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Absence of an anticipated racial disparity in interval breast cancer within a large health care organization

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ABSTRACT

Purpose: Compared to non-Latina (nL) white women, nL black women are diagnosed with more aggressive breast cancers, which in turn should be more likely to go undetected on screening mammography and subsequently arise as interval breast cancer (IBC). We sought to estimate the extent of an anticipated racial disparity in IBC within a single, large health care organization.
Methods: The present analysis focuses on 4357 breast cancers diagnosed between 2001 and 2012 and within 18 months of a screening mammogram ($N = 714,218$). We used logistic regression with model-based standardization (predictive margins) to estimate adjusted prevalence differences corresponding to a racial disparity in IBC.
Results: Overall, prevalence of IBC within 18 months was 20.7%. Contrary to expectation, in patient-adjusted models, there was no IBC racial disparity (percentage point disparity = −2.1, 95% confidence interval: −4.7, 2.6). However, when controlling for facility characteristics, including proportion of nL black patients, the model coefficient for the IBC disparity reversed sign and changed substantially ($P < .0001$) and a racial disparity emerged (percentage point disparity = +5.1, 95% confidence interval: −0.3, 9.9).
Conclusions: The sorting of patients by race across facilities appears to have mitigated an otherwise anticipated disparity in IBC. Possible explanations are discussed.

Introduction

Mammography screening increases the chances of early detection for breast cancer, and the balance of evidence suggests that it also reduces mortality from breast cancer [1–4]. Although mammography screening has made a substantial contribution to reducing breast cancer morbidity and mortality, the sensitivity of mammography is inherently limited (varying from 68% to 93%), especially in young women and women with dense breast tissue [5]. Therefore, some breast cancers among screened women are diagnosed as so-called interval breast cancer (IBC); that is, they arise between screens, as the result of a symptom or an indication on a breast physical examination.

Non-Latina (nL) black women are more likely than nL white women to be diagnosed with certain, more aggressive forms of breast cancer, including those that are high grade or negative for estrogen and progesterone receptors, and these tumors are more likely to evade detection with mammography [6–8]. In addition to having more aggressive tumors, nL black women also appear to be less likely to have access to the highest quality breast cancer screenings, according to studies of mammography access and quality conducted in Chicago [9–15]. A recent analysis from the population-based Breast Cancer Care in Chicago study revealed that nL black breast cancer patients were more likely than their nL white counterparts to report symptomatic

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awareness of their breast cancer despite a recent screening mammogram [10]. For these reasons, it would be reasonable to expect an excess diagnosis of IBC among nL black women. In the present analysis, we sought to estimate the extent of an anticipated racial difference in IBC within a single, large health care organization.

Materials and methods

The study received approval from the Institutional Review Boards at Advocate Health Care, University of Illinois at Chicago, and the Illinois Department of Public Health. Data on mammography examinations came from a single, large health care delivery organization with health care facilities throughout metropolitan Chicago. All sites are connected via a radiology information system developed by PenRad Technologies of Plymouth, MN. The PenRad database is used to enter all breast imaging results, biopsies and pathology results, and related data needed for Mammography Quality Standards Act compliance. For these analyses, a screening mammogram was defined as a bilateral mammogram with a description of screening in the radiology database, in women without a prior history of breast cancer, mastectomy, or breast implants, and without any imaging in the 9 months before the screen. We linked 714,218 screening examinations conducted between 2001 and 2010 to the population-based Illinois State Cancer Registry and identified 4357 breast cancers diagnosed within 18 months of a screen, between 2001 and 2012. The linkage was performed using probabilistic methods and the software Automatch, version 4 (Matchware Technologies, Inc., Silver Spring, MD) [16]. Automatch is a highly flexible linkage software developed by MatchWare Technologies, Inc. Through comparison with known breast cancers diagnosed from hospital tumor registries, approximately 99% of the breast cancers had a corresponding breast cancer record in Illinois State Cancer Registry.

Definition of IBC

IBC was defined as an *in situ* or invasive breast cancer diagnosed within 18 months after a screening mammogram (the "index" mammogram) with a negative finding (Breast Imaging Reporting and Data Systems 1, 2), but before a next screen. A breast cancer was defined as a screen-detected breast cancer if it was diagnosed within 18 months of a screening mammogram with a negative finding but ultimately diagnosed after a second screen with an abnormal finding.

Patient and clinical factors

Race/ethnicity was self-reported as nL white, nL black, Latina, other, and unknown. Age at examination was defined in years and categorized as <40, 40–49, 50–59, 60–69, 70–79, and 80+. Body mass index (BMI) was categorized based on self-reported height and weight at screening examination as underweight (BMI $<$ 20), normal weight (20–24.99), overweight (25–29.99), obese (30–34.99), and morbidly obese (BMI $>$ 35). Breast density was recorded in the radiology database using the Breast Imaging Reporting and Data Systems fourth edition categories of fatty, scattered fibroglandular, heterogeneously dense, and extremely dense. Family history of breast cancer was defined as none (no first- or second-degree relatives affected), weak (only second-degree relatives affected), moderate (one first-degree relative over age 50 years affected), and strong (multiple first-degree relatives affected or at least one under age 50 years). Time between the two most recent screens before diagnosis was calculated as the difference in the date of the index screening mammogram and most recent prior screening mammogram and categorized as 9–18, 19–24, 25–36, 37–48, >48 months or first screen in the database. Presence or absence of a comparison film during interpretation of the index screen was available in the database. Two measures of socioeconomic status, which were based on each woman's census tract of residence (concentrated disadvantage and concentrated affluence), were also calculated [11].

Facility characteristics

We defined a variable to represent each screening facility's proportion of patients who were nL black. Each mammography screening facility was as also categorized as either a standalone site, situated within a hospital that was not a comprehensive breast center, or that was situated within a comprehensive breast center. In addition, each screening examination was defined as either screen film (analog) or full-field digital mammography.

Tumor characteristics

Estrogen receptor status and progesterone receptor status were each defined as negative or positive based on information from tumor registries. Similarly, histologic grade was defined as low, intermediate, and high, and stage at diagnosis was categorized into American Joint Committee on Cancer categories of 0, I, II, III, and IV.

Statistical analyses

Ordinal and continuous variables were categorized for descriptive analyses of IBC predictors. We tabulated the distribution of patient and clinical characteristics as well as facility and tumor characteristics separately for nL black and nL white patients. We also tabulated the percentage of breast cancers after screening mammography that were IBC by these same characteristics. In both instances, we obtained a *P*-value for differences in IBC (by race) from a χ^2 test (for nominal covariates) or from a test for trend for ordered covariates.

Next, a series of multivariable logistic regression models were conducted with IBC as the dependent variable. For these, we restricted our sample to screening mammograms conducted on nL black and nL white patients, of which there were 3810 breast cancers diagnosed within 18 months of a screening mammogram. Likelihood ratio tests were conducted to compare fit across nested models. Manual backward selection (type-3 analysis using an alpha = 0.10) was used to identify potentially important patient and clinical characteristics beyond age, to control for in all subsequent models (results not shown). Based on these results, breast density, BMI, time since last screen, availability of a comparison film, and type of mammogram (analog or digital) were identified as covariates in addition to age and family history (included a priori) for the mediation analyses described in the following section.

Mediation analyses

We used two approaches to examine the potential mediation of a racial disparity in IBC. First, we conducted logistic regression with model-based standardization (predictive margins) to estimate the prevalence difference and 95% confidence interval in IBC prevalence by race [17,18]. Separate models controlled for (1) age, (2) age and patient characteristics, and (3) age, patient, and facility characteristics (facility type and proportion of nL black). We used the predictive margins from these models to estimate a series of average controlled direct associations in the form of prevalence differences to estimate what the racial disparity in IBC prevalence might be if the distributions of patient and/or facility characteristics were equalized