A local area analysis of racial, ethnic, and neighborhood disparities in advanced-stage breast cancer

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Abstract:

Few studies have examined the role of neighborhood socioeconomic condition in shaping breast cancer disparities in defined local areas. We tested associations between three measures of neighborhood socioeconomic condition (poverty, median income, and a composite neighborhood score) on breast cancer staging in two urban counties of the state of New Jersey. Data for these counties were obtained from the New Jersey Surveillance, Epidemiology, and End Results tumor registry and were selected because of their large racial/ethnic and socioeconomic diversity and pilot prevention efforts taking place in these areas. Our study population included Black, Latina, and White women ($N = 4,589$) diagnosed with breast cancer from 1999 to 2004. Each cancer case was geocoded and linked to socioeconomic data obtained from the 2000 U.S. census. Census tracts served as proxies for neighborhoods. Logistic regression models accounting for clustering of individuals within neighborhoods were fitted with Generalized Estimating Equations. Women living in neighborhoods with lower versus higher neighborhood scores were significantly more likely to have advanced-stage disease (odds ratio, 1.6; confidence intervals, 1.1-2.3), after adjusting for age at diagnosis and race/ethnicity. In analyses stratified by race/ethnicity, results remained significant for all neighborhood measures for White and Black women, but not for Latinas. Moreover, neighborhood poverty showed a weaker socioeconomic gradient in breast cancer staging among White women. Our study findings support the use of a multidimensional neighborhood index to better capture differences in cancer staging risk across racial/ethnic groups and provides evidence that population-based cancer data could be used to identify local needs specific to local populations.

Keywords: breast cancer | neighborhood | socioeconomic disadvantage

Article:

Introduction

Research over the past two decades has indicated that the socioeconomic condition of the places where people live influences health (1-6), above and beyond individual-level risk factors. In recent years, there has been a particular interest in determining the role that area-based socioeconomic characteristics play in breast cancer disparities (7-13). Barry and Breen (7) showed that women living in metropolitan areas of the United States under varying conditions of socioeconomic deprivation (e.g., social "underclass," medically underserved areas, and extreme poverty areas) were 30% to 200% more likely to be diagnosed with advanced-stage cervical and breast cancer compared with women living in relatively more affluent areas of the nation. Also, using the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) data, Singh and colleagues (13) found a consistent pattern of increasing advanced-stage of breast cancer disease with increasing area-level poverty, accompanied by a recent increase in breast cancer mortality in high poverty areas. The few survival studies conducted to date have similarly shown increased mortality from breast cancer for women living in poorer versus better-off areas (9, 14).

Few of these studies, however, have conceptualized "area" effects as representing neighborhood socioeconomic disadvantage and how neighborhoods may contribute to racial/ethnic cancer disparities. Neighborhood socioeconomic disadvantage may be particularly relevant to study in the case of breast cancer because mammograms are an effective screening tool that are available in primary care settings typically located at the neighborhood level (15). However, because of differences in the types of neighborhoods in which racial/ethnic populations tend to live, neighborhoods may also contribute to racial/ethnic disparities to timely breast cancer screening.

An additional limitation of most studies conducted to date has been to examine associations between area measures and cancer outcomes across geographic areas spanning entire regions, large metropolitan areas, or states with varying geographic and demographic characteristics, thereby potentially masking cancer patterns in smaller localized areas. As an example, urban areas with large pockets of poverty and a large concentration of minority groups in defined areas may show increased cancer risks that may be missed in large-scale analyses. Alternatively, results observed in large-scale geographic analyses may be driven by defined, local area patterns, and thus, potentially lead to incorrect conclusions regarding overall area effects on cancer outcomes. Thus, focusing on defined local areas may not only reveal significant cancer disparities for particular areas and particular populations, but also could lead to more effective public health strategies that address local, as opposed to national or statewide, needs.

Over the last few decades, the state of New Jersey has consistently ranked as one of the top states for breast cancer–related deaths (16). In the present study, we focused on two counties in the northeastern part of the state of New Jersey that were previously identified (17, 18) as having an excess of advanced-stage breast cancer cases to examine associations between neighborhood socioeconomic condition and advanced-stage breast cancer. We focus on breast cancer staging because it more clearly represents screening practices and access to primary care, factors which are strongly patterned by area-level socioeconomic disadvantage (15, 19, 20). Specifically, because we were interested in the role of neighborhood socioeconomic conditions in breast cancer staging in this defined local area, we examined whether associations differed according to

selected neighborhood socioeconomic measures and further by race/ethnicity. We were particularly interested in investigating the potential differences for Latinas, since the Latino population has generally been shown to fare better in some health outcomes despite their relatively lower socioeconomic status, a phenomenon often termed the Latino health paradox (21-23).

Materials and Methods

Study Design. The study sample consisted of women residing in Essex and Hudson counties of New Jersey who were diagnosed with *in situ* or invasive breast cancer and reported to the New Jersey State Cancer Registry (NJSCR) for the period 1999 to 2004 (18). The NJSCR is a member of the National Cancer Institute's SEER program and the Centers for Disease Controls and Prevention's National Program of Cancer Registries. The NJSCR classifies cancer cases according to the International Classification of Diseases for Oncology, second edition (24), and is a population-based registry that collects data on all cancer cases diagnosed and/or treated in New Jersey since October 1, 1978. The NJSCR maintains strict quality control measures of the data that are collected and reported. These include timeliness of the data submitted, completeness of cancer case ascertainment, completeness of specific information on the cancer cases, percentage of death certificate–only cases, percentage of duplicate cases, and a stringent edit program. The registry also uses an algorithm developed by the National Cancer Institute to further identify individuals of Latino/Hispanic ethnicity, which may be missed by standard reporting procedures.

Breast Cancer Data. Following other studies (25), breast cancer staging was collapsed into the following SEER summary categories: *in situ*, local (restricted to breast tissue), regional (tumor with direct extension to adjacent tissue or lymph nodes), distant (metastasized to distant tissue or lymph nodes), and unknown (unstaged). Age and year at diagnosis were included in the analyses as covariates.

Neighborhood Data. Census tracts served as proxies for neighborhoods in this study. The NJSCR registry geocoded each individual case that formed part of the study sample and staff provided a measure of the level of geocoding accuracy obtained for each case. Only cases matched to an exact street address were included in the study. Nearly all prior cancer studies have used single area-level measures such as median income, percentage of the population in poverty, or educational achievement (e.g., percentage of the adult population completing college) to examine associations with cancer staging. We used a neighborhood summary index previously developed and tested in population-based cohort studies (26) for outcomes other than cancer. Briefly, the neighborhood index was derived from a factor analysis of all U.S. 2000 census tract socioeconomic data in which the factor explaining the higher variance included six items representing wealth/income (median household income, median home value, and percentage of households receiving interest, dividend, or net rental income), education (percentage of adults ≥25 y of age with a high school diploma, percentage of adults ≥25 y of age who completed college), and occupation (percentage of people employed in executive, managerial, or professional specialty occupations). A *Z*-score for each variable was estimated by subtracting the mean from the grand mean and dividing by the grand SD of the two counties. Each *Z*-score was then summed to obtain the neighborhood score for a given census tract. The neighborhood

socioeconomic score for the census tracts represented in our study population ranged from −12.41 to 8.02, with increasing scores indicating increasing neighborhood socioeconomic advantage. The neighborhood score was categorized into tertiles for analysis involving the full sample and into race/ethnic-specific tertiles for stratified analyses.

Data for this study included all incident cases of breast cancer for women ages 20 to 80 y old for the period 1999 to 2004, yielding a total sample of 6,662. Of these, 93% were matched to an exact street address ($n = 6,195$). Records that were missing data on race/ethnicity ($n = 9$) as well as women that were not White, Black, or Latina were excluded ($n = 339$). Cases classified as "unstaged" ($n = 233$) or *in situ* stage ($n = 1,024$) were also excluded because of the unclear role of the *in situ* stage in the progression to invasive carcinoma (27, 28). Thus, the final analytic sampled consisted of 4,589 women who lived across 371 census tracts in Essex and Hudson counties with a mean of 12.4 and median of 10.0 participants per census tract (range, 1-52). This study involved the analysis of existing public health surveillance data collected by the NJSCR. No identifiers were linked to subjects. The study was approved by the Institutional Review Boards at University of Medicine and Dentistry of New Jersey and NJSCR.

Statistical Analysis. Distributions of sociodemographic, neighborhood-level socioeconomic characteristics, and cancer staging were calculated and presented for the full sample and by race/ethnicity. The distribution of cases that were not geocoded were also evaluated and compared with the records of those geocoded. The proportion of advanced-stage breast cancer cases was examined by tertiles of the neighborhood index score. To assess potential differences in detecting socioeconomic gradients in breast cancer staging based on the neighborhood measure employed, the neighborhood index score, neighborhood-level median income, and neighborhood poverty were compared using racial/ethnic-specific tertile distributions for each of the neighborhood measures. Logistic regression was used to estimate odds ratios (OR) of advanced-stage (i.e., distant) breast cancer for women living in the most disadvantaged, middle, and most advantaged areas, before and after adjusting for age and year at diagnosis. Tests for trend across the neighborhood tertiles were conducted by entering the neighborhood socioeconomic measures as ordinal variables in the regression models. Interaction terms of race/ethnicity with neighborhood socioeconomic score and selected component of the neighborhood score were tested by entering appropriate cross-product terms in the models. Generalized Estimating Equations were used to fit the models and to account for the potential correlation between participants residing in the same neighborhoods. All analyses were done using SAS 9.1.

Results

Overall, White women tended to live in neighborhoods with higher levels of socioeconomic advantage than Black and Latina women. The mean neighborhood score was 3.1 for White women, −1.1 for Black women, and −0.7 for Latinas. Examining each component of the neighborhood socioeconomic score as well as the score itself suggests that Black and Latina women lived in worse neighborhood environments than White women. Also, fewer Black (40.8%) and Latina women (43.2%) were diagnosed with localized breast cancer as compared with White women (48.8%). Latinas were the least likely to be diagnosed with distant stage breast cancer (4.3%), whereas the highest percentage of distant stage breast cancer cases was

diagnosed among Black women (7.4%). White women were slightly older at age of diagnosis than Black and Latina women (Table 1).

Table 1. Mean neighborhood socioeconomic characteristics and individual characteristics of breast cancer cases, by race/ethnicity (NJSCR, 1998-2004)

Characteristic	Total sample (N= 4,589)	Whites (n = 2,710)	Latinas (712)	Blacks (1,167)
Neighborhood				
Mean neighborhood score (SD)	1.4 (3.5)	3.1 (3.0)	−0.7 (2.7)	−1.1 (2.5)
Median household income ($)	44,479	60,732	35,313	32,977
Median value of occupied housing units ($)	165,400	187,900	163,800	123,600
Households with interest, dividends or rental income (%)	36.0	46.0	25.2	18.9
Adult residents who completed high school only (%)	26.7	24.9	26.9	31.0
Adult residents who completed college (%)	18.2	22.5	12.3	11.0
Employed residents with executive, managerial, or professional occupations (%)	36.0	43.0	25.5	26.0
Poverty (%)	13.1	8.1	17.3	22.1
Individual				
Mean age at diagnosis (SD)	61.4 (20.2)	62.9 (14.5)	56.9 (14.1)	59.8 (31.1)
Stage at diagnosis (%)				
In situ	17.5	18.3	18.1	15.5
Local	45.9	48.8	43.2	40.8
Regional	27.0	24.5	29.4	31.6
Distant	5.5	5.1	4.3	7.4
Unstaged	4.0	3.4	5.0	4.8

NOTE: Comparisons across racial/ethnic groups significant at $P < 0.01$.

Table 2. Proportion of case diagnoses at *in situ*, local, regional, and distant stage breast cancer, by neighborhood socioeconomic characteristics (NJSCR, 1999-2004)

Neighborhood socioeconomic characteristic[*]	*In situ*	Local	Regional	Distant	Unstaged
Neighborhood score					
1 (Low)	14.9	42.0	31.3	6.6	5.2
2	16.5	46.4	27.2	6.2	3.7
3 (High)	20.9	49.3	22.8	3.9	3.0
Neighborhood median income					
1 (Low)	14.4	42.1	31.3	6.9	5.2
2	16.7	46.3	27.4	5.8	3.9
3 (High)	21.3	49.3	22.5	4.0	2.9
Neighborhood poverty					
<10%	19.9	48.4	24.0	4.5	3.2
10-19%	16.4	45.4	28.0	6.4	3.8
≥20%	13.9	41.3	32.4	6.7	5.7

*Neighborhood socioeconomic distribution based on the full sample distribution.

Table 2 shows the relation between neighborhood socioeconomic condition and breast cancer staging. As the neighborhood index score increased (indicating increasing socioeconomic advantage) the proportion of cases diagnosed at the local stage also increased ($P < 0.001$). However, an inverse relation was observed for distant stage breast cancer ($P < 0.001$), with fewer cases reported as the neighborhood score increased. A similar pattern was observed for neighborhood median income. For the neighborhood poverty measure, although fewer cases

were diagnosed at distant stage in the least impoverished neighborhood category, there was relatively little difference in staging between the middle and highest poverty category.

Table 3 presents results for models using the full sample and stratified by race/ethnicity. For the full sample, results indicated that women living in disadvantaged neighborhoods, as measured by the neighborhood index score, were 60% [OR, 1.6; confidence intervals (CI), 1.1-2.3] more likely to be diagnosed with advanced-stage breast cancer than women living in more socioeconomically advantaged neighborhoods, after adjusting for age at diagnosis and race/ethnicity. Tests for trend were only significant for White women across all three neighborhood measures, although it was marginally significant for the neighborhood deprivation index for Black women. We also examined if these patterns persisted when calculating breast cancer rates (rates per 100,000 female population). Overall, we found that socioeconomically advantaged neighborhoods had higher age and race-adjusted *in situ* and local stage breast cancer rates (suggesting increased screening) whereas poorer neighborhoods had higher rates of advanced-stage disease, although with less pronounced differences (results not shown). It is worth noting that the 434 cases excluded (7% of sample) because they could not be geocoded were Black, from poorer neighborhoods, and with more advanced stage disease, suggesting that if included in our final analyses, we would have observed even stronger measures of association.

Table 3. Crude and age-adjusted ORs of the incidence of advanced-stage breast cancer, by neighborhood characteristics, and race and ethnicity (NJSCR, 1999-2004)

Neighborhood socioeconomic characteristic	Total sample*		Whites[†]		Latinas[†]		Blacks[†]	
	Crude	Adjusted[‡]	Crude	Adjusted[‡]	Crude	Adjusted[‡]	Crude	Adjusted[‡]
Neighborhood score								
1 (Low)	1.6 (1.2-2.2)	1.6 (1.1-2.3)	1.9 (1.3-2.9)	1.8 (1.2-2.6)	0.9 (0.4-2.1)	0.8 (0.3-2.1)	1.6 (1.0-2.5)	1.6 (1.0-2.5)
2	1.5 (1.1-2.1)	1.5 (1.1-2.1)	1.4 (0.9-2.2)	1.3 (0.8-2.0)	1.3 (0.6-2.9)	1.3 (0.6-2.9)	1.2 (0.7-1.9)	1.2 (0.7-1.9)
3 (High)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
P for trend	0.001	0.03	<0.01	<0.01	0.74	0.62	0.06	0.06
Neighborhood median income								
1 (Low)	1.7 (1.2-2.3)	1.6 (1.1-2.4)	1.9 (1.3-2.9)	1.8 (1.2-2.6)	1.1 (0.5-2.5)	1.0 (0.4-2.2)	1.4 (0.9-2.4)	1.4 (0.9-2.4)
2	1.4 (1.1-1.9)	1.4 (1.0-2.0)	1.4 (0.9-2.2)	1.3 (0.9-2.1)	1.4 (0.6-3.3)	1.4 (0.6-3.3)	1.4 (0.9-2.4)	1.4 (0.9-2.4)
3 (High)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
P for trend	<0.001	0.01	<0.01	<0.01	0.84	0.91	0.17	0.17
Neighborhood poverty								
	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1 (Low)	1.3 (1.1-1.5)	1.2 (1.0-1.4)	1.2 (1.0-1.5)	1.3 (1.0-1.6)	1.3 (0.9-1.9)	1.3 (0.9-1.9)	1.1 (0.8-1.4)	1.1 (0.8-1.4)
3 (High)	1.6 (1.4-1.9)	1.5 (1.2-1.7)	1.5 (1.3-1.8)	1.5 (1.3-1.9)	1.1 (0.8-1.6)	1.1 (0.9-1.6)	1.4 (1.1-1.9)	1.5 (1.1-2.0)
P for trend	0.01	0.11	<0.01	0.01	0.51	0.55	0.13	0.13

*Neighborhood socioeconomic characteristics categorized according to the distribution of the full sample.
[†]Neighborhoods characterized according to race and ethnic-specific distributions. The final sample included 2,710 White women, 1,167 Black women, and 712 Latinas.
[‡]Adjusted for age at diagnosis and race/ethnicity for the full sample and age only for the race/ethnic-specific analyses.

We found no evidence of heterogeneity in the association between neighborhood of residence and advanced-stage breast cancer by race/ethnicity (*P* > 0.10 for all three neighborhood measures). However, because evidence suggests that the three racial/ethnic groups reside in different socioeconomic contexts and these contexts might be associated with health in different ways, we present the analyses stratified by race/ethnicity (Table 3). The adjusted ORs for women living in poorer versus more advantaged areas remained significant and were comparable for

White (OR, 1.8; CI, 1.2-2.6) and Black women (OR, 1.6; CI, 1.0-2.5). For Latinas, the pattern seemed to be reversed, showing greater odds of advanced-stage disease with increasing neighborhood advantage, but CIs included the null (OR, 0.8; CI, 0.3-2.1). Moreover, there seemed to be an overall stronger socioeconomic gradient in breast cancer staging for White women for the neighborhood deprivation or neighborhood income measures, as compared with the measure of neighborhood poverty. For Black women, the point estimates on all three measures were similar.

Discussion

Our focus on a defined local area revealed significant associations between living in disadvantaged neighborhoods and being diagnosed with advanced-stage breast cancer. Women living in more deprived neighborhoods were 60% more likely to be diagnosed with advanced-stage breast cancer than women living in more socioeconomically advantaged neighborhoods. These results remained after adjusting for age at diagnosis and race/ethnicity. In analyses stratified by race/ethnicity, the relationship between neighborhood deprivation, neighborhood median income, and neighborhood poverty and breast cancer staging remained significant for Black and White women, but was nonsignificant for Latinas. Moreover, the single-item measure of neighborhood poverty seemed to be more weakly associated with breast cancer staging among White women than the composite measure capturing neighborhood deprivation.

Our results are striking in that they included only two counties in the state of New Jersey and showed strong and significant associations between neighborhood socioeconomic condition and breast cancer staging. In a recent study conducted by Pawlish et al. (29), the authors also showed a socioeconomic gradient in breast cancer staging in the state of New Jersey. Other studies conducted in the nearby states of New York (25) and Connecticut (30) have similarly found associations between various area-level socioeconomic measures (e.g., education, median income, and medically underserved areas) and breast cancer staging. However, these studies have examined the role of "area-based" socioeconomic condition across large geographic areas and did not consider if, and which, neighborhood-level socioeconomic measures were associated with advanced-stage breast cancer.

Furthermore, few studies have explicitly examined the relation between neighborhood of residence and breast cancer staging and whether this differs by race/ethnicity. Our results were comparable to the study by Merkin et al. (25), in which the authors found no evidence of effect measure modification among a sample of White and Black women in New York. Following this work, we also used race/ethnic-specific distributions to detect neighborhood-based disparities in breast cancer staging. Despite using racial/ethnic-specific distributions, however, our analysis for the Latina subsample did not show any clear pattern of staging risk by neighborhood socioeconomic condition. This finding may possibly be due to sample size limitations and the range of the score of the neighborhoods in which Latinas lived. Specifically, Latina women tended to live in neighborhoods with a neighborhood score mean closer to 0, and thus, closer to the distribution of all neighborhoods included in the analysis, when compared with Black women. Another study (31) has specifically examined neighborhood-based differences in breast cancer staging for Latinas. The authors used data from 13 SEER areas and found that both lower mean neighborhood income and increasing percentage of Latino residents were associated with

higher odds of advanced-stage breast, cervical, and colorectal cancer, suggesting that lack of access to screening in poor neighborhoods and cultural isolation may contribute to staging disparities. In contrast, other studies suggest that neighborhoods/areas with a large concentration of Latino populations may actually confer a protective effect on select health outcomes (32, 33). More research is needed that includes both national and local SEER samples to more accurately characterize the cancer burden experienced by Latinas in general, and specific Latino subgroups (e.g., Mexicans or Puerto Ricans) that may have varying risk factors for cancer.

Consistent with prior work, we examined whether patterns of breast cancer staging differed based on the neighborhood socioeconomic measure used. In contrast to Krieger and colleagues (5), we found a weaker gradient in breast cancer staging by neighborhood poverty for White women as compared with Black women. It is possible that the counties included in our sample exhibit a high degree of racial/ethnic residential segregation, and thus, neighborhood-level poverty may be a less reliable measure for estimating area effects on cancer staging for White women, who are less likely to live in very poor neighborhoods. For example, in our sample, 67% of all Black women diagnosed with breast cancer lived in the most deprived neighborhoods, compared with only 13% of White women (data not shown). Thus, our study suggests the need for future research to consider the local residential context of areas being examined and the advantage of multidimensional measures of neighborhood socioeconomic condition to more accurately capture differences in cancer outcomes across racial and ethnic subgroups.

Our study results should be interpreted with some caveats in mind. The lack of individual-level socioeconomic data in cancer registries prevented us from determining how much of our observed association could have been explained by individual-level socioeconomic position. However, based on findings from the broader literature on neighborhood-health effects, individual-level socioeconomic position would likely reduce but not completely explain our reported associations. In addition, although we were interested in the general area encompassing the two counties examined, it may be that our results were partly driven by the county in our study (Essex), which contains a highly disadvantaged urban city with a disproportionate cancer burden. Lastly, an important next step in this line of research is to identify specific neighborhood-level factors such as access to screening services or transportation routes that may explain why neighborhood-level deprivation is associated with breast cancer staging.

A strength of our study is the use of reliable population-based cancer data to examine patterns in cancer staging by neighborhood socioeconomic condition in a defined, local area. Other studies have examined local patterns in cancer outcomes, but this work has largely focused on detecting cancer "clusters" and determining the adequate spatial scale for small area analyses (17, 34). Future work from our research team includes complementing our population-based analysis with qualitative data to better understand the complex process by which neighborhoods may hinder (or promote) cancer prevention and cancer care across distinct racial/ethnic groups. An important implication of our study findings is the potential for developing targeted health policy and programmatic interventions to reach areas and populations most at risk. Several authors have called for more extensive use of public health surveillance data (19, 20) to achieve national goals of eliminating cancer disparities. Our study provides evidence that population-based cancer data can be used to identify local needs specific to local populations.

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