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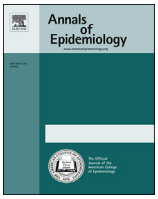

Original article

The socioeconomic gradient in all-cause mortality for women with breast cancer: findings from the 1998 to 2006 National Cancer Data Base with follow-up through 2011

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ABSTRACT

Purpose: To analyze the association between socioeconomic status (SES) and all-cause mortality among women diagnosed with breast cancer before and after controlling for insurance status, race and ethnicity, stage, treatment modalities, and other demographic and hospital characteristics.
Methods: Data analyzed included follow-up through 2011 for 582,396 patients diagnosed between 1998 and 2006 with ductal carcinoma in situ or invasive (stage I–IV) breast cancer from the National Cancer Data Base. SES was measured by grouping patients into six income and education-level ZIP code categories. Hierarchical Cox regression models were used to analyze SES survival differences.
Results: Five- and 10-year survival probabilities for the highest SES group were 87.8% and 71.5%, versus 79.5% and 61.5% for the lowest SES group. Controlling for all covariates reduced the highest-to-lowest SES hazard ratio from 1.69 (95% confidence interval: 1.64–1.74) to 1.27 (95% confidence interval: 1.24–1.31). Results were virtually identical in models that included comorbidity and invasive cancer patients only.
Conclusions: Differences in insurance status, race, and stage at diagnosis are important components of SES disparities and explain about two-thirds of the initial SES survival disparity. The residual SES effect likely mirrors underlying social determinants of health for all American women.

Introduction

Because racial differences in breast cancer mortality between white and Black women emerged in the 1980s, there has been a major research effort to document associations with diagnosis and treatment disparities. In particular, racial disparities in mortality have been attributed to the fact that lower income and minority women were consistently diagnosed with higher-stage cancer and disproportionately receive less than optimal treatment [1–4]. However, much less is known about the extent to which racial disparities reflect broader socioeconomic status (SES) disparities in all-cause mortality for women diagnosed with breast cancer.

The social epidemiology of breast cancer has been shaped by high incidence rates among white, more affluent women, even after a mid-2000s, reduction in white women's cancer incidence related to reductions in hormone replacement therapy [5,6]. Both breast cancer–specific and all-cause mortality have been shown to vary by education and household income in earlier studies [7,8]. However, more recent population-based breast cancer mortality rates, measured across county-level income quintiles, appear to have largely converged across SES categories [4].

The socioeconomic "gradient" in all-cause mortality for women with breast cancer is complex as it reflects both broader social determinants of health as well as social differences in breast cancer screening, incidence, and treatment. Data from the Surveillance, Epidemiology, and End Results (SEER) database on women diagnosed with breast cancer between 1999 and 2005 and followed through 2010, indicate that breast cancer was the cause of death for only a small proportion of women with localized cancer but increased to half of deaths among women with regional disease and over two-thirds of deaths among women with distant disease [9]. Especially for early-stage breast cancer, age and comorbidity play a crucial role in life expectancy. For example, among the 1,190 women initially diagnosed with invasive breast cancer in the Canadian National Breast Screening study, less than 30% had died of breast cancer over a 25-year follow-up period [10].

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This study was undertaken to estimate the effect of SES on all-cause mortality among women diagnosed with breast cancer, examining both the joint and separate effects of health insurance status, race and ethnicity, breast cancer stage at diagnosis, and surgical and adjuvant treatment. Our survival estimates are based on vital status follow-up through 2011 of more than 582,000 female patients, including more than 104,000 patients diagnosed with DCIS, from the National Cancer Data Base (NCDB). We sought to provide an estimate of SES associations with all-cause mortality during a period of important changes in breast cancer diagnosis and treatment and coinciding with a significant reduction in average person-years of life lost because of breast cancer in the United States [11].

Methods

Study sample

The NCDB is a joint project of the American Cancer Society and the Commission of Cancer of the American College of Surgeons (http://ncdbpuf.facs.org). NCDB hospital-based cancer registries include patient demographics, American Joint Committee on Cancer staging, and surgical and adjuvant treatments. Our sample includes all female patients diagnosed with breast cancer at 1,630 NCDB-reporting hospitals with up to 176-month follow-up through 2011 for patients diagnosed between 1998 and 2006. NCDB-deidentified data were ruled exempt by the Northwestern University Institutional Review Board.

Patient demographic and clinical characteristics, hospital characteristics, and time period

We categorized patients' ages as 39 and under, 40 to 49, 50 to 69, and 70 years or greater. Race and ethnicity were categorized as non-Hispanic white, non-Hispanic Black, Hispanic, Asian, and other or unknown. When categorizing patients by TNM staging, the pathologic TNM was used whenever available; in case the pathology was not available, staging by clinical TNM was substituted. Treatment variables included primary surgery type (lumpectomy, mastectomy, or no or unknown primary surgery) and whether patients received radiation therapy, chemotherapy, or hormone therapy. Multivariate analyses were controlled for regional location of the treating hospital (large urban region, medium urban region, small urban region, rural region, or unknown) and whether a hospital had an academic or research designation or was a community institution. We created three time periods (1998–2000, 2001–2003, and 2004–2006) to control for trends in diagnosis and treatment over the study period. We excluded records for patients with missing ZIP codes ($n = 28{,}410$; 4.65%) or stage at diagnosis ($n = 22{,}239$; 3.68%).

Socioeconomic status

A six-level measure of SES was computed from patients' combined ZIP code quartiles of census-based median income and educational attainment at the time of diagnosis. To validate a monotonic SES scale, we ranked hazard ratios for all 16 combinations of income and education ZIP code quartiles. Based on those results, we then aggregated patients into five SES categories with almost completely nonoverlapping hazard ratio 95% confidence intervals which could be contrasted with those of patients living in the highest income and highest education quartile (about one-third of the sample). Finally, we included a variable for patients who were uninsured or had Medicaid coverage at the time of their diagnosis as an additional indicator of SES that has been directly associated with higher breast cancer death rates [2].

Table 1

Percent of patients diagnosed with breast cancer by ZIP code income and education quartiles ($n = 582{,}396$): women from 1,630 National Cancer Data Base–reporting hospitals diagnosed between 1998 and 2006

Quartile education	Lowest quartile income	Second quartile income	Third quartile income	Highest quartile income	Total
Lowest quartile education	7.3	4.2	2.5	0.4	14.4
Second quartile education	3.4	6.8	8.2	3.0	21.3
Third quartile education	0.8	4.5	10.5	7.9	23.7
Highest quartile education	0.5	1.3	6.4	32.5	40.7
Total	12.0	16.7	27.6	43.7	100.0

Secondary analyses of Charlson-Deyo comorbidity score and invasive cancer

We examined the effect of the Charlson-Deyo comorbidity score, which is based on ICD-9 codes for chronic diseases, trichotomized as 0, 1, or 2 or greater [12] This measure was only available for patients diagnosed between 2003 and 2006 (32.8% of the sample). We also tested the sensitivity of our final model with analyses restricted to the 82.1% of patients diagnosed with stage I to IV breast cancer, excluding patients diagnosed with DCIS.

Statistical analysis

Cox proportional hazards regression was used to calculate initial hazard ratios for our SES measure after confirming proportional hazards assumptions graphically. The Kaplan-Meier estimator and log rank test were used to test the significance of bivariate survival probabilities. χ^2 Tests of proportions were used to test the significance of baseline SES differences. Hierarchical Cox proportional hazards models were then used to test the significance of SES controlled for other patient and hospital covariates, with standard errors adjusted for intragroup correlation (clustering) within hospitals using STATA software (version 12; College Station, Texas). Differences across SES category hazard ratios were examined sequentially before and after adding insurance status, race and ethnicity, stage at diagnosis, and finally, treatment modalities. Secondary analyses used the final model to investigate sensitivity of our SES results for post-2003 NCDB patients with Charlson scores and for analyses limited to patients diagnosed as stage I to IV.

Results

Deriving a SES status measure

Table 1 tabulates patients by ZIP code quartile of median education and income. There was modest but significant spread between intermediate cells with only 7.2% of NCDB patients coming from the lowest quartile education and income ZIP codes. Table 2 tabulates Cox regression results, first from the original 16 possible categories and then collapsed across six categories with virtually nonoverlapping hazard ratios There was a clear SES gradient in survival with a 69% greater hazard ratio for the lowest compared to the highest SES category. Survival probabilities for each of the SES categories through 174 months (median = 80.99 months) are displayed in Figure 1. Five-year survival for the highest SES group was 87.8% compared to 79.5% for the lowest SES group; at 10 years, the difference was 10% (71.5% to 61.5%; $P < 0.001$).