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Title: Neighborhood Contexts and Breast Cancer among Asian American Women

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ABSTRACT

Background: This study examines how neighborhood socioeconomic status (nSES) and ethnic composition are associated with breast cancer risk for Asian American women.

Methods: We linked individual level data from a population-based case-control study of breast cancer among Asian American women with neighborhood level data in the Greater San Francisco Bay Area (cases: n=119, controls: n=390). Multivariable logistic regression models examined the association between nSES, ethnic composition, and odds of having breast cancer.

Results: Asian American women living in neighborhoods with high nSES and high ethnic composition had the highest odds of breast cancer, compared to those living in neighborhoods with high nSES and low ethnic composition (OR=0.34, 95% CI: [0.16-0.75]) or in neighborhoods with low nSES and high ethnic composition (OR=0.37, 95% CI: [0.17-0.83]).

Discussion: Neighborhood socioeconomic and ethnic contexts are associated with breast cancer for Asian American women. We discuss explanations and avenues for future research.

KEYWORDS

breast cancer; Asian American; neighborhoods; socioeconomic status; ethnic composition

Neighborhood Contexts and Breast Cancer among Asian American Women

INTRODUCTION

Rates of breast cancer are rapidly increasing among Asian women living in the United States (U.S.), even as rates are stabilizing or decreasing among the general population and white women [1–3]. One possible reason might be related to neighborhood factors. Research has shown that the neighborhood context in which women reside is associated with breast cancer [4,5]. Most research finds that living in areas with high neighborhood socioeconomic status (nSES) is associated with higher risk of breast cancer, independent of individual socioeconomic status (SES) [6,7]. Mechanisms linking contextual factors with breast cancer include the physical built environment, exposure to environmental pollutants, access to early detection (i.e. mammograms), psychosocial pathways of community stress and anxiety, and social norms affecting diet, physical activity, or reproductive factors [6,8]. Much of this literature relies on a composite measure of nSES [8,9], although higher neighborhood education and income are separately associated with breast cancer risk [10,11]. However, while nSES associations with breast cancer have been found for white, black, and Latina women in the U.S. [4,6–9], the evidence is less clear for Asian American women. One of the only studies that included both individual and neighborhood data for Asian women found no association between nSES and breast cancer among Japanese American women [7].

Additionally, studies report that neighborhood racial/ethnic composition is associated with breast cancer. Living in neighborhoods with higher co-ethnic composition may be protective against breast cancer, especially among immigrant groups. Specifically, Latina individuals in the U.S. living in neighborhoods with higher concentration of Latinx residents

have lower risk of breast cancer compared with their counterparts living in neighborhoods with lower concentrations [5,12]. It is unknown whether this same protective nature of neighborhood ethnic composition is true for Asian American women. One known study suggested that greater isolation of Asian American women in neighborhoods was associated with decreased likelihood of late stage breast cancer diagnosis [13].

Neighborhood SES and ethnic composition may interact to influence breast cancer risk for Asian American women [5,14,15]. In areas with high ethnic composition, neighborhood resources are more likely to be ethnic-specific, catering to the population with more culturally-relevant resources, including minority-owned businesses, culturally competent social and health services, and co-ethnic social ties [16,17]. Understanding how the interplay between nSES and ethnic composition impacts breast cancer risk for Asian American women will inform preventive programs and policies aimed at reducing cancer disparities in this diverse racial group.

In this study, we assess how nSES and ethnic composition are jointly associated with breast cancer for Asian American women. Additionally, we investigate the pathways by which neighborhood contexts may influence breast cancer, including the roles of individual SES, mammogram access, behavioral risk factors, and built environment [9,15,18–20].

METHODS

Participants and Data Collection

Data came from a population-based case-control study of breast cancer among Asian American women—the Asian Community Health Initiative (CHI) [21]. The San Francisco Bay Area was an appropriate study location because this area has the highest concentration of Asian residents in the U.S. outside of Hawai'i, with 29% of the population (1.7 million people)

identifying as Asian American in 2010 [22]. Study participants provided written informed consent. All research protocol received Institutional Review Board approval.

Women with breast cancer (i.e. cases) were sampled from a population-based source, the Greater Bay Area Cancer Registry—a Surveillance, Epidemiology, and End Results (SEER) cancer registry—which contains information for all people diagnosed with cancer in the geographic study area. Participants were originally recruited to the Equality in Breast Cancer Care Study (EBCC), which interviewed women with breast cancer by phone from 2010 to 2013. Response rates in the EBCC were 32% for Chinese women, 35% for Filipina women, and 31% for Japanese women. CHI researchers followed-up with EBCC participants who indicated they were willing to be recontacted. Eligible CHI cases were Asian American women 20 years old and older, who were diagnosed with breast cancer between January 1, 2005 and December 31, 2009. Recruitment of CHI cases ran from February 2013 to September 2014. Of the EBCC eligible cases, 70.6% participated in CHI.

Women without breast cancer (i.e. controls) were recruited to frequency-match cases by age group and Asian ethnicity, and to otherwise be representative of the underlying population in the San Francisco Bay Area from which cases arose. Age matching was based on age at diagnosis for cases and age at interview for controls. This study utilized multiple recruitment methods for controls—community health centers, a registry of cancer study volunteers, online-based methods, address-based sampling, and traditional community-based sampling. CHI controls were similar to the source population of Asian American women at risk for breast cancer in the study area on key demographics [21]. Recruitment of controls ran from March 2013 to October 2014.

Survey data for both cases and controls were collected through telephone interviews and self-administered questionnaires, available in English, Mandarin, Cantonese, and Tagalog. CHI included questions about known breast cancer risk factors and sociodemographic characteristics. Written materials were translated and independently back translated. Data included the respondents' addresses. For cases, addresses were reported at the time of their breast cancer diagnoses. For controls, addresses were reported at the time of interview. Respondents' addresses were geocoded using the Texas A&M Geocoding Client [23] and linked with data from the California Neighborhoods Data System (CNDS) [24]. CNDS included measures of neighborhood sociodemographic composition, consolidating data from the U.S. Census and American Community Survey. In addition, CNDS provided data on the built environment.

A total of 568 Asian American women participated in CHI. Of those, 60 respondents (10.6%) were excluded because of missing data on key variables. The final sample consisted of 508 Asian American women, which included 118 women with breast cancer (cases) and 390 without breast cancer (controls).

Measures

The dependent variable was *having breast cancer* (0=no cancer; 1=has breast cancer).

Main independent variable

The main independent variable of interest was *nSES and neighborhood Asian ethnic composition*. Neighborhoods were defined as Census block groups. Neighborhood SES was measured using the Yang Index, which was created using principal components analysis including seven neighborhood variables: education, median household income, percent living 200% above poverty level, percent blue-collar workers, percent employed, median rent, and median house value based on data from the 2007 to 2011 American Community Survey (ACS)

[25]. Based on the distribution of the summary score across California, a quintile index was created with one indicating the lowest and five indicating the highest nSES. The Yang Index has been validated for use in several cancer studies as a measure of nSES for diverse populations [7,26,27]. In the CHI sample, the majority of respondents (68%) lived in the highest two statewide quintiles for nSES. Therefore, nSES was dichotomized into high (index=4 or 5) or low (index<4).

Neighborhood Asian ethnic composition was measured using an index created using principal components analysis that included four neighborhood characteristics from the 2000 U.S. Census: 1) percent Asian, 2) percent recent immigrant (defined as having immigrated in the past 5 years), 3) percent households that are Asian/Pacific Islander language-speaking and linguistically isolated, and 4) percent of residents who are Asian/Pacific Islander language-speaking with limited English proficiency [24]. This index has been used in studies of breast cancer risk and survivorship among Asian American women [4,7], and a similar index has been used examining breast cancer incidence among Latina individuals [5]. A quintile index was created using the distribution of these variables across the state of California. The Asian ethnic index was measured on a scale of one to five, with one representing the least ethnic and five representing the most ethnic block groups in California. In the CHI sample, the majority of respondents (74%) lived in the most ethnic neighborhoods (ethnic index=5). This is unsurprising because the study location—the San Francisco Bay Area—has one of the highest concentrations of Asian American residents in the state [22]. The index was dichotomized into high (ethnic index=5) and low (ethnic index<5) ethnic composition, as has been done in previous studies using this measure [14,28].

The composite measure of nSES and ethnic composition included four neighborhood-level categories: 1) high nSES-high ethnic, 2) high nSES-low ethnic, 3) low nSES-high ethnic, and 4) low nSES-low ethnic.

Potential mediating variables

Potential mediators were grouped into four general categories: 1) individual SES, 2) mammogram access, 3) behavioral risk factors, and 4) built environment. To measure individual SES, we included self-reported measures at the time of interview for *education* (college graduate, some college, less than or equal to a high school degree), *employment* (full time, part time, and not employed), and *homeownership* (homeowner, non-homeowner). As a proxy for access to mammograms, we included the *frequency of mammograms* that women reported on average over the past 10 years from time of interview.

The behavioral risk factors that we included were *age at menarche*, *menopausal status/hormone replacement therapy use* (pre-menopausal, postmenopausal/no hormone replacement therapy use, postmenopausal/hormone replacement therapy user), *pregnancy history* (age at first birth<25, age at first birth 25-29, age at first birth 30-34, age at first birth 35+, never pregnant), *number of months that women breastfed* their children, *physical activity* (reported average hours per week of moderate physical activity over the past year from time of interview) and *body mass index (BMI)* (weight in kilograms/height in meters^2 at time of interview). These risk factors have been found to be associated with breast cancer [29–32].

Measures of the built environment were calculated for each respondent based on a 1,600-meter network distance (i.e. distance that could be travelled using streets) around respondents' residential addresses [24]. This distance is thought to best capture people's relationship to their built environment that is accessible via walking [33,34]. *Walkability* was measured using the

gamma index, which is interpreted as the percentage of street connectivity ranging from zero to one, with higher values representing greater walkability. We multiplied the gamma index by 10. *Number of recreational facilities* was the count of facilities such as gymnasiums, dance studios, sporting and recreational campgrounds, gardens, bowling alleys, and other similar facilities. *Number of parks* was the count of all parks. Due to skewedness of the distribution of number of recreational facilities and parks, we transformed these two variables by taking the square root in analyses [35].

Control variables

We adjusted for the variables used to match cases and controls: *age group* (20-39, 40-59, and 60+ years-old) and *Asian ethnicity* (Chinese, Filipina, or other Asian). Further, we included the following control variables: *marital status* (married, formerly married, single), *survey language* (English, non-English), *nativity* (foreign-born, US-born), *family history of breast cancer* (no immediate family member [mother, sister, daughter] with breast cancer, immediate family member with breast cancer) and *urbanicity* (metropolitan urban, suburb/town/rural).

Analysis

We conducted the analysis in Stata v.15 [36]. First, we examined descriptive statistics for the total sample and separately for cases and controls. We used multivariable logistic regression to examine association between the composite measure of nSES and neighborhood ethnic composition and having breast cancer. Multilevel modeling was not used in this analysis due to the low clustering of observations within block groups; 97.6% of block groups had only one or two participants living there. In regression models, we used standard errors that were clustered by 2010 US Census block group to account for potential correlation of errors for observations within the same geographic area. Finally, we conducted a series of mediation analyses using the

Karlson, Holm, and Breen (KHB method) to calculate the indirect effects within nested nonlinear probability models [37].

RESULTS

Table 1 provides descriptive statistics for the study. The largest proportion of all participants (46.5%) lived in high nSES-high ethnic neighborhoods. A higher proportion of cases (60.2%) lived in high nSES-high ethnic neighborhoods compared to controls (42.3%). Few participants (3.5% or 18 participants) lived in low nSES-low ethnic neighborhoods, as is reflective of the San Francisco Bay Area.

TABLE 1 ABOUT HERE

Table 2 presents the odds ratios of having breast cancer by nSES and ethnic composition. Model 1 shows that individuals living in either high nSES-low ethnic or low nSES-high ethnic neighborhoods had lower odds of breast cancer compared to those living in high nSES-high ethnic neighborhoods (OR=0.44, 95% CI: [0.25, 0.79] and OR=0.43, 95% CI: [0.24, 0.75], respectively). Asian American women living in low nSES-low ethnic neighborhoods seemed to have lower odds of breast cancer compared to those in high nSES-high ethnic neighborhoods, but the confidence interval was wide (OR=0.54, 95% CI: [0.19 - 1.52]). After accounting for control variables (marital status, survey language, nativity, family history of breast cancer, and urbanicity) in Model 2, the association between odds of breast cancer and nSES and ethnic composition was similar to the association in Model 1. Model 3 additionally accounted for potential mediators (individual SES, mammogram access, reproductive factors, health lifestyles, and/or features of the built environment). Women living in both the high nSES-low ethnic neighborhoods and the low nSES-high ethnic neighborhoods continued have lower odds of breast cancer than those living in high nSES-high ethnic neighborhoods (OR=0.34, 95% CI:

[0.16-0.75] and OR=0.37, 95% CI: [0.17-0.83], respectively). Those living in low nSES-low ethnic neighborhoods had similar odds of breast cancer as those living in high nSES-high ethnic neighborhoods, but the 95% CI was too wide to be conclusive (OR=0.97, 95% CI: [0.37, 2.54]).

Due to the small number of Asian American women living in low nSES-low ethnic neighborhoods, we conducted sensitivity analyses to see if findings differed when either excluding this group completely or creating an aggregate low nSES category (regardless of ethnic composition). The results of these sensitivity analyses were similar to those presented (data available upon request).

TABLE 2 ABOUT HERE

Figure 1 displays the probability of having breast cancer by the four categories of nSES and neighborhood ethnic composition, controlling for age, Asian ethnicity, marital status, survey language, nativity, family history of breast cancer, and urbanicity. The probability of breast cancer was higher among women living in high nSES-high ethnic neighborhoods compared to those living in high nSES-low ethnic and low nSES-high ethnic neighborhoods. The 95% confidence interval for the probability of having breast cancer in the low nSES-low ethnic neighborhoods was too wide to determine meaningful differences compared to the other groups.

FIGURE 1 ABOUT HERE

The results of mediation analyses are shown in Table 3. These findings revealed that none of the potential mediators—including individual SES, mammogram access, behavioral breast cancer risk factors, and built environment features—robustly explained associations between breast cancer and neighborhood context.

TABLE 3 ABOUT HERE

DISCUSSION

Our findings indicated that Asian women living in neighborhoods with both high nSES and high ethnic composition had higher odds of breast cancer than those in neighborhoods with high nSES and low ethnic composition, or low nSES and high ethnic composition. This study is one of the few to examine neighborhood contexts and breast cancer risk among Asian American women [13], and it is the first to our knowledge to show higher breast cancer risk in high nSES-high ethnic neighborhoods. Furthermore, we tested potential mechanisms linking neighborhood context and breast cancer, but found that neither individual SES, mammogram access, behavioral factors, nor built environment explained the associations. The potential mediators that we tested are factors that are often blamed for higher breast cancer risk among more acculturated immigrant groups [5,38,39]. It is possible that other unmeasured factors—such as behaviors earlier in life or prior exposure to carcinogenic chemicals—could explain why living in neighborhoods with high nSES and high ethnic composition was associated with higher odds of breast cancer among Asian American women [40,41]. These are areas for future research.

This study contrasts prior research among Latina individuals, that found the highest breast cancer risk to be among those living in neighborhoods with high nSES and low ethnic composition [5,12]. In those studies, ethnic composition was protective against breast cancer among Latina individuals. Our finding implies that neighborhood ethnic composition does not coincide with cancer risk for all racial/ethnic groups uniformly [42]. Latinx and Asian American people differ in histories of settlement and migration, which create differences in the features of Latinx neighborhoods versus Asian neighborhoods [43,44]. For Latinx residents, greater ethnic composition is often highly correlated with neighborhood socioeconomic disadvantage [5]. Many neighborhoods with high Asian composition do not have the same level of concentrated disadvantage as Latinx American residents [17,43]. Areas with high Asian composition may be

more socioeconomically advantaged, or these Asian ethnic enclaves may have other factors that lead to higher breast cancer risk, such as reproductive behavioral norms, cancer screening beliefs, or health care resources [42].

Limitations and strengths

Neighborhood measures were only available for one point in time, based on reported address of residence at the time of breast cancer diagnosis for cases, or at the time of interview for controls. With the cross-sectional design, it was not possible to examine how exposures to environments at earlier times in life were associated with breast cancer status. This is especially important for breast cancer, which develops over the life course and has a lag time between exposure and the development of noticeable disease [45]. In addition, our measure of access to mammograms was limited because survey respondents reported on frequency of mammograms in the past 10 years at the time of the survey. This measure overestimates mammogram access for breast cancer cases, who received more frequent mammograms post-diagnosis, and is an imperfect proxy for actual mammogram access. Furthermore, although the analyses accounted for age, more controls (11.3%) compared to cases (1.7%) were in the age category under 40 years old, and therefore are not recommended for mammograms. There may have been undiagnosed cases of breast cancer among younger women in the control sample. An additional limitation is that these data only represent Asian American women living in the Greater San Francisco Bay Area. These findings are not generalizable to the population of Asian American women in the U.S.

Mortality may have influenced the selection of cases because women who did not survive to participate in this study were not included. Compared to non-responders, breast cancer cases in this study were slightly more likely to be diagnosed with earlier stage of breast cancer.

Nevertheless, cases were similar to non-responders in the cancer registry in terms of clinical characteristics and nSES, making CHI participants generally representative of the underlying population of Asians with breast cancer in the San Francisco Bay Area. Future studies are needed to examine breast cancer risk longitudinally to consider survivorship.

Future work should examine differences in breast cancer risk among Chinese, Filipinos, and other Asian ethnic groupings. We could not disaggregate data in the Asian CHI sample due to small sample size. Chinese women made up the largest proportion of the sample. It is possible that these findings are driven by and most relevant to Chinese women. Data disaggregation is vital for future research, as studies show differences in breast cancer by Asian subgroup. For instance, one study disaggregating Asian American data found some of the highest incidence rates of breast cancer among U.S.-born Chinese and U.S.-born Filipina women, and the highest annual increases in breast cancer incidence among U.S.-born Filipinas and foreign-born Korean women [38].

Despite these limitations, this study has a major strength. Asian American people are often left out of larger U.S. population-based cancer studies due to their relatively small representation in national datasets. The case-control design of the Asian CHI dataset allowed for the in-depth examination of how neighborhood contexts were associated with breast cancer for Asian American women, while simultaneously accounting for individual-level risk factors. Very few other studies have examined neighborhood contexts and breast cancer diagnosis for Asian American women [13].

CONCLUSION

This study adds to a growing body of literature on how neighborhood contexts are associated with breast cancer risk in diverse populations. Living in high nSES ethnic

communities may exacerbate risk of breast cancer among Asian American women. Importantly, patterns of how neighborhood social contexts are associated with breast cancer are not uniform across racial/ethnic groups. More research is needed to determine how neighborhood contexts influence breast cancer risk, especially among diverse Asian American populations.

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Table 1. Descriptive statistics for selected variables by breast cancer status. Asian Community Health Initiative 2013-2014, n=508.

	Percent or mean (SD)		
VARIABLE	Total (n=508)	Cases: Women with breast cancer (n=118)	Controls: Women without breast cancer (n=390)
nSES & neighborhood ethnic composition			
High nSES-high ethnic	46.5	60.2	42.3
High nSES-low ethnic	22.2	16.1	24.1
Low nSES-high ethnic	27.8	20.3	30.0
Low nSES-low ethnic	3.5	3.4	3.6
Age			
20-39	9.1	1.7	11.3
40-59	61.2	55.1	63.1
60+	29.7	43.2	25.6
Asian ethnicity			
Chinese	56.1	60.2	54.9
Filipina	17.7	18.6	17.4
Other Asian	26.2	21.2	27.7
Marital status			
Married/cohabiting	68.5	66.1	69.2
Formerly married	17.1	22.0	15.6
Single	14.4	11.9	15.1
Survey language non-English	37.4	43.2	35.6
US-born	28.5	16.1	32.3
Has family history of breast cancer	16.1	24.6	13.6
Metropolitan urban	33.7	33.0	33.9
Education			
College graduate	62.0	60.2	62.6
Some college	18.9	17.0	19.5
<=High school	19.1	22.9	18.0
Employment			
Full time	42.9	37.3	44.6
Part time	19.5	12.7	21.5
Not employed	37.6	50.0	33.9
Homeowner	66.9	75.4	64.4
Mammogram frequency (times in past 10 years)	6.2 (4.0)	8.8 (2.9)	5.4 (4.0)
Age at menarche (years-old)	13.0 (1.8)	12.9 (1.7)	13.0 (1.8)
Menopausal status/hormone replacement therapy use			
Pre-menopausal	48.8	52.5	47.7
Post-menopausal, did not use hormone replacement therapy	42.1	32.2	45.1
Post-menopausal, used hormone replacement therapy	9.1	15.3	7.2

Pregnancy history			
Age at first birth <25	16.5	12.7	17.7
Age at first birth 25-29	27.4	37.3	24.4
Age at first birth 30-34	21.1	19.5	21.5
Age at first birth 35+	10.6	14.4	9.5
Never pregnant	24.4	16.1	26.9
Months breastfed[a]	11.4 (16.9)	11.5 (16.0)	11.4 (17.2)
Physical activity (average hours per week, past year)	5.1 (3.5)	5.1 (3.6)	5.1 (3.5)
Body mass index (kg/m^2)	23.7 (3.9)	23.6 (3.4)	23.7 (4.0)
Walkability (gamma index)	4.6 (0.7)	4.5 (0.7)	4.7 (0.7)
Number of recreational facilities	5.1 (7.3)	3.8 (5.4)	5.5 (7.8)
Number of parks	3.0 (2.6)	2.8 (2.6)	3.0 (2.6)

Notes. Not all percentages may add up to 100 due to rounding. SD = standard deviation. nSES = neighborhood socioeconomic status.

[a] Months breastfed is 0 for those who gave birth but never breastfed and for women who were never pregnant. Months breastfed are cumulative for women who gave birth to multiple children. Of those who gave birth, 17.1% never breastfed (19.0% of cases and 16.5% of controls).

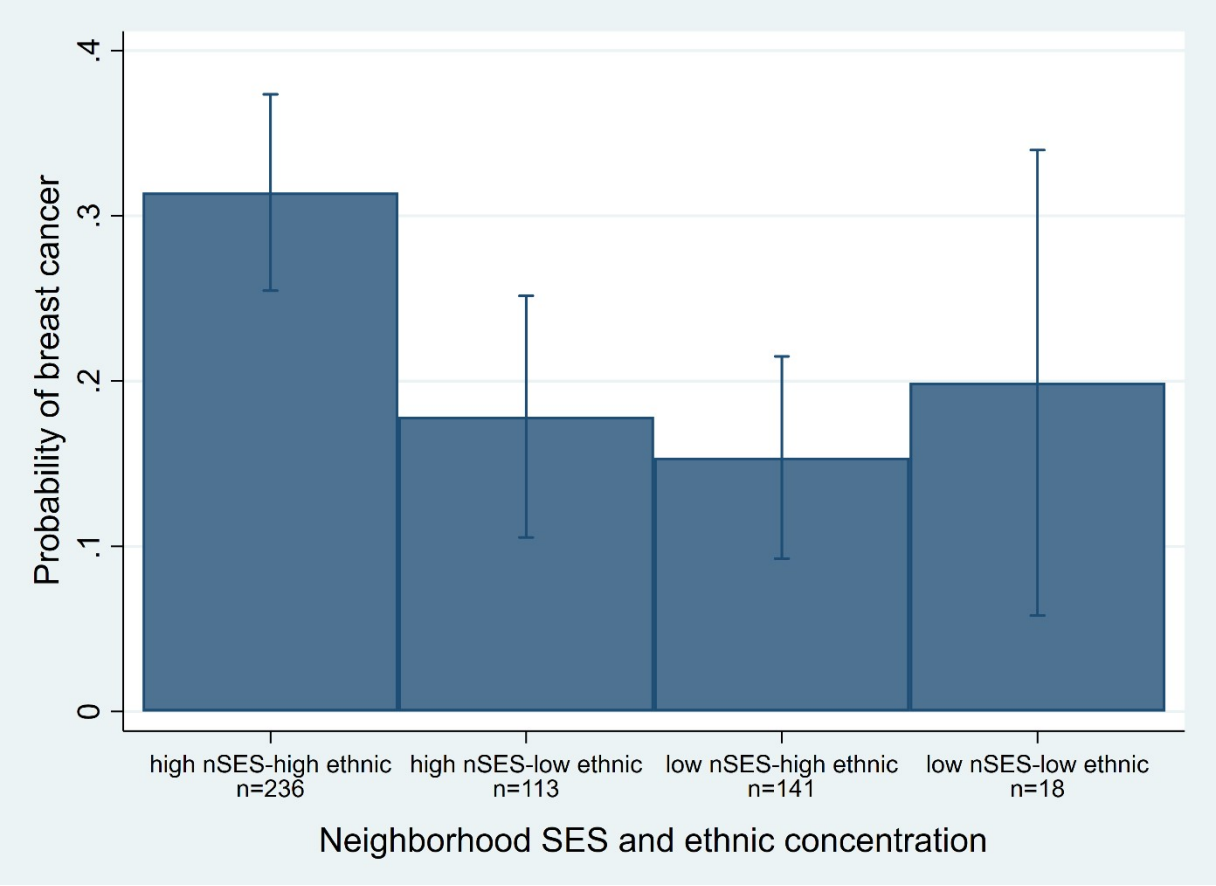
Table 2. Logistic regression showing odds of having breast cancer associated with neighborhood socioeconomic status, neighborhood ethnic composition, and covariates. Asian Community Health Initiative 2013-2014, n=508.

	Odds of having breast cancer					
VARIABLES	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
nSES & neighborhood ethnic composition (ref = high nSES-high ethnic)						
High nSES-low ethnic	0.44	(0.25 - 0.79)	0.44	(0.24 - 0.81)	0.34	(0.16 - 0.75)
Low nSES-high ethnic	0.43	(0.24 - 0.75)	0.40	(0.22 - 0.72)	0.37	(0.17 - 0.83)
Low nSES-low ethnic	0.54	(0.19 - 1.52)	0.51	(0.19 - 1.39)	0.97	(0.37 - 2.54)
Marital status (ref = married)						
Formerly married			1.13	(0.64 - 2.01)	1.71	(0.84 - 3.47)
Single			0.96	(0.48 - 1.93)	2.11	(0.72 - 6.16)
Survey language (ref = English)						
Non-English			0.85	(0.49 - 1.50)	1.05	(0.53 - 2.08)
Nativity (ref = foreign-born)						
U.S.-born			0.36	(0.19 - 0.67)	0.27	(0.11 - 0.64)
Family history of breast cancer (ref = none)						
Any immediate family member with breast cancer			1.96	(1.09 - 3.55)	1.60	(0.77 - 3.33)
Urbanicity (ref = suburb/town/rural)						
Metropolitan urban			0.97	(0.58 - 1.64)	1.12	(0.50 - 2.55)
Education (ref = college graduate)						
Some college					1.14	(0.50 - 2.60)
<=High school					2.38	(1.11 - 5.13)
Employment (ref = full time)						
Part time					0.56	(0.27 - 1.17)
Not employed					1.33	(0.74 - 2.37)
Homeownership (ref = homeowner)						
Non-homeowner					0.66	(0.32 - 1.36)
Mammogram frequency (times in past 10 years)					1.33	(1.20 - 1.47)
Age at menarche					0.93	(0.79 - 1.09)
Menopausal status/hormone replacement therapy (ref = pre-menopausal)						
Post-menopausal, no hormone replacement therapy					0.090	(0.037 - 0.22)
Post-menopausal, hormone replacement therapy use					0.13	(0.037 - 0.48)
Pregnancy history (ref = age at first birth <25)						
Age at first birth 25-29					2.95	(1.23 - 7.09)
Age at first birth 30-34					2.02	(0.71 - 5.74)

Age at first birth 35+	6.06	(1.75 - 21.0)
Never pregnant	0.93	(0.27 - 3.23)
Months breastfed	1.00	(0.98 - 1.02)
Physical activity (average hours per week, past year)	1.06	(0.98 - 1.15)
Body mass index (kg/m^2)	1.03	(0.95 - 1.13)
Walkability (gamma index)	0.96	(0.57 - 1.62)
Number of recreational facilities (sqrt)	0.60	(0.42 - 0.86)
Number of parks (sqrt)	1.32	(0.82 - 2.14)

Notes. OR = odds ratio; CI = confidence interval; nSES = neighborhood socioeconomic status; ref = reference category; sqrt = square root. Model 1 examines associations between nSES, neighborhood ethnic composition, and breast cancer. Model 2 accounts for the control variables. Model 3 adds potential mediators to Model 2. All models additionally controlled for age and Asian ethnicity, but these ORs are not shown above because the case and control sample were matched on these factors, so interpretations of these ORs are not meaningful.

Figure 1. Probability of having breast cancer by neighborhood socioeconomic status and neighborhood ethnic composition. Asian Community Health Initiative 2013-2014, n=508.



NOTE: nSES = neighborhood socioeconomic status. Vertical lines represent 95% confidence intervals. Probabilities of breast cancer were based on Table 2, Model 2, and control for age, Asian ethnicity, marital status, survey language, nativity, family history of breast cancer, and urbanicity.

Table 3. Estimates of mediation by potential mediating variables of the association between neighborhood socioeconomic status, neighborhood ethnic composition, and odds of having breast cancer. Asian Community Health Initiative 2013-2014, n=508.

	Estimates of the mediated effect explaining differences in having breast cancer between residents of neighborhoods with:					
	high nSES-high ethnic composition vs. high nSES-low ethnic composition		high nSES-high ethnic composition vs. low nSES-high ethnic composition		high nSES-high ethnic composition vs. low nSES-low ethnic composition	
POTENTIAL MEDIATORS	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
ALL POTENTIAL MEDIATORS	-0.11	(-1.04 - 0.81)	-0.32	(-1.27 - 0.64)	-0.95	(-1.95 - 0.05)
All Individual SES Factors	-0.01	(-0.26 - 0.24)	0.00	(-0.30 - 0.29)	-0.20	(-0.51 - 0.10)
Education	0.00	(-0.13 - 0.14)	0.12	(-0.06 - 0.31)	-0.01	(-0.14 - 0.13)
Employment	0.01	(-0.18 - 0.19)	-0.05	(-0.24 - 0.14)	-0.17	(-0.43 - 0.09)
Homeownership	-0.02	(-0.13 - 0.08)	-0.08	(-0.23 - 0.08)	-0.02	(-0.13 - 0.08)
Mammogram Frequency	-0.13	(-0.79 - 0.52)	-0.11	(-0.76 - 0.56)	-0.40	(-1.07 - 0.26)
All Individual-level or Behavioral Risk Factors	0.07	(-0.50 - 0.65)	0.02	(-0.56 - 0.60)	-0.21	(-0.84 - 0.43)
Age of menarche	0.02	(-0.06 - 0.11)	-0.03	(-0.12 - 0.07)	-0.02	(-0.09 - 0.06)
Menopausal status/hormone replacement therapy	-0.06	(-0.50 - 0.38)	-0.05	(-0.50 - 0.39)	-0.12	(-0.57 - 0.33)
Pregnancy history	0.06	(-0.26 - 0.38)	0.07	(-0.25 - 0.39)	-0.24	(-0.65 - 0.17)
Months breastfed	0.00	(-0.03 - 0.03)	0.00	(0.00 - 0.00)	0.00	(-0.12 - 0.12)
Physical activity	0.02	(-0.11 - 0.16)	0.01	(-0.13 - 0.14)	0.07	(-0.09 - 0.23)
BMI	0.01	(-0.06 - 0.08)	0.04	(-0.07 - 0.14)	0.02	(-0.06 - 0.09)
All Built Environment Factors	-0.01	(-0.28 - 0.26)	-0.01	(-0.28 - 0.27)	0.05	(-0.24 - 0.33)
Walkability	0.00	(-0.03 - 0.04)	0.00	(-0.02 - 0.02)	0.00	(-0.04 - 0.04)
Number of recreational facilities (sqrt)	-0.04	(-0.29 - 0.22)	0.02	(-0.23 - 0.28)	0.09	(-0.17 - 0.35)
Number of parks (sqrt)	-0.03	(-0.12 - 0.07)	0.04	(-0.07 - 0.16)	0.06	(-0.07 - 0.19)

NOTE: nSES = neighborhood socioeconomic status. CI = confidence interval. BMI = body mass index. All models additionally account for age, marital status, Asian ethnicity, survey language, nativity, family history of breast cancer, urbanicity, and all other potential mediating variables. The mediated effects (a.k.a. indirect effects) were estimated using the KHB method in Stata v.15. Note that all of the 95% confidence intervals for the mediated effects overlap with zero.