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Breast Cancer in San Francisco: Disentangling Disparities at the Neighborhood Level

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Abstract

Background: This study uses a novel geographic approach to summarize the distribution of breast cancer in San Francisco and aims to identify the neighborhoods and racial/ethnic groups that are disproportionately affected by this disease.

Methods: Nine geographic groupings were newly defined based on racial/ethnic composition and neighborhood socioeconomic status. Distribution of breast cancer cases from the Greater Bay Area Cancer Registry in these zones were examined. Multivariable logistic regression models were used to determine neighborhood associations with stage IIB+ breast cancer at diagnosis. Cox proportional hazards regression was used to estimate the hazard ratios for all-cause and breast cancer specific mortality.

Results: A total of 5,595 invasive primary breast cancers were diagnosed between January 1, 2006 and December 31, 2015. We found neighborhood and racial/ethnic differences in stage of diagnosis, molecular subtype, survival, and mortality. Patients in the Southeast (Bayview/Hunter's Point) and Northeast (Downtown, Civic Center, Chinatown, Nob Hill, Western Addition) areas were more likely to have stage IIB+ breast cancer at diagnosis, and those in the East (North Beach, Financial District, South of Market, Mission Bay, Potrero Hill) and Southeast were more likely to be diagnosed with triple negative breast cancers (TNBC). Compared to other racial/ethnic groups, Blacks/African Americans (B/AA) experienced the greatest disparities in breast cancer related outcomes across geographic areas.

Conclusion: San Francisco neighborhoods with lower socioeconomic status and larger minority populations experience worse breast cancer outcomes.

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*Drs. Gomez and Fejerman contributed equally to this manuscript

Conflict of Interest:

The authors have no conflicts of interest to report.

Impact: Our findings, which reveal breast cancer disparities at sub-county geographic levels, have implications for population level health interventions.

Keywords

Breast cancer; health disparities; race/ethnicity; place and health

INTRODUCTION

Breast cancer is one of the most commonly diagnosed cancers among women in the United States, accounting for one in three cancer diagnoses. It is also the second leading cause of cancer death among women, following lung cancer (1). From 2005–2015, new breast cancer cases in the United States increased an average of 0.3% per year (2).

Racial/ethnic disparities in breast cancer risk and survival at the national and regional (e.g., states, counties) level have been well documented (3,4). However, researchers have recently begun to examine this phenomenon at sub-county geographic levels (5,6). More granular geographic level studies offer a unique opportunity to understand the local impacts of disease and to inform the targeted development of programs and policies to address them.

Studies on breast cancer at sub-county (e.g., city) levels have revealed trends in disparities across racial/ethnic categories that are similar to those at the national level. Black or African American (B/AA) vs. Non-Hispanic White (NHW) differences in breast cancer incidence and mortality have not improved over time in Chicago, Illinois (7), Memphis, Tennessee (8), and across many of the most populous cities in the United States.

To our knowledge, no recent studies have described the state of breast cancer in San Francisco, California. San Francisco, which is both a city and county with a population of approximately 880,000 (9), is unique in having one of the highest socioeconomic profiles in the U.S., and through established mechanisms, among the highest breast cancer incidence rates in California (10). In 2017, the population of San Francisco had an average income of $96,265, which is the highest among the 25 largest metropolitan areas in the country (11). San Francisco is also characterized by a high degree of racial/ethnic diversity, which is particularly relevant for breast cancer burden. A plurality of the city's population is NHW (40.5% of the population), followed by Asian American, Native Hawaiian, or Pacific Islanders (AANHPI, 36.3% of the population), Hispanics/Latinos (H/L, 15.2% of the population), B/AA (5.5% of the population) and other/mixed (5.0% of the population) (12).

Building upon the work being done by the San Francisco Cancer Initiative (13), this paper aims to (1) introduce a novel approach for describing meaningful disease burden in the city of San Francisco by establishing new geographic groupings based on racial/ethnic composition and neighborhood SES, and (2) provide an update on the burden of breast cancer in the city, including identifying specific geographic regions that might experience disparate rates of disease.

MATERIALS AND METHODS

Neighborhood definition

In order to investigate breast cancer disparities in San Francisco, it was necessary to define new geographic grouping of neighborhoods because most traditionally defined neighborhoods are too small to yield stable estimates of disease distribution. We opted to combine contiguous clusters of block groups based on attribute similarity on the basis of racial/ethnic composition and neighborhood SES (nSES). A series of racial/ethnic composition variables were created based on the block group population being above or below the San Francisco median population proportion for each of the main racial/ethnic non-NHW groups (B/AA, H/L, and AANHPI). These variables were combined into 8 mutually exclusive categories as follows: 1) below median for all 3 groups (predominantly NHW), 2) above median for AANHPI only, 3) above median for B/AA only, 4) above median for H/L only, 5) above AANHPI and B/AA median only, 6) above AANHPI and H/L median only, 7) above B/AA and H/L median only, and 8) above median for all 3 groups (predominantly minority neighborhoods). We used a multi-component measure of nSES at the census block group level (14,15). This measure incorporated the 2010 U.S. Census and the 2007–2011 American Community Survey data on education, occupation, unemployment, household income, poverty, rent, and house values. Each block group was assigned a neighborhood SES (nSES) quintile, which was then categorized into a low/high level (low is quintile 1–3 and high is quintile 4–5), based on the distribution of SES across census block groups in San Francisco.

A 16-category combined race/ethnicity-nSES variable was developed and assigned to each of the 579 inhabited block groups in San Francisco (Supplementary Table S1). The variable is developed as: 1) low nSES/below median for all three race-ethnicity groups, 2) high nSES/below median for all three race-ethnicity groups, 3) low nSES/above AANHPI median only, 4) high nSES/above AANHPI median only, 5) low nSES/above B/AA only, 6) high nSES/above B/AA only, 7) low nSES/above H/L median only, 8) high nSES/above H/L median only, 9) low nSES/above AANHPI and B/AA median only, 10) high nSES/above AANHPI and B/AA median only, 11) low nSES/above AANHPI and H/L median only, 12) high nSES/above AANHPI and H/L median only, 13) low nSES/above B/AA and H/L median only, 14) high nSES/above B/AA and H/L median only, 15) low nSES/above median for all 3 groups, and 16) high nSES/above median for all 3 groups (Supplementary Table S1). We mapped the San Francisco block groups using the combined race/ethnicity-nSES variable, and visually grouped contiguous block units to create 9 newly defined areas in San Francisco (Figure 1). This 16-category classification was used to combine contiguous block groups into neighborhoods. For block groups with unclear neighborhood classification, adjudication was conducted via discussion and community feedback. Thus, the process was both data- and community- driven.

Breast Cancer Case Population

Information about all breast cancers [defined by SEER Site Recode 26000] diagnosed among residents of San Francisco from 1/1/2006 to 12/31/2015 was obtained from the population-based Greater Bay Area Cancer Registry (GBACR). Available information

routinely abstracted from the medical record included age at diagnosis, race/ethnicity (grouped into NHW, B/AA, H/L, AANHPI, or other/unknown), marital status, residential address at diagnosis, stage at diagnosis, tumor size (in centimeters [cm]), lymph node involvement, histology, grade (I, II, III/IV, or unknown), primary source of payment (private, any public/Medicaid/military, Medicare only/Medicare + private, no insurance, and unknown), tumor marker expression status [estrogen receptor (ER) and progesterone receptor (PR)-together referred as hormone receptor (HR), and human epidermal growth factor receptor 2 (HER2)], as well as initial treatment modalities [surgery, radiation, and chemotherapy (endocrine therapy is under-captured in cancer registry data)]. We classified breast cancers into four mutually exclusive subtype categories: HR+/HER2- (defined as ER and/or PR positive and HER2 negative), HR+/HER2+ (ER and/or PR positive and HER2 positive), HR-/HER2+ (ER and PR negative and HER2 positive), and triple-negative breast cancer (TNBC, ER, PR, and HER2 negative). The residential address at diagnosis was geocoded and assigned to a block group and one of the nine newly-designed neighborhood areas. Forty-four males, 4 cases with sex coded other than male or female, 5 cases with invasive behavior but coded to in situ stage, and 7 cases with unknown address at diagnosis were excluded, resulting in a total of 5,622 cases for analysis.

Statistical Analysis

Distributions of breast cancer cases by key patient and tumor characteristics within each of the newly defined areas were examined. We estimated the association between the newly defined areas and odds of stage IIB+ breast cancer at diagnosis using sequential multivariable logistic regression. We chose stage IIB+ as our outcome of interest because of the comparatively more burdensome treatment implications of IIB+ (larger tumor and lymph node compromise) compared to cancers diagnosed at stage I or IIA. Covariates included age, race/ethnicity, nSES, insurance status, marital status, and molecular subtype, and were selected a priori. Survival analysis was limited to the first breast cancer diagnosis per patient. Cases that were diagnosed on death certificate or autopsy only (n=25) or not microscopically confirmed (N=53) were excluded from survival analysis. Patients with missing/unknown tumor size, diagnosis by mammography only, tumor not found, diffuse tumor, and macroscopic focus only (N=234) were additionally excluded, for a final sample size of 5,363 for the survival analysis. Cox proportional hazards regression was used to estimate hazard ratios and corresponding associated 95% confidence intervals (CI). The multivariable model included year of diagnosis, age at diagnosis, marital status, molecular subtypes, race/ethnicity, insurance status, nSES block group quintile (specific to San Francisco), tumor size, lymph node involvement, tumor grade, and histological subtype; AJCC stage was included as underlying stratifying variable given lack of proportionality of hazards by stage, and we additionally adjusted for clustering by block group. For deceased patients, survival time was measured in days from the date of diagnosis to the date of death. For cause-specific survival analysis, patients who died of a cause other than breast cancer (ICD-10 = C50) were censored on the date of death. Patients were followed for vital status by linkage with vital records as of December 31st, 2015. Patients alive at the study end date (12/31/2015) were censored at this time or at the date of last follow-up (i.e., last known contact). All statistical tests were carried out using SAS software version 9.4 (SAS Institute).

Mammography prediction surfaces were created using an optimized ordinary kriging model in ArcGIS (16) based on the census tract level mammogram values from the 500 Cities Project (17). Neighborhood level estimates were derived by extracting the values from the prediction surface for 1000 randomly placed points in each neighborhood polygon and calculating the mean. The interpolation of mammography prediction surfaces allowed for the assignment of predicted values across our newly defined geographic units.

RESULTS

A total of 5,622 invasive primary breast cancers were diagnosed in San Francisco female residents between January 1, 2006 and December 31, 2015. Figure 1 shows the newly defined areas based on neighborhood SES and race/ethnicity composition in San Francisco. Characteristics and distribution of the breast cancer cases within the newly defined areas are shown on Table 1. There are substantial variations in the racial/ethnic distribution of breast cancer cases within specific areas compared to San Francisco overall. NHW and AANHPI made up the greatest proportion of patients in San Francisco overall (47.5% and 36.3%, respectively), but the racial/ethnic distribution of breast cancer cases varied across areas. While 7.2% of the breast cancer cases in San Francisco were B/AA, 25.5% of the cases in the Southeast (Bayview/Hunter's Point) were B/AA. Similarly, while 8.4% of the breast cancer cases in San Francisco were H/L, 24.8% of the cases in the Center-East (Mission and Bernal Heights) were H/L.

Compared to other areas, more cases in the East (12.4%, including North Beach, Financial District, South of Market, Mission Bay, Potrero Hill) and Southeast (11.9%) were diagnosed with a triple-negative breast cancer (TNBC, a more aggressive molecular subtype of breast cancer). The Southeast and Northeast (Downtown, Civic Center, Chinatown, Nob Hill, Western Addition) areas had greater proportions of stage IIB+ breast cancer at diagnosis (, 30.3% and 29.0%, respectively), as well as unknown stage at diagnosis (3.9% and 4.3%, respectively). The Northeast area also had the highest proportion of unclassified molecular subtype (10.7%). (Table 1). This is consistent with the model-based estimates for mammography use obtained from the 500 cities data, which show that the Southeast and Northeast areas have the lowest screening rates (Figure 1).

B/AA breast cancer patients have the highest proportion of TNBC (20.0%, compared to 8.2%, 11.6%, and 9% in NHW, H/L, and AANHPI) (Supplementary Figure S1). The proportion of B/AA patients diagnosed with TNBC is high across all San Francisco areas, even those with low proportions of B/AA residents (33.3%, 19.3% and 21.3% in the East, Southwest, and Northeast areas) (Supplementary Table S2).

The survival analyses were limited to microscopically confirmed first primary breast tumors not reported on death certificate only, resulting in 5,363 patients with breast cancer. The lowest 5-year breast cancer specific survival rates were observed in the Northeast (rate 88.5, 95% CI 85.6–90.9), Center-South (rate 89.7, 95% CI 85.9–92.5), and Southeast (rate 89.7, 95% CI 86.1–92.4). Compared to other racial ethnic groups, B/AA had worse 5-year overall (rate 71.1, 95% CI 65.4–76.1) and breast cancer specific survival (rate 81.8, 95% CI 76.5–86.0) (Table 2).

Results from sequential multivariable-adjusted analysis examining the association between neighborhood and stage IIB+ cancer at diagnosis are shown in Table 3. Results from the univariable analysis show that, compared to the North, which comprises a greater proportion of wealthy NHW residents, those living in the Northeast (OR 1.64, 95% CI 1.28–2.11), Center-East (1.41, 95% CI 1.02–1.95), Southeast (1.77, 95% CI 1.35–2.32) and Center-West (1.48, 95% CI 1.13–1.94) had greater odds of being diagnosed at a higher stage. Observed disparities associated with the Center-East area could be mostly explained by the area-specific age distribution, race/ethnicity and nSES composition. In both the Northeast and Southeast, the biggest change on the coefficient occurred with the incorporation of nSES, although there also appears to be a smaller change when adding race/ethnicity to the model. After adding all relevant covariates, women in the Center-West area still have 1.53-fold increased odds (95% CI 1.16–2.02) of having a stage IIB+ diagnosis (Table 3 and Supplementary Table S5).

Hazard ratios for breast cancer specific mortality are presented in Table 4. In univariable analysis, the Northeast (HR 1.82, 95% CI 1.21–2.74) and Southeast (HR 1.70, 95% CI 1.09–2.64) had higher overall mortality compared to the North. These estimates were largely diminished upon inclusion of age, race/ethnicity, and nSES in the model, though the effect of race/ethnicity appeared to be more substantial in the Southeast (Table 4 and Supplementary Tables S3 & S4).

DISCUSSION

Our study introduces an innovative approach to describe the burden of cancer at a sub-county level. Our findings reveal that, similar to other regions across the United States, women that reside in low SES areas with larger representation of minority populations are diagnosed with more advanced and aggressive breast cancer and have lower survival than women who reside in high SES NHW neighborhoods (18). In particular, although B/AA make up only 7.2% of all breast cancer cases between 2006–2015, they experienced the greatest proportion of TNBC diagnosis across all neighborhoods, as well as the worst 5-year overall and breast cancer specific survival. H/L and AANHPI communities experience disparities as well, but differences are less marked than those between B/AA and NHW.

Ongoing research suggests that disparities observed in tumor subtype distribution between B/AA and NHW could be due, in part, to genetics (19). There is also evidence that some lifestyle factors, such as number of full-term pregnancies and breastfeeding are associated with risk of TNBC and could also explain the higher incidence of TNBC in B/AA women (20,21). The particular tumor subtype distribution in H/L and AANHPI could also be partly due to differences in genetics and environmental/lifestyle exposures that impact tumor biology (22,23). However, the overlap between stage at diagnosis and screening rates in the different areas of San Francisco (Figure 2) strongly suggest that the observed disparity in stage at diagnosis and its impact on breast cancer survival and quality of life could be addressed, at least in part, by closing the gap in screening rates between women in different areas of the city.

While several studies have suggested that improving access to high quality care and follow-up in patients from low SES areas is likely to reduce survival disparities (24,25), simply increasing access may not be sufficient for eliminating racial differences (18,26,27). In fact, although health care for all has been available in San Francisco since 2007 (28), in meetings of the SF CAN Breast Cancer Task Force, community representatives from underserved communities report that they do not generally know about this. The disproportional burden of unknown stage at diagnosis and unclassified molecular subtype may reflect the quality of care that individuals in certain SF areas receive. Similar to other metropolitan cities in the United States (29,30), structural racism could be a contributing factor to disparities among B/AA women in San Francisco.

Even after accounting for the effect of age, race/ethnicity, nSES, insurance type, marital status, and clinical features, living in the Center-East area is still associated with increased odds of stage IIB+ cancer at diagnosis. The Center-East comprises the Castro district, which has historically served as a safe haven for sexual and gender minority (SGM) populations. There is some evidence suggesting higher risk of breast cancer and mortality among lesbian and bisexual women (31,32), but results are inconsistent, in large part due to lack of data (e.g., no data on sexual gender minority status in cancer registries). Considering the large population and diversity of SGM status within the city, San Francisco could be an ideal location to further investigate the relationship between gender identity, sexual orientation, and breast cancer risk and mortality, and to tailor interventions toward non-heterosexual women. Incorporation of sexual gender minority data into population-based cancer registries will be crucial to better document the burden of cancer in this underserved population (33,34).

One of the limitations of our current study is the inability to produce neighborhood level incidence estimates. Using block groups as a building block provided the fine granularity to define areas with meaningful specificity. However, as population estimates required to compute incidence and mortality rates are available at the census tract level, not at the block group level, we were unable to calculate incidence rates for the 9 areas. Our recommendation for future studies is to use census tracts as the building blocks if the intent is to calculate disease rates requiring population denominators. An additional limitation in our study is the small number of breast cancer specific deaths, which could have contributed to the lack of significant associations for breast cancer specific mortality across neighborhoods. Additionally, since the San Francisco population is rapidly changing, our description based on most recently available cancer registry data may not be an accurate picture of the current burden of breast cancer in the city. Specifically, as the economic and technological landscape continues to expand, it will be critical to continue monitoring breast cancer disparities due to both racial/ethnic and socioeconomic inequity. Finally, although data are available on neighborhood-level attributes that may potentially account for some of the observed neighborhood-level disparities, the intent of this analysis was to provide a descriptive examination of the burden of breast cancer across the city. We recognize, however, the importance of providing neighborhood-level data to stakeholders and, as such, have extended this work to develop a statewide tool that allows interactive query and mapping of cancer incidence rates alongside population-level sociodemographic and behavioral risk factors (www.californiahealthmaps.org).

Given what our research has revealed regarding breast cancer health disparities in San Francisco, our present challenge will be to design programs and interventions that could more effectively promote breast cancer preventive behaviors and access to appropriate care among the city's most impacted racial/ethnic groups. This work is being undertaken by the San Francisco Cancer Initiative's Breast Cancer Task Force. Specifically, the Task Force will be focusing on the design and implementation of programs tailored toward AA/B, H/L and AANHPI populations in San Francisco, with the long-term goal of reducing observed disparities in stage at diagnosis and survival. Ongoing programs, based on community feedback and evidence of efficacy, include the compilation and distribution of information about resources and services that are already available to support breast health related practices among women in San Francisco (35–37), and the implementation of a high school student-based breast cancer awareness and education program to promote screening and health behavior change in their communities (38–41). We plan to monitor changes in geographic burden over time and document potential impacts of these and future programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations list:

B/AA	Black or African American
NHW	Non-Hispanic White
AANHPI	Asian American, Native Hawaiian, or Pacific Islanders

H/L	Hispanic/Latino
nSES	Neighborhood socioeconomic status
TNBC	Triple Negative Breast Cancer
HER2	Human epidermal growth factor receptor 2

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Figure 1.

Newly defined areas based on neighborhood SES and racial/ethnic composition in San Francisco.

SF CAN Areas:

1. Center-South: West Portal, Diamond Heights, Glen Park
2. Center-West: Inner Sunset, Haight Ashbury, Castro
3. Center-East: Mission, Bernal Heights
4. East: North Beach, Financial District, South of Market, Mission Bay, Potrero Hill
5. Southeast: Bayview/Hunter's Point
6. Southwest: Lakeshore, Excelsior
7. West: Sunset, Richmond
8. North: Presidio, Marina, Pacific Heights
9. Northeast: Downtown, Civic Center, Chinatown, Nob Hill, Western Addition.

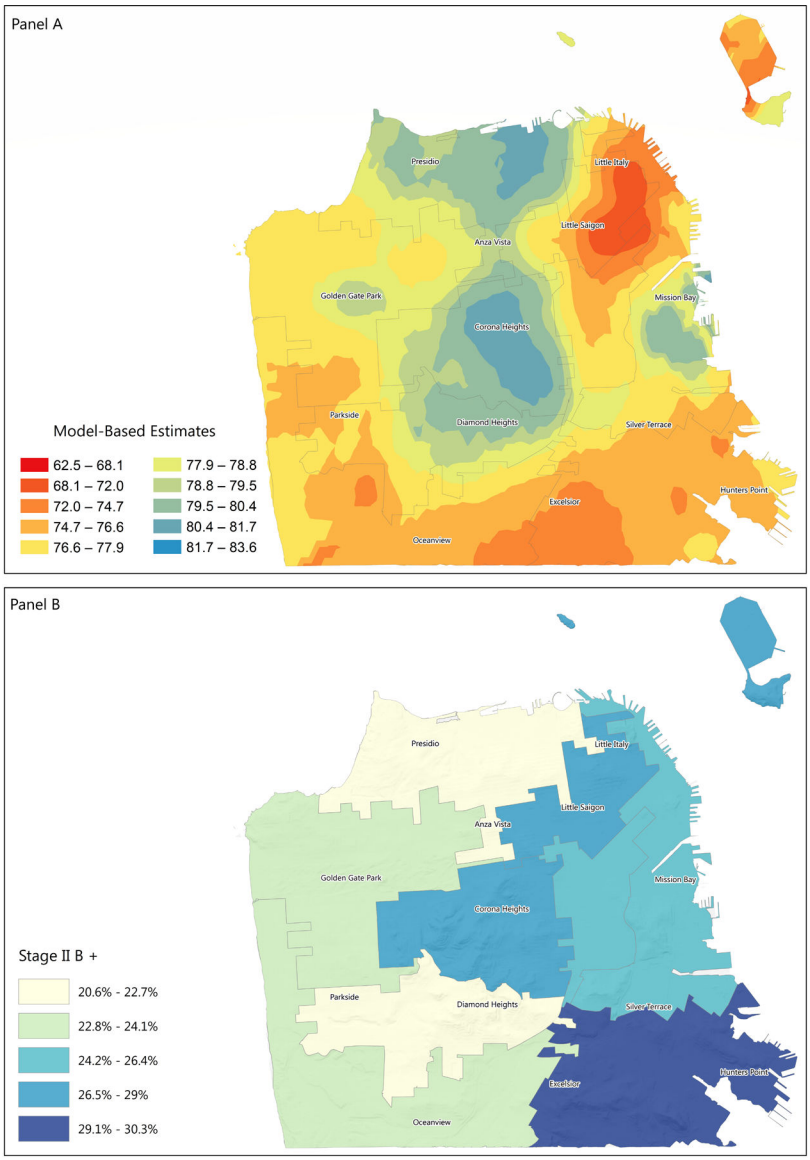

Figure 2:

Distribution of mammography and stage IIB+ cancer at diagnosis in San Francisco

Panel A: Model-based estimates for mammography use among women aged 50–74 years, 2016

Panel B: Proportion of cases with stage IIB+ cancer at diagnosis

Table 1.

Distribution of race/ethnicity, nSES, stage at diagnosis and molecular subtype by newly defined areas for female invasive breast cancer cases diagnosed in San Francisco, 2006–2015

	All	1. Center-South	2. Center-West	3. Center-East	4. East	5. Southeast	6. Southwest	7. West	8. North	9. Northeast
All	5622	511 (9.1%)	614 (10.9%)	330 (5.9%)	348 (6.2%)	588 (10.5%)	810 (14.4%)	871 (15.5%)	671 (11.9%)	879 (15.6%)
Race/ethnicity										
NHW	2,673 (47.5%)	290 (56.8%)	424 (69.1%)	121 (36.7%)	219 (62.9%)	116 (19.7%)	236 (29.1%)	369 (42.4%)	519 (77.3%)	379 (43.1%)
B/AA	404 (7.2%)	17 (3.3%)	23 (3.7%)	15 (4.5%)	18 (5.2%)	150 (25.5%)	57 (7.0%)	12 (1.4%)	18 (2.7%)	94 (10.7%)
H/L	475 (8.4%)	31 (6.1%)	41 (6.7%)	82 (24.8%)	34 (9.8%)	80 (13.6%)	102 (12.6%)	30 (3.4%)	28 (4.2%)	47 (5.3%)
AANHPI	2,043 (36.3%)	171 (33.5%)	121 (19.7%)	110 (33.3%)	74 (21.3%)	239 (40.6%)	411 (50.7%)	458 (52.6%)	104 (15.5%)	355 (40.4%)
Other/Unknown	27 (0.5%)	*	*	*	*	*	*	*	*	*
nSES										
1	1,133 (20.2%)	*	*	71 (21.5%)	12 (3.4%)	381 (64.8%)	224 (27.7%)	*	*	445 (50.6%)
2	1,224 (21.8%)	*	<5 (0.5%)	169 (51.2%)	13 (3.7%)	122 (20.7%)	448 (55.3%)	222 (25.5%)	12 (1.8%)	235 (26.7%)
3	1,127 (20.0%)	59 (11.5%)	81 (13.2%)	84 (25.5%)	*	85 (14.5%)	133 (16.4%)	481 (55.2%)	34 (5.1%)	170 (19.3%)
4	1,053 (18.7%)	234 (45.8%)	237 (38.6%)	*	152 (43.7%)	*	5 (0.6%)	148 (17.0%)	261 (38.9%)	16 (1.8%)
5	1,085 (19.3%)	218 (42.7%)	293 (47.7%)	6 (1.8%)	171 (49.1%)	*	*	20 (2.3%)	364 (54.2%)	13 (1.5%)
Age at Diagnosis (m, SD)	61.07 (14.81)	63.53 (15.15)	59.64 (14.78)	57.87 (15.63)	56.56 (14.1)	59.81 (13.99)	61.2 (13.8)	61.54 (14.92)	61.82 (15.37)	63.32 (14.76)
Stage at Diagnosis										
Stage I-IIa	4,022 (71.5%)	382 (74.8%)	433 (70.5%)	232 (70.3%)	254 (73.0%)	387 (65.8%)	598 (73.8%)	632 (72.6%)	518 (77.2%)	586 (66.7%)
Stage IIb and higher	1,430 (25.4%)	116 (22.7%)	165 (26.9%)	87 (26.4%)	88 (25.3%)	178 (30.3%)	193 (23.8%)	210 (24.1%)	138 (20.6%)	255 (29.0%)
Stage unknown	170 (3.0%)	13 (2.5%)	16 (2.6%)	11 (3.3%)	6 (1.7%)	23 (3.9%)	19 (2.3%)	29 (3.3%)	15 (2.2%)	38 (4.3%)
Molecular Subtype										
HR+/HER2-	3,785 (67.3%)	364 (71.2%)	438 (71.3%)	221 (67.0%)	237 (68.1%)	381 (64.8%)	521 (64.3%)	607 (69.7%)	474 (70.6%)	542 (61.7%)
HR+/HER2+	565 (10.0%)	40 (7.8%)	56 (9.1%)	40 (12.1%)	37 (10.6%)	59 (10.0%)	91 (11.2%)	73 (8.4%)	64 (9.5%)	105 (11.9%)
HR-/HER2+	296 (5.3%)	21 (4.1%)	28 (4.6%)	15 (4.5%)	15 (4.3%)	36 (6.1%)	43 (5.3%)	51 (5.9%)	26 (3.9%)	61 (6.9%)
TNBC	540 (9.6%)	42 (8.2%)	52 (8.5%)	35 (10.6%)	43 (12.4%)	70 (11.9%)	86 (10.6%)	81 (9.3%)	54 (8.0%)	77 (8.8%)
Unclassified	436 (7.8%)	44 (8.6%)	40 (6.5%)	19 (5.8%)	16 (4.6%)	42 (7.1%)	69 (8.5%)	59 (6.8%)	53 (7.9%)	94 (10.7%)

*Suppressed due to n<5

Table 2.

Overall and breast cancer specific survival and 95% confidence interval for female invasive breast cancer cases diagnosed in San Francisco by neighborhood and race-ethnicity, San Francisco, 2006–2015

	5-year	
Area	**Overall**	**BCa-specific**
1. Center-South	83.2 (78.8–86.8)	89.7 (85.9–92.5)
2. Center-West	86.0 (82.1–89.1)	91.5 (88.2–93.9)
3. Center-East	85.4 (79.9–89.5)	89.8 (84.8–93.2)
4. East	88.3 (82.9–92.1)	94.1 (89.9–96.6)
5. Southeast	82.7 (78.6–86.1)	89.7 (86.1–92.4)
6. Southwest	85.2 (82.0–88.0)	91.9 (89.3–93.9)
7. West	85.6 (82.5–88.1)	92.1 (89.7–94.0)
8. North	88.3 (84.9–91.0)	94.0 (91.3–95.8)
9. Northeast	80.5 (77.1–83.5)	88.5 (85.6–90.9)
Race/ethnicity		
NHW	84.9 (83.1–86.5)	92.0 (90.6–93.2)
B/AA	71.1 (65.4–76.1)	81.8 (76.5–86.0)
H/L	84.2 (79.6–87.8)	90.0 (86.1–92.8)
AANHPI	87.7 (85.8–89.3)	92.3 (90.8–93.6)
Stage		
Stage I-IIa	91.3 (90.2–92.3)	97.3 (96.6–97.9)
Stage IIb and higher	69.0 (66.0–71.9)	75.2 (72.3–77.9)
Stage unknown	56.5 (46.5–65.4)	73.9 (63.5–81.7)
Molecular subtype		
HR+/HER2+	87.3 (83.6–90.2)	93.0 (89.8–95.2)
HR+/HER2-	87.9 (86.5–89.2)	94.2 (93.1–95.0)
HR-/HER2+	82.3 (76.3–86.9)	86.5 (80.8–90.6)
TNBC	71.6 (66.8–75.8)	77.8 (73.2–81.7)
Unclassified	73.0 (67.8–77.4)	83.9 (79.3–87.6)

Table 3:

Sequential logistic models for the association between neighborhood area and diagnosis at stage IIB+, San Francisco, 2006–2015

	Model 1 (Univariable)	Model 2 (+Age)	Model 3 (+Race/Ethnicity)	Model 4 (+SES Quintile)	Model 5 (+Insurance)	Model 6 (+Marital Status)	Model 7 (+Subtype)
Area							
1. Center-South	1.17 (0.87– 1.56)	1.20 (0.89– 1.60)	1.18 (0.88– 1.59)	1.19 (0.89– 1.60)	1.20 (0.89– 1.61)	1.24 (0.92– 1.67)	1.27 (0.94– 1.71)
2. Center-West	**1.48 (1.13– 1.94)**	**1.46 (1.11– 1.92)**	**1.45 (1.10– 1.91)**	**1.46 (1.11– 1.92)**	**1.48 (1.12– 1.95)**	**1.50 (1.13– 1.97)**	**1.53 (1.16– 2.02)**
3. Center-East	**1.41 (1.02– 1.95)**	1.37 (0.99– 1.90)	1.26 (0.90– 1.75)	1.05 (0.70– 1.59)	1.03 (0.68– 1.56)	1.00 (0.66– 1.51)	0.99 (0.65– 1.50)
4. East	1.30 (0.95– 1.79)	1.25 (0.91– 1.72)	1.22 (0.88– 1.68)	1.19 (0.86– 1.64)	1.18 (0.85– 1.63)	1.16 (0.84– 1.60)	1.17 (0.84– 1.62)
5. Southeast	**1.77 (1.35– 2.32)**	**1.76 (1.35– 2.31)**	**1.57 (1.18– 2.09)**	1.21 (0.82– 1.78)	1.23 (0.84– 1.82)	1.27 (0.86– 1.87)	1.25 (0.84– 1.86)
6. Southwest	1.21 (0.94– 1.57)	1.23 (0.95– 1.60)	1.17 (0.90– 1.53)	0.94 (0.65– 1.36)	0.98 (0.68– 1.42)	0.99 (0.69– 1.44)	0.96 (0.66– 1.40)
7. West	1.24 (0.96– 1.61)	1.26 (0.97– 1.62)	1.26 (0.97– 1.64)	1.21 (0.88– 1.68)	1.24 (0.90– 1.72)	1.27 (0.91– 1.75)	1.27 (0.91– 1.76)
8. North	Ref	Ref	Ref	Ref	Ref	Ref	Ref
9. Northeast	**1.64 (1.28– 2.11)**	**1.70 (1.32– 2.18)**	**1.64 (1.27– 2.12)**	1.30 (0.91– 1.86)	1.26 (0.88– 1.80)	1.24 (0.86– 1.77)	1.19 (0.83– 1.71)

Table 4.

Hazard ratios and 95% confidence intervals for female invasive breast cancer cases living in San Francisco, 2006–2015

		Breast cancer specific mortality HR (95% CI)				
Area	**N deaths**	**Model 1 (Univariable)**	**Model 2 (+Age)**	**Model 3 (+nSES)**	**Model 4 (+ Race/Ethnicity)**	**Full Model†**
1. Center-South	38	1.55 (0.97–2.47)	1.52 (0.96–2.43)	1.55 (0.97–2.47)	1.53 (0.95–2.44)	1.23 (0.76–2.01)
2. Center-West	40	1.37 (0.86–2.17)	1.43 (0.90–2.26)	1.48 (0.93–2.34)	1.46 (0.92–2.31)	1.04 (0.65–1.67)
3. Center-East	18	1.15 (0.65–2.04)	1.22 (0.69–2.16)	1.33 (0.66–2.69)	1.32 (0.65–2.68)	1.29 (0.63–2.64)
4. East	17	1.00 (0.56–1.79)	1.11 (0.62–2.00)	1.09 (0.60–1.95)	1.04 (0.58–1.88)	0.77 (0.42–1.41)
5. Southeast	49	**1.70 (1.09–2.64)**	**1.78 (1.14–2.77)**	1.67 (0.89–3.14)	1.33 (0.70–2.53)	1.00 (0.52–1.90)
6. Southwest	49	1.15 (0.74–1.78)	1.16 (0.75–1.80)	1.24 (0.67–2.29)	1.17 (0.63–2.17)	0.94 (0.50–1.74)
7. West	56	1.26 (0.82–1.94)	1.25 (0.82–1.93)	1.61 (0.96–2.72)	1.64 (0.97–2.79)	1.16 (0.67–1.99)
8. North	33	Ref	Ref	Ref	Ref	Ref
9. Northeast	75	**1.82 (1.21–2.74)**	**1.74 (1.15–2.62)**	1.74 (0.97–3.12)	1.69 (0.94–3.04)	1.22 (0.68–2.19)

† Full model includes area, age, nSES, race/ethnicity, marital status, insurance, molecular subtype, stage (as a stratification variable), grade, surgery, radiation, and chemotherapy