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Socioeconomic disparities in the decline in invasive breast cancer incidence

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Abstract

Breast cancer incidence in the United States has declined dramatically since the year 2002. To improve our understanding of the underlying factors driving breast cancer trends, we explored potential socioeconomic disparities in the recent decline in incidence. We examined the decline in breast cancer incidence according to county-level socioeconomic indicators using data from the Surveillance, Epidemiology and End Results (SEER) program. Since socioeconomic status is associated with mammography screening, we also examined the relation between incidence of ductal carcinoma in situ (DCIS; a strong marker of mammography utilization) and the decline in invasive breast cancer. The reduction in invasive breast cancer incidence between 1998–2001 and 2003–2006 in the SEER 9 registries was greatest among women living in counties with higher median household income (–16% change for $\geq \$85,000$ vs. –4% for $< \$35,000$; $P_{trend} < 0.01$) and a higher percentage of adults aged 25 years or older with a bachelor's degree (–13% change for $\geq 40\%$ vs. –8% for $< 15\%$; $P_{trend} < 0.01$). Counties with higher DCIS incidence during 1985–2001 had a larger decrease in invasive breast cancer incidence (absolute decrease 1.7 percentage points greater per 5 per 100,000 increase in DCIS incidence; $P = 0.01$). This association was present for both ER-positive and ER-negative invasive cancers ($P < 0.05$). In summary, the decline in breast cancer incidence has been largest in areas with high socioeconomic status and high screening utilization rates. These results are consistent with the hypothesis that a saturation of screening mammography utilization contributed to the overall decline in breast cancer incidence.

Keywords

breast neoplasms; mammography screening; ductal carcinoma in situ; incidence; epidemiology

INTRODUCTION

After decades of rising incidence, invasive breast cancer incidence declined dramatically in the United States in 2003 [1]. The reduction has been sustained through 2006, with incidence lower now than it has been since the early 1980s [2]. This trend has been widely attributed to a reduction in the use of postmenopausal hormones – a known breast cancer risk factor [3] – following the publication of results from the Women's Health Initiative (WHI) randomized trial in 2002 [4]. However, there are certain aspects of the decline in breast cancer incidence which suggest that other factors may also have contributed to this trend. For instance, incidence

of ductal carcinoma in situ (DCIS) has remained stable since the year 2000 [2] despite the fact that hormone use is also a risk factor for DCIS [5–7]. Similarly, incidence of invasive breast cancer among black women has not declined [2,8] despite substantial cessation of hormone use among this subgroup [9].

Several groups have hypothesized that the overall decline in breast cancer incidence is a natural result of the recent plateau in screening mammography utilization [8,10]. Breast cancer incidence rose markedly during the 1980s and 1990s as the utilization of screening mammography increased [11,12]. By the year 2000, screening mammography utilization had peaked and since then appears to have declined slightly [13]. As screening both advances the time of diagnosis and detects some cancers that would not have otherwise been diagnosed [14], a plateau in screening can lead to a decline in incidence. Such a phenomenon was observed for prostate cancer following the introduction of prostate-specific-antigen (PSA) screening [15].

To improve our understanding of the underlying factors driving trends in breast cancer, we examined economic disparities in the recent decline in breast cancer incidence using data from the Surveillance, Epidemiology and End Results (SEER) cancer registries, linked with county-level socioeconomic indicators from the US census.

METHODS

Study Population

The SEER 9 registries provide data on breast cancer incidence from 1975–2006 in the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii, the metropolitan areas of Detroit, San Francisco-Oakland, and Atlanta, and the 13-county Seattle-Puget Sound area [2]. Incidence data from SEER were obtained using SEER*Stat software (version 6.5.1, National Cancer Institute, Silver Spring, Maryland) [16].

Study Variables

Year 2000 county-level median household income and percent of population 25 years and older with a bachelor's degree were obtained from the US census using SEERStat software [16]. DCIS was defined as histologic codes 8201, 8230, 8500, 8501, 8503, 8507, and 8523, as defined in the International Classification of Disease for Oncology [17].

Analytic Methods

We investigated patterns in breast cancer incidence among the 200 counties included in the nine SEER registries which have reported cancer incidence from 1973–2006. Data from all Hawaii counties was combined since complete county-level data from individual Hawaii counties was unavailable prior to the year 2000.

Invasive breast cancer incidence in the United States transitioned in 2002 from a period of high incidence, 1998–2001, to a period of low incidence, 2003–2006 [2]. Thus, we calculated the percent change in invasive breast cancer incidence between these time periods. For analyses according to socioeconomic indicators, age-adjusted incidence in each time period was calculated for women in all counties in the specific socioeconomic category (e.g. median household income less than \$35,000). The percent change in incidence was then calculated by taking the difference of the two rates, dividing by the 1998–2001 rate, and multiplying by 100. 95% Confidence intervals about the percent change in incidence were constructed using $\alpha=0.05$. Weighted least squares regression was used to determine the statistical significance of the trend in percent change incidence according to each socioeconomic variable.

Socioeconomic status is associated with screening utilization [18]. A disparity in the decline in breast cancer incidence according to socioeconomic status could thus be due to associated patterns in screening. While county-level screening rates within SEER are not available, the incidence rate of ductal carcinoma in situ – which is almost exclusively detected by mammography [6,19] – provides a strong indicator of screening utilization [20]. If widespread screening ultimately led to a reduction in invasive breast cancer incidence, then the observed decrease in incidence should be greatest in areas with the highest screening rates. We used linear regression to evaluate at the county level the relation between DCIS incidence during the preceding period (1985–2001) and the percent change in invasive breast cancer (1998–2001 vs. 2003–2006). All regression analyses were weighted by the population size of the county in the year 2000.

RESULTS

The overall age-adjusted rate of invasive breast cancer incidence declined by 10.4% (95% CI: –9.4, –11.3) from 139.0 per 100,000 during 1998–2001 to 124.6 per 100,000 during 2003–2006. As expected, there was a positive association between invasive breast cancer incidence and county level markers of socioeconomic status during each time period (Figure 1). The reduction in invasive breast cancer incidence between 1998–2001 and 2003–2006 was greatest among women in counties of high socioeconomic status (Figure 2). Women in counties with a median household income greater than or equal to \$85,000 experienced a 16% (95% CI: 7.9, 24.1) decline in invasive breast cancer on average, whereas women in counties with a median income less than \$35,000 experienced a 4% (95% CI: –3.0, 10.2) decline (Figure 2A; $P_{trend} < 0.01$). Women in counties with at least 40% of adults aged 25 or older with a bachelor's degree experienced a 13% (95% CI: 9.8, 16.3) decline in breast cancer incidence on average, whereas women in counties with less than 15% of adults with a bachelor's degree experienced an 8% (95% CI: 3.5, 12.7) decline in incidence (Figure 2B; $P_{trend} < 0.01$).

These markers of socioeconomic status were also associated with the incidence of DCIS during 1985–2001 (Figure 2). Thus the association between socioeconomic indicators and the change in incidence could be due to variation in screening utilization. To further explore this we examined the direct relation between DCIS incidence and the change in invasive breast cancer incidence by county. Counties which experienced higher DCIS incidence during 1985–2001 tended to have a larger decrease in invasive breast cancer incidence after 2002 (Figure 3). Across counties, the percent decrease in invasive breast cancer incidence was 1.7 (95% CI: 0.4 – 3.1) percentage points greater for every 5 per 100,000 increase in DCIS incidence ($P = 0.01$). This corresponds to an average 5.3% decrease for a county with DCIS incidence of 5 per 100,000 during 1985–2001, compared to an average 12.2% decrease for a county with DCIS incidence of 25 per 100,000. The relation was similar within strata defined by estrogen-receptor (ER) status (Figure 4). For every 5 per 100,000 increase in DCIS incidence there was a 4.1 (95% CI: 1.5 – 6.6) percentage point greater decrease in ER-positive invasive breast cancer and a 3.8 (95% CI: 0.1 – 7.6) percentage point greater decrease in ER-negative invasive breast cancer.

DISCUSSION

These findings provide evidence for substantial socioeconomic disparities in the recent decline in breast cancer incidence. The greatest reductions in breast cancer incidence between 1998–2001 and 2003–2006 were observed among women living in counties with higher levels of income and education. Counties which had the highest DCIS rates during the years preceding the national peak in invasive breast cancer incidence tended to have the largest decline in incidence, suggesting an important role for screening mammography utilization.

These disparities were driven mainly by reductions in the high incidence of invasive breast cancer among women in counties with high socioeconomic status. While this is the first study to report disparities in the recent decline in incidence according to income and education, the positive association between socioeconomic status and breast cancer incidence is well known [21,22]. This association is largely due to increased utilization of screening mammography [23] and variation in known risk factors (e.g. reproductive patterns) [24].

Our observation of an association between socioeconomic status and DCIS incidence is consistent with the known association between socioeconomic status and screening mammography. The National Health Interview Survey [18] found that in the year 2000 approximately 55% of women aged 40 or older with income below the poverty level had a mammogram within the past two years, compared to 74% of women with income more than twice the poverty level. A similar difference is observed by education; approximately 58% of women without a high school diploma were screened within the past two years, compared to 77% of women with at least some college education. Notably, screening utilization has varied according to race as well. Uptake of screening mammography utilization occurred earlier in whites compared to blacks, though current levels now appear to be quite similar [18].

The associations between socioeconomic status, DCIS rates, and the decline in invasive breast cancer incidence are consistent with the hypothesis that a saturation of screening mammography utilization contributed to a decline in incidence. With screening utilization reaching a plateau, years of intense screening may have largely depleted the pool of prevalent invasive breast cancers. Additionally, invasive cases which would have otherwise been diagnosed after the year 2000 were instead diagnosed at an earlier date as in situ lesions. With a deficit of advance-stage cases due to early detection [10] and a deficit of new early stage cases as fewer women are being screened for the first time, a decline in incidence could be expected.

Notably, socioeconomic status is also associated with use of postmenopausal hormones [9, 25,26]. In the nationally representative National Health and Nutrition Examination Survey conducted between 1988 and 1994 [25], 46.8% of women older than age 60 with 16 years of education reported ever using hormone replacement therapy, compared with 41.3% of women with 12 years of education. Similarly, 39.6% of women with \$50,000 or more of income per year reported having used hormones, compared to only 24.2% among women with less than \$10,000 of income per year. A more recent report [9] from the Cancer Research Network described the changes in hormone therapy use after publication of the results of the WHI randomized trial of estrogen plus progestin hormone therapy [4]. Though hormone use was more common among higher socioeconomic groups before and after the WHI results, similar percent reductions in use (approximately 40 – 45%) were observed across socioeconomic groups following the publication of the WHI results in July 2002. While this study was perhaps the largest of its kind (over 200,000 women), it was restricted to women in five health maintenance organizations and thus may not be generalizable to the general population. Thus, the potential ability of trends in hormone use to explain disparities in the decline in breast cancer incidence remains unclear. Notably, we observed similar associations between screening (as reflected by DCIS incidence) and trends in both ER-positive and ER-negative breast cancer. This finding is not likely to be attributed to patterns in hormone use, which is a risk factor for ER-positive breast cancer only [27].

The decreased incidence of invasive breast cancers is likely multi-factorial. While cessation of hormone therapy and a plateau in screening utilization may play major roles, other factors may also contribute [28]. For example, increased use of chemoprevention therapies may contribute to decreased invasive breast cancer incidence, which may also disproportionately affect groups according to socioeconomic status.

Since individual-level data on screening utilization is not available within the SEER database, county-level incidence of DCIS was used as a proxy. It should be recognized that DCIS incidence is also influenced by other factors aside from screening – most notably, variation in population risk factors [29] – though mammography utilization is a very strong predictor of DCIS incidence and is perhaps the strongest risk factor [6]. In addition, it is important to distinguish between community- and individual-level indicators of socioeconomic status [22]. With county-level data only, we were unable to evaluate trends in breast cancer incidence among women according to individual-level income and education. Finally, the SEER database does not include information on postmenopausal hormone use. Thus we were unable to directly examine the contribution of trends in hormone use to disparities in the decline of breast cancer incidence.

In conclusion, our results indicate that the recent decline in invasive breast cancer incidence has been greatest among women living in counties with high socioeconomic status. The observed association between DCIS incidence and the decline in invasive breast cancer suggests an important role for utilization of screening mammography. Future studies may be able to improve our understanding of this relation by examining trends in breast cancer incidence according to individual-level indicators of socioeconomic status, postmenopausal hormone use, and mammography utilization. Sophisticated simulation models, such as those developed by the CISNET consortium [30], may be particularly useful in evaluating the complex contributions of screening and postmenopausal hormone use to trends in breast cancer incidence. An improved understanding of the factors driving the recent decline in invasive breast cancer incidence may help to enhance this desirable trend among all socioeconomic groups, while also permitting better prediction of future trends in breast cancer incidence and mortality.

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A. **B.** **Figure 1.**

Invasive breast cancer incidence in the SEER 9 registries during both 1998–2001 (dashed line) and 2003–2006 (solid line) is positively associated with year 2000 county-level median household income (A) and percent of adults aged 25 and older with a bachelor's degree (B).

Figure 2.

The percent decline invasive breast cancer incidence (solid line) was largest among women living in counties with higher median household income (A) and counties with a higher percent of adults aged 25 and older with a bachelor's degree (B). These same socioeconomic indicators were positively associated with incidence of ductal carcinoma in situ (DCIS; dashed line) during 1985–2001. The error bars represent 95% confidence intervals.

Figure 3.

The percent decline in invasive breast cancer incidence tended to be largest in counties with the highest incidence of ductal carcinoma in situ (DCIS) during 1985–2001. Circle sizes are proportional to the year 2000 county population. The Pearson correlation coefficient was -0.18 ($P = 0.01$).

Figure 4.

The association between incidence of ductal carcinoma in situ and the percent decline in invasive breast cancer was similar for both estrogen receptor (ER) positive (A) and ER-negative breast cancers (B). Circle sizes are proportional to the year 2000 county population. The Pearson correlation coefficients were -0.22 ($P = 0.002$) and -0.15 ($P = 0.04$) for ER-positive and ER-negative cancers, respectively.