispanic women of Mexican, Puerto Rican, and Central and South American descent were all at increased risk of late-stage diagnosis, compared with non-Hispanic White women.⁴ The Black–White disparity is the most prominent, with 34% of White women diagnosed at the regional or metastatic stage, compared with 44% of Black women.⁵ This, however, does not explain all of the Black–White disparity in breast cancer mortality, because even within stage categories, Black women have significantly poorer survival than do White women.^{3–5,8,10,11}

Exposure to mammography screening explains some of the racial/ethnic disparity in breast cancer stage at diagnosis.^{12,13} In

Objectives. Previous research has generally found that racial/ethnic differences in breast cancer stage at diagnosis attenuate when measures of socioeconomic status are included in the analysis, although most previous research measured socioeconomic status at the contextual level. This study investigated the relation between race/ethnicity, individual socioeconomic status, and breast cancer stage at diagnosis.

Methods. Women with stage 0 to III breast cancer were identified from population-based data from the Surveillance, Epidemiology, and End Results tumor registries in the Detroit and Los Angeles metropolitan areas. These data were combined with data from a mailed survey in a sample of White, Black, and Hispanic women (n=1700). Logistic regression identified factors associated with early-stage diagnosis.

Results. Black and Hispanic women were less likely to be diagnosed with early-stage breast cancer than were White women ($P<.001$). After control for study site, age, and individual socioeconomic factors, the odds of early detection were still significantly less for Hispanic women (odds ratio [OR]=0.45) and Black women (OR=0.72) than for White women. After control for the method of disease detection, the White/Black disparity attenuated to insignificance; the decreased likelihood of early detection among Hispanic women remained significant (OR=0.59).

Conclusion. The way in which racial/ethnic minority status and socioeconomic characteristics produce disparities in women's experiences with breast cancer deserves further research and policy attention. (*Am J Public Health.* 2006;96:2173–2178. doi:10.2105/AJPH.2005.072132)

addition, many researchers have investigated whether racial/ethnic differences in stage at diagnosis remain significant once indicators of socioeconomic status (SES) are taken into account. A predominant hypothesis is that observed disparities may be driven more by socioeconomic position than by minority status per se. Several studies have investigated this hypothesis using tumor registry data from large medical facilities, states, or the Surveillance, Epidemiology, and End Results (SEER) program.^{3,7,14–17} Baquet and Commiskey's literature review on racial/ethnic differences in breast cancer stage at diagnosis concluded that the bulk of the published research shows that, after adjustment for prognostic indicators and SES, differences in stage at diagnosis do indeed attenuate.² Studies conducted after this review report similar findings.^{8,17} Although some previous studies have found that

SES factors explain all of the race differentials in stage at diagnosis, most studies to date suggest that although racial (predominantly Black–White) differences in stage attenuate, they also remain statistically significant after adjustment for socioeconomic variables.^{2,7,8,17}

Most previous studies on this topic had serious limitations.⁷ First, most previous research has measured SES at the geographic (i.e., census tract, zip code, or county) level rather than at the individual level. This is not surprising, because SEER and other tumor registries collect information on patient race/ethnicity but not on education, income, or other socioeconomic markers. Nonetheless, the reliance on contextual-level indicators of SES is of concern, because these measures are not perfect proxies for individual-level socioeconomic standing and may function differently in their association with cancer

stage at diagnosis.¹⁸ Although a few studies have operationalized SES at the individual level, only 1 used a population-based sample; others were confined to specific health care systems.^{3,19,20} Thus, to date, there is a paucity of research on racial/ethnic disparities in breast cancer stage at diagnosis that simultaneously uses a population-based sample and individual-level SES information. A second limitation of previous studies is that most focused on Black and White women exclusively, leaving questions regarding broader racial/ethnic disparities in breast cancer stage relatively unexplored.

To address some of the gaps in the literature, we examined the independent associations of race/ethnicity, income, and education with stage at diagnosis in a sample of women recently diagnosed with nonmetastatic breast cancer. Our approach had significant advantages over the majority of previous research on this topic: (1) we analyzed data from a population-based sample that included Whites, Blacks, and Hispanics; (2) the study population included an oversample of women with ductal carcinoma in situ (DCIS), a type of early-stage breast cancer that has become increasingly common; (3) we used individual-level rather than geographic or contextual measures of important socioeconomic indicators; and (4) we included data on the method of breast cancer detection, because exposure to screening mammography has been hypothesized to be a mediating factor between race/ethnicity, SES, and stage at diagnosis.^{12,13}

METHODS

Data for this analysis came from a study with a primary focus on the surgical treatment decision process (mastectomy vs lumpectomy) for women with nonmetastatic breast cancer.^{21,22} The study population was identified through the population-based SEER registries of the greater metropolitan areas of Detroit and Los Angeles. Potential study participants were identified through rapid case ascertainment processes at the registries between December 2001 and January 2003. Eligibility criteria included (1) a primary diagnosis of DCIS or invasive (but nonmetastatic) breast cancer, (2) no previous breast cancer diagnosis, (3) receipt of a

definitive surgical procedure, (4) age younger than 80 years, and (5) the ability to complete a self-administered questionnaire in English or Spanish. In addition, all Asian women and some US-born women younger than 50 years at diagnosis with invasive disease in Los Angeles were also excluded from the sample because they were enrolled in other studies that were already under way. The number of White, Black, and Hispanic women younger than 50 years in the final Los Angeles study sample ($n=115$) was approximately 60% of what would have been expected without excluding women involved in other studies.

We prospectively selected all DCIS cases and an approximate 20% random sample of invasive cases meeting the study criteria, accruing a preliminary sample of 2627 patients over a 14-month period. In addition to oversampling cases of DCIS (34.6% of accrued cases), we oversampled Black women by including all who met the study criteria. A rapid case ascertainment process captured 90% of all breast cancer cases in Detroit and nearly 100% of cases in Los Angeles within 6 weeks of diagnosis. Ninety percent of all accrued cases were eligible for the study ($N=2382$). A survey questionnaire was completed by 77.4% ($n=1844$) of eligible patients, with 92.4% completing a mailed questionnaire and 7.6% completing an abbreviated telephone interview. Questionnaires were completed, on average, approximately 7 months after diagnosis of breast cancer. All survey materials were translated into Spanish by native speakers of Mexican descent. A cross-cultural check was performed by speakers of Central and South American descent. Reverse translation of the questionnaire was performed, with differences evaluated and reconciled.

Physicians were notified of our intent to contact patients via a letter, and fewer than 1% of patients were excluded because of physician concerns. An introductory letter was sent to all potential subjects, followed by telephone contact to assess eligibility. A questionnaire along with a \$10 gift was mailed to all who were eligible and agreed to participate in the study. The Dillman survey method, which involves a postcard reminder and subsequent specifically timed follow-up mailings to nonresponders, was used to

enhance the response rate.²³ A patient identifier was used to merge clinical data from the SEER registries and the survey data.

Variables

The dependent variable in this analysis was breast cancer stage at diagnosis. Stage was classified as stage 0, I, II, or III by the American Joint Committee on Cancer TNM (tumor, node, metastases) Staging System for breast cancer.²⁴ Women with stage IV (metastatic) disease were not eligible for this study, which had surgical treatment choice (mastectomy vs lumpectomy) as its primary focus.^{21,22} Stage at diagnosis was dichotomized as stages 0 and I (early stage) versus stages II and III (late stage).

Individual-level demographic, socioeconomic, and behavioral characteristics were obtained from the survey data, including age at diagnosis (<50 years, 50–64 years, and ≥65 years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and other),²⁵ educational attainment (less than high school, high-school graduate, and some college and beyond), household income (<\$20 000, \$20 000–\$49 999, ≥\$50 000), and method of detection (discovered by self or partner, by clinical breast examination, or by screening mammogram). In cases where survey data were missing for age at diagnosis or race/ethnicity, information was obtained from the SEER registry.

Several prognostic variables were available from SEER, including tumor size, histologic type and grade, and estrogen receptor status. However, all of these indicators are significantly associated with each other and with extent of disease at diagnosis and thus, raise concerns about autocorrelation and endogeneity in an analytic model with stage at diagnosis as the dependent variable.²⁶ Although our study design was cross-sectional, all independent variables under consideration occurred temporally before the dependent variable and thus, could be considered as determinants of stage at diagnosis.

Statistical Methods

Analyses were performed on the 1700 participants with information on stage at diagnosis and who self-reported to be non-Hispanic White, non-Hispanic Black, or Hispanic (92.2% of the sample), excluding the 56 cases from

the “other” racial/ethnic group who were not Hispanic. The data were weighted in all analyses to account for the sampling design and to correct for nonresponse. A total sample weight was calculated for each subject, based on the probability of selection into the study. These probabilities varied according to stage at diagnosis, race, and study site. The sampling weights were then normalized for each site to maintain the original sample size for statistical testing. The weighted data represent the majority of women diagnosed with non-metastatic breast cancer in the Detroit and Los Angeles metropolitan areas during the 14-month study period.

Descriptive statistics were used to characterize the distribution of the study variables for the total sample and by stage at diagnosis. Bivariate associations between stage and each of the independent variables were tested with the Wald χ^2 test. Additional bivariate associations were tested for race/ethnicity and each

of the other covariates to identify potential confounders. A series of 3 multiple predictor logistic regression models were estimated to assess the relation between breast cancer stage and race; we controlled for a combination of independent variables. First, the odds of diagnosis at an early stage were estimated for the 3 racial/ethnic groups under study (with non-Hispanic White women as the reference group), with only age at diagnosis and study site controlled (model 1). Next, the individual-level socioeconomic variables (income and education) were added (model 2), to assess the effect of these variables on the race/ethnicity coefficients and to see if these variables had an independent effect on the odds of early-stage diagnosis. Finally, the method of disease discovery was added to the model (model 3). All 2-way interactions were tested in model 3. Because all hypotheses were specified a priori, no adjustments were made for multiple comparisons.

RESULTS

The mean age of the women in the weighted sample ($n=1700$) was 59.5 years. The distribution of self-reported race/ethnicity was 70.0% White, 18.1% Black, and 11.9% Hispanic. As shown in Table 1, the distribution of several variables under study differed significantly by breast cancer stage (early vs late). Participants with early-stage breast cancer (stage 0, I) were significantly more likely to be older than 65 years, to be White, and to have had their breast cancer detected by screening mammography.

As shown in Figure 1, there was a strong and statistically significant bivariate association between race/ethnicity and breast cancer stage at diagnosis. Women of color were much more likely to be diagnosed at a late stage than were White women. For example, 25.3% of White women were diagnosed at stage II, compared with 32.9% of Black women and 38.2% of Hispanic women ($P<.05$). For stages 0 and I combined, 64.3% of White women were diagnosed with early-stage breast cancer, compared with 53.1% of Black women and 44.8% of Hispanic women ($P<.001$). Additional results revealed that the method of disease detection (screening mammogram, clinical breast examination, or self-examination) also significantly varied by race/ethnicity. Among White women, 66.6% reported that their breast cancer was detected by screening mammography, compared with 54.6% of Black women and 48.5% of Hispanic women ($P<.001$).

The relation between stage at diagnosis and race/ethnicity persisted in multivariate analysis in a model with controls for age and study site (Table 2, model 1). Both Hispanic women and Black women had significantly lower odds of early stage at diagnosis than did White women (who were the referent group). In a model with additional controls for education and income (Table 2, model 2), the effect of race/ethnicity on breast cancer stage remained significant for both Hispanic and Black women. When age and study site were controlled, the odds of early-stage diagnosis were 0.45 (95% confidence interval [CI]=0.31, 0.64) for Hispanic women and 0.72 (95% CI=0.54, 0.96) for Black women. In this model, neither low education

TABLE 1—Characteristics of Total Study Sample and by Breast Cancer Stage at Diagnosis

	Total n = 1700 n	Total Percentage % (weighted)	Stage 0, I n = 1176 % (weighted)	Stage II, III n = 524 % (weighted)	P
Study site					.52
Los Angeles	870	51.4	52.0	50.4	
Detroit	830	48.6	48.0	49.6	
Age, y					
< 50	355	19.1	16.4	23.0	
50–64	719	42.6	41.9	43.6	
≥ 65	626	38.3	41.7	33.4	
Race/ethnicity					<.001
Hispanic	184	11.9	8.9	16.4	
Non-Hispanic Black	383	18.1	16.1	21.2	
Non-Hispanic White	1133	70.0	75.0	62.4	
Education					.08
Less than high school	196	12.9	11.4	15.2	
High-school diploma	361	23.4	23.3	23.6	
Some college or more	1013	63.7	65.3	61.2	
Annual household income, \$.15
< 20 000	320	18.6	17.9	19.6	
20 000–49 999	457	27.0	27.8	25.9	
≥ 50 000	635	37.6	38.9	35.6	
Income missing	288	16.8	15.4	18.9	
How cancer was detected					<.001
Self/partner	408	31.4	14.9	56.1	
Clinical breast examination	89	6.3	4.1	9.6	
Screening mammogram	1093	62.3	81.0	34.3	
Mean age, y ±SD		60.0 years ±11.1		58.3 years ±12.8	<.001

TABLE 2—Odds Ratios (ORs) for Association of Factors With Early-Stage Diagnosis of Nonmetastatic Breast Cancer (n = 1700)

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Study site			
Los Angeles	1.14 (0.92, 1.42)	1.07 (0.85, 1.35)	1.07 (0.82, 1.39)
Detroit	1.00	1.00	1.00
Age, y			
< 50	0.64 (0.48, 0.85)	0.60 (0.44, 0.82)	1.03 (0.71, 1.48)
50–64	0.78 (0.63, 0.98)	0.74 (0.58, 0.94)	1.01 (0.77, 1.34)
≥ 65	1.00	1.00	1.00
Race/Ethnicity			
Hispanic	0.44 (0.32, 0.61)	0.45 (0.31, 0.64)	0.59 (0.39, 0.90)
Non-Hispanic Black	0.66 (0.51, 0.86)	0.72 (0.54, 0.96)	0.79 (0.57, 1.10)
Non-Hispanic White	1.00	1.00	1.00
Education			
Less than high school		0.99 (0.68, 1.43)	0.98 (0.64, 1.49)
High-school diploma		0.91 (0.70, 1.19)	0.92 (0.68, 1.23)
Some college or more		1.00	1.00
Annual household income, \$			
< 20 000		0.90 (0.65, 1.26)	1.04 (0.71, 1.53)
20 000–49 999		1.00 (0.77, 1.31)	1.22 (0.89, 1.66)
≥ 50 000		1.00	1.00
Income missing		0.82 (0.57, 1.18)	0.81 (0.53, 1.24)
How cancer was detected			
Self/partner			0.12 (0.09, 0.16)
Clinical breast examination			0.18 (0.12, 0.28)
Screening mammogram			1.00

Note. CI = confidence interval.

nor low income was significantly associated with stage at diagnosis. However, age remained a significant factor, with women younger than 65 years significantly less likely to have an early-stage diagnosis than those aged 65 years and older.

In the final model, in which method of disease detection was added (Table 2, model 3), the results suggested that women who discovered the disease themselves (odds ratio [OR]=0.12, 95% CI=0.09, 0.16) or through a clinical breast examination (OR=0.18, 95% CI=0.12, 0.28) were significantly less likely to have an early diagnosis than were women whose disease was detected via screening mammography. Adding the detection variable to the model attenuated the Black–White difference in stage at diagnosis to insignificance (OR=0.79, 95% CI=0.57, 1.10). However, the Hispanic–White difference remained significant, with the odds of Hispanic women

having early-stage disease at 0.59 (95% CI=0.39, 0.90) compared with White women.

Additional Analysis

Models that tested for interactions (results not shown) revealed no statistically significant interactions between race/ethnicity and age, income, education, or method of detection. We also repeated all analyses, restricting the sample to women aged 50 and older (n=1345), and the results were strikingly similar in both effect sizes and patterns. Finally, we ran model 3 for Hispanic women alone, adding a variable indicating whether the survey was completed in English (n=85) or Spanish (n=44), as a proxy measure of acculturation. The inclusion of this variable attenuated the odds that Hispanic women would be diagnosed at an early stage to insignificance (from OR=0.59, CI=0.39, 0.90, to OR=0.66, 0.41, 1.04). However, the survey

language variable itself was not significantly associated with stage at diagnosis.

DISCUSSION

Our research aimed to increase understanding of disparities in breast cancer stage at diagnosis by investigating whether racial/ethnic identity captures, at least in part, individual-level aspects of socioeconomic position. We found that individual measures of income and education were not significantly associated with stage of breast cancer diagnosis in multivariate analyses. We also found that racial/ethnic differences in early-stage diagnosis remained significant in models that controlled for income and education. These results are somewhat different from those of Bradley et al., who found that after they controlled for poverty (defined as being on Medicaid) and other covariates, Black–White differences in stage at diagnosis were no longer apparent in a Detroit SEER sample.³

Our results also suggest that the method by which a breast malignancy was detected explains a significant portion of Black–White and Hispanic–White differentials in early-stage diagnosis. Although income, education, and mammography screening appear to explain all of the Black–White disparity in stage at diagnosis, these variables do not explain all of the Hispanic–White disparity. Our results are consistent with several previous studies suggesting that racial/ethnic differences in detection via mammography are important drivers in disparities in stage at diagnosis.^{12,13,27} These results, however, do not necessarily mean that increasing mammography utilization would eliminate racial differences in stage at diagnosis and survival, because tumors detected by mammography appear to have different prognostic indicators by race.^{13,28}

Racial and ethnic differences in breast cancer incidence, stage, survival, and mortality present a complex and frustrating puzzle to the fields of social epidemiology and cancer control. Why are White women with breast cancer faring so much better than women of color? Most of the research to date has focused on Black–White differences. Some clinicians and researchers have hypothesized that Black women are more likely to experience

cancers that are more aggressive or at higher prognostic risk, thus, purporting a biological mechanism for the relation between race, breast cancer stage, and survival.^{8,29,30} In these discussions, however, it is important to be clear about what we believe is being measured with variables such as race or ethnicity in the analysis of health disparities. Some may see these measures as capturing biological differences, but it is also likely that race/ethnicity captures differences between people in socioeconomic position, culturally related behaviors, access to individual and community resources for early detection and treatment, and experiences within the health care system.

Our results suggest that Black–White differences in stage at diagnosis of nonmetastatic breast cancer are not significant when individual-level socioeconomic factors and method of disease detection are controlled, contrary to the bulk of the previous literature, which measured SES at the geographic or contextual level. This, however, is not the case for Hispanic women, who are still significantly less likely to be diagnosed at an early stage even when income, education, and method of detection are controlled. This is consistent with previous published reports, especially for Hispanic women born outside of the United States.^{31,32} These findings raise important questions about the complex relations between ethnicity, SES, cultural factors, beliefs and attitudes regarding cancer and cancer screening, and interactions with the health care system. Key factors regarding access to and quality of experiences with the health care system not captured in our individual measures of SES could have played a role and may be more accurately represented by contextual SES factors.^{14,33–35} Another potential explanation for the association between race/ethnicity and breast cancer stage at diagnosis after individual socioeconomic factors are controlled is the higher prevalence of obesity in some racial/ethnic minority groups, because several studies have documented a link between obesity and late-stage detection.^{36,37}

The lack of data on individual-level socioeconomic variables in population-based tumor registries presents challenges to social epidemiological research. There are trade-offs between using a population-based sample of cancer patients from a tumor registry combined

with contextual-level SES data and using a sample confined to 1 medical institution combined with individual-level SES data. Studies such as ours—with individual-level SES data and a population-based sample—are rare. Krieger argues that, to fully document and understand health disparities, we need race/ethnicity identifiers and both individual and contextual socioeconomic data in public health surveillance systems and population-based disease registries.³⁸ Although efforts to achieve this goal are crucial to health-disparities research and policy, they face challenges, including recent political efforts to exclude the reporting of race/ethnicity in state-based information systems.³⁹

The strengths of this work are that we simultaneously used a population-based sample and individual (rather than contextual) measures of SES and other key variables and that we had a sufficient number of stage 0 cases because of oversampling. The limitations of our approach include that the study design was cross-sectional and that we did not consider individual and contextual socioeconomic indicators simultaneously (although such an analysis is under way). In addition, the Los Angeles study site excluded all Asian women and some US-born women under 50 with invasive disease (estimated $n=100$). Furthermore, almost all of the Hispanic subjects in our sample came from the Los Angeles study site. Thus, although our data represent the majority of stage 0 to III breast cancer cases diagnosed in 2 large metropolitan areas, some questions remain about the generalizability of the results.

Another limitation of this study is that women with metastatic disease were excluded from the sample. The primary purpose of the original study was to investigate surgical treatment decisionmaking and the process by which this and other treatment decisions were made. Thus, it made sense to exclude women with metastatic disease (who very rarely receive lumpectomy) from the study sample. However, the exclusion of those with metastatic disease somewhat limits the generalizability of the findings of this study because the results regarding the relation between race/ethnicity, SES, and stage could be different for women with metastatic disease. SEER data from 1995 to 2001 showed convincingly that

racial/ethnic differences are very strong in terms of the proportion of breast cancer patients diagnosed at the distant, or metastatic, stage (5% for White women vs 9% for Black women).⁵ Nonetheless, SEER data also demonstrated that only 6% of all breast cancers are distant cases.⁵ Excluding this small yet important subpopulation from our analysis likely served to attenuate rather than accentuate racial/ethnic differences to be explained in the multivariate analysis and could explain why our results differed somewhat from previous studies. Nonetheless, the results presented here are important and relevant to the vast majority of breast cancer cases in the United States. Additional research should investigate the extent to which what is happening with metastatic breast cancer is different from other diagnostic stages.

Recent trends in breast cancer incidence, mortality, and survival should be of critical interest to the public health research and policy communities. Several additional research questions and hypotheses regarding disparities in breast cancer outcomes deserve serious investigation.⁴⁰ In this, and indeed in all disparities research, it is important that researchers be clear about what they believe is being measured by race/ethnicity in the analysis and that they explore multiple mechanisms—economic, political, social, behavioral, psychological, and biological—by which minority status leads to worse outcomes, in both relative and absolute terms.^{1,6,41,42} How racial/ethnic minority status and socioeconomic characteristics produce disparities in women's experience with a leading cause of cancer is deserving of significant research and policy attention. ■

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Contributors

All authors were involved with project planning, implementation, and data collection. P.M. Lantz, M. Mujahid, K. Schwartz, and S.J. Katz analyzed the data. All authors participated in writing the article.

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Human Participant Protection

The study protocol was approved by the institutional review boards at the University of Michigan, Wayne State University, and the University of Southern California.

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