Title

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Journal

Cancer Epidemiology, Biomarkers & Prevention, 33(5)

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Publication Date

2024-05-01

DOI

10.1158/1055-9965.EPI-23-0386

Peer reviewed

HHS Public Access

Author manuscript

Cancer Epidemiol Biomarkers Prev. Author manuscript; available in PMC 2024 November 01.

Published in final edited form as:

Cancer Epidemiol Biomarkers Prev. 2024 May 01; 33(5): 694–702. doi:10.1158/1055-9965.EPI-23-0386.

Differences in Smoking Behavior by Nativity, Race/Ethnicity, and Education Among Women Diagnosed with Breast Cancer

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Abstract

Background: We evaluated smoking differences across nativity and race/ethnicity among women diagnosed with breast cancer.

Methods: In our Northern Californian pooled population of 5,653 [670 Asian, 690 Hispanic, and 4,300 Non-Hispanic White (White)] women diagnosed with breast cancer, we evaluated smoking differences across nativity, race/ethnicity, and acculturation and effect modification of nativity by race/ethnicity and education.

Results: Foreign-born women currently smoked less than US-born women [odds ratio (OR) = 0.46, 95% confidence limit (CL): 0.29, 0.72]. Hispanic (OR = 0.50, 95% CL: 0.32, 0.78) women currently smoked less than White women. Among those who ever smoked (n = 2,557), foreign-born women smoked 5.23 fewer pack-years (PY) than US-born women (95% CL: −2.75, −7.70). Furthermore, Asian (−4.60, 95% CL: −0.81, −8.39) and Hispanic (−6.79, 95% CL: −4.14, −9.43) women smoked fewer PY than White women. Associations were generally suggestive of greater smoking with greater acculturation (immigration age, US years, survey language). Finally, associations for nativity differed by education but not race/ethnicity, with a higher likelihood of smoking in US-born women only among those with less than a bachelor's degree (OR = 2.84, 95% CL: 2.15, 3.77) (current smoking: $p = 0.01$, PY: $p = 0.05$).

Conclusions: Asian and Hispanic (vs. White) and foreign-born (vs. US-born) breast cancer survivors reported fewer smoking behaviors. Smoking differences across nativity and education were driven by higher rates of smoking in US-born women with lower educational attainment.

Impact: Smoking behavioral patterns were similar among breast cancer survivors and the general population, informing potential smoking interventions.

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Author's contributions

S.P. Uong provided data analysis and interpretation and drafted the manuscript. B.J. Caan and L.H. Kushi provided funding for data collection, study data, and critical revision of the manuscript. B.N. Morey, J. Torres, and S. Alexeeff provided critical revision of the manuscript. C.H. Kushi provided funding, conception and design of the work, study data, data analysis and interpretation, manuscript drafting, and critical revision of the manuscript. All authors provided final approval of the manuscript.

Conflict of interest: The authors have no conflict of interest to disclose.

INTRODUCTION

In the United States (US), breast cancer is the most common cancer diagnosis in Asian and Hispanic women, with an increasing incidence among Asian American women (1–3). A growing number of studies show that cigarette smoking, measured either as current or lifetime smoking (pack-years), is related to higher risks of breast cancer incidence and mortality (4–7).

Given the smoking impacts on breast cancer risk and variation among women across countries, it is important to study differences in smoking behaviors across race, ethnicity, and nativity (8,9). Studies in the general US population have consistently shown that immigrants (characterized by nativity, self-identification, or levels of acculturation (10,11)) have a lower smoking prevalence compared to US-born people (12,13). A nationally-representative annual household survey of people 12 years and older showed that there was a lower smoking prevalence in 2010–2013 among Asian or Hispanic compared to White women (14). Lower smoking prevalence among Asian, Hispanic, and immigrant people, especially among women, have been attributed to differences in cultural and gender norms (15–18). Furthermore, a previous study using national US data suggested that smoking prevalence differed by both immigrant status and country of birth, and a systematic review and meta-analysis showed that smoking was more common with greater levels of acculturation among Asian immigrants and Mexican women (15,19,20).

There is sparse information about nativity and racial/ethnic smoking differences among breast cancer survivors. A systematic review indicated that current smoking among survivors is more strongly associated with breast cancer mortality than formerly smoking among survivors, a difference that may further vary by nativity and race/ethnicity (4). A national study using the 2009 Behavioral Risk Factor Surveillance System reported less smoking among Hispanic (16.2%) compared to White (33.7%) breast cancer survivors but aggregated Asian survivors in an “other” category (21). However, no prior studies to our knowledge have evaluated the relationship between nativity with smoking behavior among women diagnosed with breast cancer. Studying patterns of smoking behaviors by race, ethnicity, and nativity may help inform where resources need to be targeted to reduce smoking, particularly given the higher motivation patients have to quit smoking after a cancer diagnosis (22,23). In these studies, it is important to include diverse study populations that captures variation in immigration and acculturation experiences across racial/ethnic groups.

Therefore, in a pooled study of two Kaiser Permanente Northern California (KPNC) breast cancer cohorts with high representation of Asian and Hispanic women, we assessed the relationship between nativity and smoking. Consistent with previous literature in more general populations, we hypothesized that foreign-born (vs. US-born) and Asian and Hispanic (vs. Non-Hispanic White) women would be less likely to smoke and to smoke fewer pack-years. We had the ability to consider associations in more specific racial/ethnic groups, a limitation in prior studies (13). Though traditions and norms for behaviors may explain why immigrant women in prior studies may be less likely to smoke, educational attainment powerfully shapes whether people take up smoking in the US (24). We therefore further evaluated potential effect modification of this association by educational attainment.

Finally, we considered how smoking varied across markers of acculturation, including years in the US, age at when women immigrated, and language of survey completion.

MATERIALS AND METHODS

Study Population

The study included women diagnosed with breast cancer within the KPNC population who participated in the Life After Cancer Epidemiology (LACE) and Pathways Study cohorts. Previous studies have described the LACE and Pathways cohorts in detail, including descriptions about recruitment methods and study characteristics (25,26). Briefly, the LACE cohort included women aged 18–79 years who were diagnosed with invasive breast cancer (American Joint Committee on Cancer (AJCC) stage I with tumor size ≥ 1 cm, II, or IIIA) from 1997 to 2000 (27,28). Study staff recruited women who had no self-reported breast cancer recurrence 11–39 months after their breast cancer diagnosis. At study enrollment, the women had completed adjuvant cancer treatment and had no previous diagnoses of other cancer within the previous 5 years. The Pathways Study included women aged 21 years or older with a recent (usually within two months) invasive breast cancer diagnosis of any stage from 2005 to 2013. All participants provided informed written consent. Our research was conducted in accordance with the Declaration of Helsinki and approved by the KPNC Institutional Review Board. We included only Asian, Hispanic, and Non-Hispanic White women (N = 5,708) due to the low numbers of foreign-born women across other racial/ethnic groups across the study populations, such as Black and Pacific Islander women. Of these women, we excluded the following number of women due to missingness for a final study population of 5,663 women: 15 for smoking status, 49 for nativity, and 2 for educational attainment. Our analyses of pack-years of smoking included women who had ever smoked (N = 2,556).

Nativity and Acculturative Factors

We categorized study participants as foreign- or US-born based on their self-report of their country (Pathways) or region (LACE) of birth at study baseline. Furthermore, questions were asked about acculturation only among Pathways participants, which allowed us to create measures of dichotomous age at immigration (<18 or ≥18 years of age), length of US residence (calculated difference between ages at study baseline and immigration), and language of survey completion (English or Spanish/Chinese).

Race/Ethnicity

In the Pathways Study, staff asked participants if they identified as: American Indian or Alaska Native, Asian, Black/African American, Native Hawaiian or Pacific Islander, White, or another race. Participants further reported if they identified as Latina or Hispanic and their specific ethnic group (e.g., Chinese, Filipina, Mexican, among others). In the LACE Study, staff asked participants if they identified as: Hispanic or Non-Hispanic Black/African American, Hispanic or non-Hispanic White, Middle Eastern, Asian (Chinese, Japanese, Korean, Vietnamese), East Indian (Indian, Pakistani, Sri Lankan), Pacific Islander/Hawaiian, American Indian or Alaskan Native, or another race. We categorized women in broad (Asian, Hispanic, and Non-Hispanic White) and more specific (only partially disaggregated

categories in Pathways participants- Chinese, Filipina, Mexican, Non-Hispanic White- due to low sample sizes in other ethnic groups) racial/ethnic categories.

Smoking Outcomes

Participants reported their smoking behaviors at baseline: their smoking status as current, past, or never, average number of cigarettes smoked per day, and years of smoking. We defined ever smoking as having smoked at least 100 cigarettes across the lifetime (5-pack equivalent). For our current smoking analysis, we defined "current smoking" as reporting smoking at study baseline and "not currently smoking" as never smoking or smoking in the past. For our second set of analyses among those who ever smoked, we calculated smoking pack-years from questions asking about the average number of cigarettes smoked per day and years of smoking (computed as the difference of age of initiation and age at quitting). We considered twenty cigarettes smoked every day for one year as one pack-year.

Confounders, Effect Modifiers, and Other Relevant Characteristics

At study baseline, we collected self-reported data on educational attainment, which we categorized as less than or at least a bachelor's level education. We obtained data on cancer-related characteristics from the KPNC Cancer Registry, including age at breast cancer diagnosis, breast cancer diagnosis date, AJCC stage, hormone receptor status (estrogen receptor or progesterone receptor positive), and lymph node status. Finally, we considered age at diagnosis, study, days between diagnosis and baseline date, and educational attainment as confounders as we conceptualized them to be related to our exposures and outcomes of interest in a way that would introduce a spurious association without adjustment (29).

Statistical Analysis

First, we performed descriptive analyses, summarizing study population characteristics by nativity (foreign- and US-born) and race/ethnicity (Asian, Hispanic, and Non-Hispanic White) (Table 1). In primary analyses, we examined how nativity, race/ethnicity, and acculturation factors were associated with current smoking and pack-years of smoking. We fitted logistic regression models to calculate odds ratios (ORs) between nativity and race/ethnicity with current smoking among all women in the study (Table 2). Next, we fitted linear regression models to calculate estimates between nativity and race/ethnicity with smoking pack-years among women who ever smoked (Table 3). Further analyses included comparing both smoking outcomes in separate statistical models across more specific racial/ethnic categories (Chinese, Filipina, Mexican, Non-Hispanic White, or other ethnicity) and acculturation measures (age of immigration to the US by age 18, years in the U.S, and language of survey completion) (Tables 2 and 3). Finally, we assessed effect modification of nativity and both smoking outcomes by 1) race/ethnicity and 2) education with likelihood-ratio tests and a significance level of 0.05. First, we adjusted for age at diagnosis in minimally adjusted models and all of our conceptualized confounders in fully adjusted models (age at diagnosis, study, days between diagnosis and baseline date, and educational attainment).

Due to differences that may result in varied associations across the two study populations that compose our pooled cohort such as the timing of smoking, we assessed for heterogeneity across study using the DerSimonian and Laird's *Q* test (30,31). Because there was no evidence of heterogeneity of associations by study *(p-heterogeneity* = 0.39 for nativity and current smoking and *p-heterogeneity* = 0.79 for nativity and smoking pack-years), we combined the cohorts and reported pooled results. We assessed differences in smoking between Asian and Hispanic women and varying levels of acculturation among foreign-born women (age at immigration, length of US residence, and survey language) by calculating contrasts between marginal means with the *marginaleffects* R package. All analyses were conducted in SAS 9.4 and R 3.6.3.

Data Availability

The data generated in this study contains protected health information and therefore are not publicly available. The data are available upon request from the Pathways Study team and the senior author.

RESULTS

Of the 5,663 women in our study, there were 690 (12.2%) Asian, 673 (11.9%) Hispanic, and 4,300 (75.9%) Non-Hispanic White women and 3,029 (53.5%) with less than and 2,634 (46.5%) with at least a Bachelor's-level education (Table 1). A higher percentage (73%, n = 504) of Asian and Hispanic (39%, n = 264) women were foreign-born compared to Non-Hispanic White women (9%, n = 366). Furthermore, there were similar percentages of foreign-born women across educational attainment levels [19% (n = 582) among women with less than and 21% (n = 552) among women with at least a Bachelor's degree]. The overall mean age at breast cancer diagnosis was 59 years (SD = 12). Asian (53 ± 11 years) and Hispanic (55 ± 12 years) women tended to be diagnosed at a younger age compared to Non-Hispanic White women (61 ± 11 years). Descriptively, current smoking prevalence tended to be lower among foreign-born compared to US-born women [2.5% (n = 28) vs. 6.2% (n = 283)] and Asian and Hispanic women compared to Non-Hispanic White women [2.5% (n = 17) and 3.7% (n = 25) vs. 6.3% (n = 269), respectively]. Similarly, former smoking prevalence tended to be lower among foreign-born compared to US-born women [24.6% (n = 279) vs. 43.4% (n = 1,966)] and Asian and Hispanic women compared to Non-Hispanic White women [15.1% (n = 104) and 33.3% (n = 224) vs. 44.6% (n = 1,917), respectively].

Current Smoking

The prevalence of current smoking was 5.5% (n = 311) among all women in the study. We summarized associations between nativity and race/ethnicity with current smoking in Table 2. Associations were similar whether the models were age- and fully-adjusted. Foreign-born women had a 0.46 times lower odds of currently smoking compared to US-born women [2.5% vs 6.2%; 95% confidence limit (CL): 0.29, 0.72 in fully-adjusted models]. Hispanic (3.7% vs. 6.3%, OR = 0.50; 95% CL: 0.32, 0.78) women had lower odds of currently smoking compared to Non-Hispanic White women (Table 2). Current smoking did not differ between Asian and Hispanic women ($p = 0.59$). Associations using more specific

racial/ethnic categories (Chinese, Filipina, Mexican, and Non-Hispanic White) did not differ substantially from primary analyses using broader racial/ethnic categories (Asian, Hispanic, Non-Hispanic White). There were suggestive lower odds of current smoking among Mexican (OR = 0.51, 95% CI: 0.26, 0.99) women compared to Non-Hispanic White women. Compared US-born women, foreign-born women who immigrated to the US at age 18 or after (0.46, 95% CL: 0.24, 0.90) and lived in the US for 0–23 years (0.36, 95% CL: 0.14, 0.97) had lower odds of currently smoking. Statistically non-significant results for Chinese, Filipina, and other subsets of foreign-born women are shown in Table 2.

Associations between nativity and current smoking did not differ by race/ethnicity (*p-value, test for effect modification* = 0.64; Figure 1) but differed strongly by educational attainment (*p-effect modification* = 0.01) (Figure 2). Among women with less than a bachelor's degree, we found an even lower odds of smoking among foreign-born compared to US-born women (OR 0.32, 95% CI 0.18, 0.58). Among women with at least a bachelor's degree, however there was no difference in the odds of current smoking for foreign-born compared to US-born women (OR 0.96, 95% CL: 0.50, 1.83) (Figure 2).

Smoking Pack-Years

Of all the women in our study, 45.1% (n = 2,556 of 5,666) reported ever smoking. Associations with pack-years of smoking (for women who ever smoked) were also similar whether the models were age- or fully-adjusted. In fully-adjusted models, foreign-born women smoked 5.23 fewer pack-years (95% CL: −2.75, −7.70) than US-born women on average. Additionally, on average, Asian women smoked 4.60 fewer pack-years (95% CL: −0.81, −8.39) and Hispanic women smoked 6.79 fewer pack-years (95% CL: −4.14, −9.43) than did Non-Hispanic White women (Table 3). Smoking pack-years did not differ between Asian and Hispanic women ($p = 0.32$). There was suggestive fewer reported pack-years among Mexican (−7.62, 95% CI: −11.55, −3.68) women compared to Non-Hispanic White women. Compared US-born women, foreign-born women who immigrated to the US at age 18 or after (−5.96, 95% CL: −9.55, −2.38), lived in the US for at least 39 years (−5.83, 95% CL: −9.72, −1.94), and completed the study survey in Chinese or Spanish (−11.56, 95% CL: −21.56, −1.56) reported smoking fewer pack-years. Statistically non-significant results for Chinese, Filipina, and other subsets of foreign-born women are shown in Table 3.

Associations between nativity and smoking pack-years did not differ by race/ethnicity (*p-effect modification* = 0.67; Figure 1) but differed by educational attainment (*p-effect modification* = 0.05) (Figure 2). Similar to current smoking, we found an even stronger association for foreign-born compared to US-born women among those with less than a bachelor's degree (6.91 fewer pack years, 95% CL: −3.75, −10.06). Among women with at least a bachelor's degree, however there was no difference in the number of pack-years among foreign-born compared to US-born women (−2.20, 95% CL: −5.87, 1.47) (Figure 2).

DISCUSSION

In a pooled cohort of women diagnosed with breast cancer, foreign-born women were less likely to currently smoke and smoked fewer pack-years than US-born women. Race/ethnicity was independently associated with smoking outcomes; Asian and Hispanic women

were less likely to currently smoke and smoked fewer pack-years than Non-Hispanic White women. Furthermore, there was suggestion of lower odds of current smoking and fewer pack-years smoked among Chinese and Mexican women (vs. Non-Hispanic White women) with greater levels of acculturation as indicated by age of immigration, years lived in the US, and language of survey completion. We did not observe effect modification of nativity and smoking by race/ethnicity for either outcome. However, associations were apparent only among those of lower educational attainment. To our knowledge, this is the first study evaluating differences in smoking behavior by immigrant status among women diagnosed with breast cancer.

Our observations of fewer smoking behaviors among foreign-born (vs. US-born) women Asian and Hispanic (vs. Non-Hispanic White) women suggests that differences in smoking by nativity and race/ethnicity is similar among women with breast cancer and the general population (12–14). Furthermore, greater levels of smoking observed with high levels of acculturation was similarly observed in our population of women with breast cancer, consistent with previous studies of Asian and Latina women in general populations (15,19,20,32). These results are consistent with previous literature that have investigated the “healthy immigrant effect,” where immigrants have been observed to have better health on average than people born in their country of origin or host country (33,34). Lower levels of smoking we observed among foreign-born compared to US-born women in our study population is consistent with the healthy immigrant effect, with the effect decreasing among those who experienced higher levels of acculturation (34). With a higher rate of breast cancer mortality from current smoking, women diagnosed with breast cancer would benefit from smoking cessation interventions (4,35). Understanding that patterns in smoking behaviors across race, ethnicity, and nativity among women diagnosed with breast cancer parallels women in the general population would inform how these interventions may be targeted, especially considering that smoking was more common among women experiencing higher levels of acculturation. As immigrant women further acculturate to the US, increases in smoking behaviors that we see in our study may manifest in greater breast cancer mortality among these women.

Interestingly, smoking was lower in all immigrant groups regardless of race/ethnicity in our study, suggesting that gendered smoking norms may consistently discourage smoking among Asian, Hispanic, and Non-Hispanic White women who were foreign-born compared to those who were US-born around the world. We did not notice differences in smoking comparing Hispanic and Asian women and across more specific ethnic groups. However, our analysis was underpowered, and a previous study using a nationally-representative household survey of people aged 12 and older suggested that smoking varied across Asian and Hispanic women and across more specific ethnic groups within those racial and ethnic groups (14). Furthermore, previous studies have suggested that fewer smoking behaviors observed in Asian and Hispanic people, especially women are heavily influenced by cultural and gender norms (15–18).

Additionally, we observed stronger associations between nativity and smoking among those a low level of educational attainment (less than a Bachelor’s level education) but no association among those with a high level of educational attainment (at least a Bachelor’s

level education), a similar difference seen a previous cross-sectional study using national data (24). This is consistent with smoking norms in the US which are powerfully shaped by social networks characterized by levels of educational attainment, a relationship that may be similar in other high income countries but may differ in low and middle income countries where disparities in socioeconomic status (SES) may be more mixed (36–38). Some researchers have explained variation in smoking inequities across countries through a cigarette epidemic model that proposes that after tobacco is introduced to a country, its use is first primarily characterized by gender disparities before transitioning to primarily SES disparities in later stages. (37). Previous studies using the model have generally categorized Asian and Latin American countries as being in an earlier stage that characterized by high levels of smoking in men compared to women and with lower SES disparities (39,40). It is possible that we did not see an SES difference in smoking behaviors among foreign-born women because most immigrant women in our study were born in Mexico, China, and the Philippines, countries in earlier stages of the cigarette epidemic where SES disparities in smoking among women may not have emerged. Related to this, differences in cultural norms by immigrant status may be protective against adoption of smoking behavior among immigrant women of low SES (24).

Strengths of our study include a large population of women from KPNC, who are representative of the underlying population of patients (compared to academic medical centers) and of people in the Northern California geographic region (except for people who are very poor and very wealthy) (41–43). As a result, we were able to include diverse immigrant women in our study when we pooled breast cancer survivors across the two studies. In contrast, many prior studies have focused on single ethnic groups or have been limited in their ability to assess how associations between nativity and smoking differ across race/ethnic groups (13). Secondly, we were able to evaluate associations with both current smoking and pack-years of smoking, a measure of lifetime exposure to smoking. Prior studies that included diverse immigrant groups observed less current smoking among immigrant groups across several different regions and countries of origin compared to those who were US-born, but did not investigate smoking pack-years (9,44). Lifetime measures of smoking, such as smoking pack-years, may be better predictors of subsequent mortality rather than smoking status alone among breast cancer survivors (45).

One limitation was that our study was not sufficiently powered to evaluate statistical differences across more specific racial and ethnic groups and different levels of acculturation. Despite this limitation, suggestive differences were consistent with previous literature and supported our overall findings. Second, women in our study may have underreported smoking behaviors. Previous studies that compared self-reports of smoking behaviors with biomarker data (i.e., cotinine concentrations) found that smoking was underreported among various subpopulations, including Hispanic people living in New Mexico, Mexican Americans, and Southeast Asian immigrant women (46–48). Due to the lack of biomarker data available in our study, we were unable to make similar assessments in our study. We recommend that future assessments of smoking behaviors among racially and ethnically minoritized and immigrant women assess potential underreporting of smoking behaviors. Although we conducted this study in a large, pooled cohort with large numbers of racially and ethnically diverse women, we recommend even larger studies and longitudinal

studies examining changes in smoking behavior following a breast cancer diagnosis and possible impact of changing smoking behaviors on breast cancer outcomes across race, ethnicity, and nativity. This would allow for further examination of diverse groups by specific race and ethnic grouping and countries of origin. Finally, our findings reflect historic (early 2000s for LACE participants and 2005–2013 for Pathways participants) rather than more recent comparisons in smoking behaviors across race, ethnicity, and nativity among women diagnosed with breast cancer. Although our study does not answer the question as to whether these differences still persist today among those who have been recently diagnosed, there are still opportunities to prevent breast cancer mortality among those diagnosed during our study period. A life course approach to population health posits the importance of understanding the behavioral trajectories of individuals, among other factors (e.g., social, biological, psychological) in preventing adverse health outcomes (49). Our study findings would inform future studies that consider historic comparisons in understanding smoking behavior trajectories and adverse outcomes among breast cancer survivors.

Conclusion

In a pooled study of women with breast cancer, foreign-born women were less likely than US-born women to report smoking behaviors. Furthermore, Asian and Hispanic women were less likely to report smoking behaviors compared to Non-Hispanic White women. The association between nativity and smoking appeared to be driven by higher rates of smoking in US-born women with lower educational attainment.

ACKNOWLEDGEMENTS

We would like to thank Scarlett Lin Gomez for her feedback on the conceptualization of the study and analysis. Research reported in this publication was supported by the following grants from the National Cancer Institute of the National Institutes of Health. All authors were supported by NCI grant R01CA230440, L.H. Kushi was supported by NCI grants R01CA105274 and U01CA195565, and B.J. Caan was supported by NCI grant R01CA129059. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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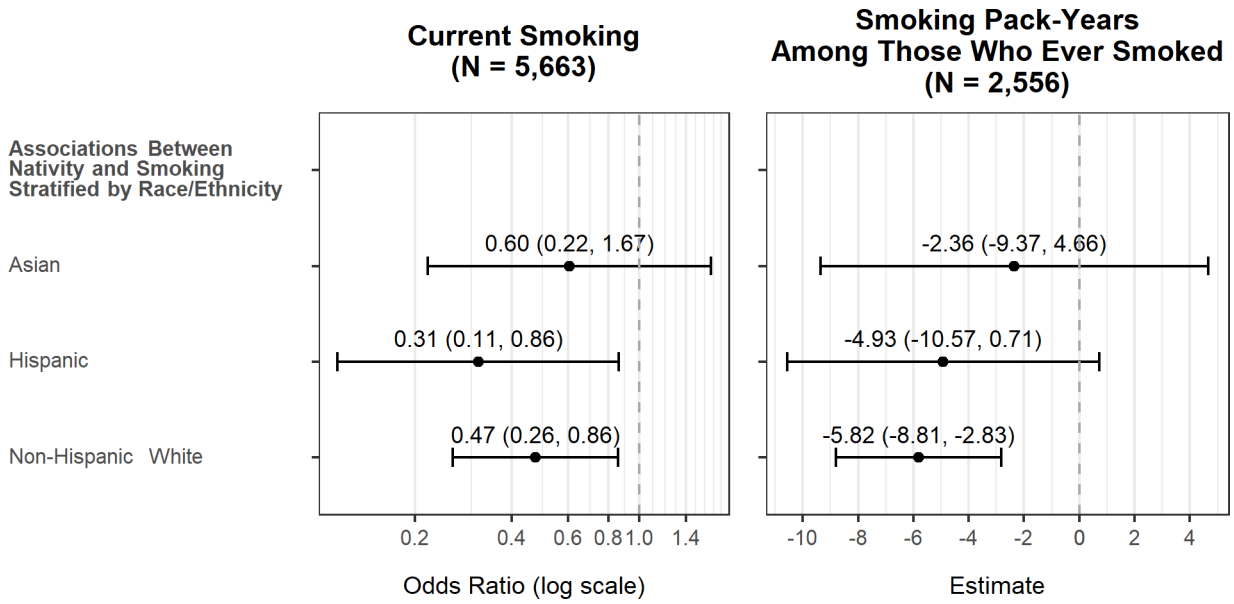

Figure 1. Associations Between Nativity and Smoking Behavior Stratified by Race/Ethnicity Among Women Diagnosed with Breast Cancer, Kaiser Permanente Northern California, LACE (1997–2000) and Pathways (2005–2013) Study Cohorts.

The figure shows associations between nativity [foreign- vs. US-born (ref)] and smoking behavior stratified by race/ethnicity. Stratified associations were obtained from a model with an interaction term between nativity and race/ethnicity and adjustment for continuous age at diagnosis, study, days between diagnosis and baseline dates, and education. Of the 690 Asian women in the study, 2.2% (n = 11) of foreign-born and 3.2% (n = 6) of US-born women currently smoked. Of the 673 Hispanic women in the study, 1.9% (n = 5) of foreign-born and 4.9% (n = 20) of US-born women currently smoked. Of the 4,300 non-Hispanic White women in the study, 3.3% (n = 12) of foreign-born and 6.5% (n = 257) of US-born women currently smoked. Overall, associations between nativity and smoking behavior did not differ by race/ethnicity (current smoking: *p-effect modification* = 0.64; smoking pack-years: *p-effect modification* = 0.67).

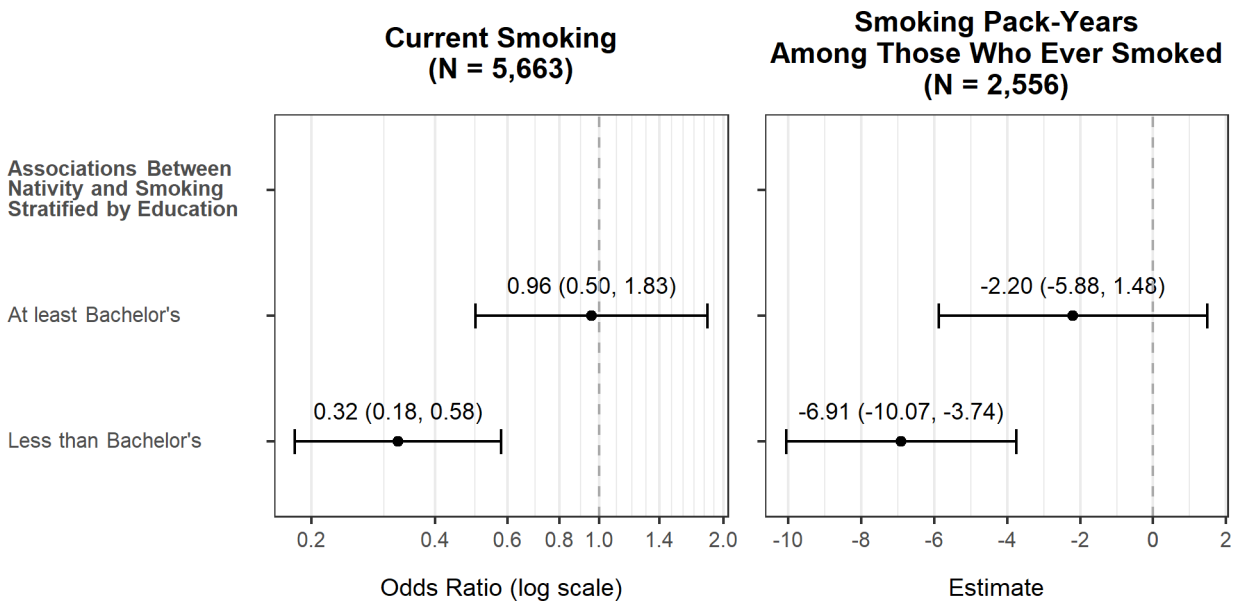

Figure 2. Associations Between Nativity and Smoking Behavior Stratified by Education Among Women Diagnosed with Breast Cancer, Kaiser Permanente Northern California, LACE (1997–2000) and Pathways (2005–2013) Study Cohorts.

The figure shows associations between nativity [foreign- vs. US-born (ref)] and smoking behavior stratified by educational attainment. Stratified associations were obtained from a model with an interaction term between nativity and education and adjustment for adjusted for race/ethnicity, continuous age at diagnosis, study, days between diagnosis and baseline dates. Of the 2,634 women with at least a Bachelor's-level education in the study, 2.5% (n = 14) of foreign-born and 3.5 % (n = 72) of US-born women currently smoked. Of the 3,029 women with less than a Bachelor's-level education in the study, 2.4% (n = 14) of foreign-born and 8.6 % (n = 211) of US-born women currently smoked. Associations between nativity and smoking behavior differed by educational attainment (current smoking: *p-effect modification* < 0.05; smoking pack-years: *p-effect modification* < 0.05).

Table 1.

Characteristics of Women Diagnosed with Breast Cancer by Nativity and Race/Ethnicity, Kaiser Permanente Northern California, LACE (1997–2000) and Pathways (2005–2013) Cohorts

Characteristics	Overall (N = 5,663)	Nativity (N, %)		Race/Ethnicity (N, %)		
		Foreign-Born (N = 1,134)	US-Born (N = 4,529)	Asian (N = 690)	Hispanic (N = 673)	Non-Hispanic White (N = 4,300)
Study Enrollment						
LACE	1,648 (29.1%)	231 (20.4%)	1,417 (31.3%)	113 (16.4%)	119 (17.7%)	1,416 (32.9%)
Pathways	4,015 (70.9%)	903 (79.6%)	3,112 (68.7%)	577 (83.6%)	554 (82.3%)	2,884 (67.1%)
Days Between Diagnosis and Baseline Date						
< 52	1,508 (26.6%)	329 (29.0%)	1,179 (26.0%)	205 (29.7%)	199 (29.6%)	1,104 (25.7%)
52 – <76	1,521 (26.9%)	360 (31.7%)	1,161 (25.6%)	224 (32.5%)	211 (31.4%)	1,086 (25.3%)
46 – <520	1,472 (26.0%)	268 (23.6%)	1,204 (26.6%)	178 (25.8%)	175 (26.0%)	1,119 (26.0%)
520 or more	1,162 (20.5%)	177 (15.6%)	985 (21.7%)	83 (12.0%)	88 (13.1%)	991 (23.0%)
Age at Diagnosis						
Mean (SD)	59 (12)	56 (12)	60 (12)	53 (11)	55 (12)	61 (11)
Nativity						
Foreign-Born	1,134 (20.0%)	-	-	504 (73.0%)	264 (39.2%)	366 (8.5%)
US-Born	4,529 (80.0%)	-	-	186 (27.0%)	409 (60.8%)	3,934 (91.5%)
Region of Birth [2]						
East Asia	185 (3.3%)	-	-	177 (25.7%)	-[3]	-[3]
Central America and Mexico	204 (3.6%)	-	-	0 (0%)	194 (28.8%)	10 (0.2%)
Pacific Islands and the Philippines	258 (4.6%)	-	-	239 (34.6%)	-[3]	-[3]
USA	4,529 (80.0%)	-	-	186 (27.0%)	409 (60.8%)	3,934 (91.5%)
Other	486 (8.6%)	-	-	88 (12.8%)	53 (7.9%)	345 (8.0%)
Education						
Less than Bachelor's	3,029 (53.5%)	582 (51.3%)	2,447 (54.0%)	230 (33.3%)	498 (74.0%)	2,301 (53.5%)
At least Bachelor's	2,634 (46.5%)	552 (48.7%)	2,082 (46.0%)	460 (66.7%)	175 (26.0%)	1,999 (46.5%)
AJCC Stage [4]						
Stage I	2,981 (52.6%)	588 (51.9%)	2,393 (52.8%)	369 (53.5%)	334 (49.6%)	2,278 (53.0%)
Stage II	2,190 (38.7%)	441 (38.9%)	1,749 (38.6%)	264 (38.3%)	266 (39.5%)	1,660 (38.6%)
Stage III or IV	492 (8.7%)	105 (9.3%)	387 (8.5%)	57 (8.3%)	73 (10.8%)	362 (8.4%)
Hormone Receptor Positive	4,801 (84.8%)	947 (83.5%)	3,854 (85.1%)	583 (84.5%)	551 (81.9%)	3,667 (85.3%)
Node positive	1,774 (31.3%)	374 (33.0%)	1,400 (30.9%)	204 (29.6%)	230 (34.2%)	1,340 (31.2%)
Smoking Status						
Never	3,107 (54.9%)	827 (72.9%)	2,280 (50.3%)	569 (82.5%)	424 (63.0%)	2,114 (49.2%)
Former	2,245 (39.6%)	279 (24.6%)	1,966 (43.4%)	104 (15.1%)	224 (33.3%)	1,917 (44.6%)
Current	311 (5.5%)	28 (2.5%)	283 (6.2%)	17 (2.5%)	25 (3.7%)	269 (6.3%)

[1] Nativity, educational attainment, and smoking behavior were determined on the baseline survey date.

[2]One study participant was excluded due to missing country of birth. East Asian countries included China, Japan, South Korea, North Korea, and Taiwan. Due to the original grouping of regions of birth in the LACE data, we categorized Mexico along with Central American countries that included Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. For similar reasons, we categorized the Philippines with Pacific Islands that included the Melanesian, Micronesian, and Polynesian Islands.

[3]Masked due to low counts.

[4]Cancer staging as defined by the American Joint Committee on Cancer (AJCC).

Table 2.

Current Smoking by Nativity and Race/Ethnicity Among Women Diagnosed with Breast Cancer, Kaiser Permanente Northern California[1]

Characteristics	Total (n, column %)[3]	Currently Smoking (n, row %)[4]	OR (95% CL)	
			Age-Adjusted	Fully Adjusted[2]
Model 1. Broad Racial/Ethnic Categories				
LACE (1997–2000) and Pathways (2005–2013) Study Cohorts (N= 5,663)				
Nativity				
Foreign-Born	1,134 (20.0%)	28 (2.5%)	0.48 (0.31, 0.76)	0.46 (0.29, 0.72)
US-Born	4,529 (80.0%)	283 (6.2%)	1.0 (Ref.)	1.0 (Ref.)
Race/Ethnicity				
Asian	690 (12.2%)	17 (2.5%)	0.48 (0.28, 0.84)	0.60 (0.34, 1.05)
Hispanic	673 (11.9%)	25 (3.7%)	0.61 (0.39, 0.94)	0.50 (0.32, 0.78)
Non-Hispanic White	4,300 (75.9%)	269 (6.3%)	1.0 (Ref.)	1.0 (Ref.)
Model 2. More Specific Racial/Ethnic Categories [5]				
Pathways (2005–2013) Cohort (N = 4,015)				
Race/Ethnicity				
Chinese	211 (5.3%)	6 (2.8%)	0.65 (0.27, 1.56)	0.74 (0.30, 1.81)
Filipina	232 (5.8%)	6 (2.6%)	0.64 (0.26, 1.61)	0.67 (0.27, 1.67)
Mexican	317 (7.9%)	11 (3.5%)	0.65 (0.34, 1.23)	0.51 (0.26, 0.99)
Other	371 (9.2%)	9 (2.4%)	0.50 (0.25, 1.02)	0.49 (0.24, 1.01)
Non-Hispanic White	2,884 (71.8%)	154 (5.3%)	1.0 (Ref.)	1.0 (Ref.)
Model 3. Nativity and Acculturation [5]				
Pathways (2005–2013) Cohort (N = 4,015)				
Model 3a. Age at Time of Immigration				
Nativity and Age at Immigration				
Foreign-Born, ≥18	583 (14.5%)	12 (2.1%)	0.48 (0.25, 0.92)	0.46 (0.24, 0.90)
Foreign-Born, <18	217 (5.4%)	9 (4.1%)	0.88 (0.42, 1.83)	0.85 (0.41, 1.77)
Foreign-Born, Unknown	103 (2.6%)	<5 (<4.9%)	0.21 (0.03, 1.57)	0.20 (0.03, 1.46)
US-Born	3,112 (77.5%)	164 (5.3%)	1.0 (Ref.)	1.0 (Ref.)
Model 3b. Years in the U.S.				
Nativity and Years in the U.S.				
Foreign-Born, 0–23	277 (6.9%)	5 (1.8%)	0.36 (0.14, 0.94)	0.36 (0.14, 0.97)
Foreign-Born, 24–38	270 (6.7%)	7 (2.6%)	0.58 (0.25, 1.34)	0.54 (0.23, 1.26)
Foreign-Born, ≥39	253 (6.3%)	9 (3.6%)	0.83 (0.41, 1.68)	0.79 (0.39, 1.61)
Foreign-Born, Unknown	103 (2.6%)	<5 (<4.9%)	0.20 (0.03, 1.51)	0.19 (0.03, 1.40)
US-Born	3,112 (77.5%)	164 (5.3%)	1.0 (Ref.)	1.0 (Ref.)
Model 3c. Language of Survey Completion				
Nativity and Language of Survey Completion				
Foreign-Born, Chinese or Spanish	120 (3.0%)	<5 (<4.2%)	0.66 (0.20, 2.25)	0.54 (0.16, 1.88)

Characteristics	Total (n, column %)[3]	Currently Smoking (n, row %)[4]	OR (95% CL)	
			Age-Adjusted	Fully Adjusted[2]
Foreign-Born, English	362 (9.0%)	11 (3.0%)	0.69 (0.35, 1.37)	0.71 (0.36, 1.41)
Foreign-Born, Unknown	421 (10.5%)	8 (1.9%)	0.42 (0.20, 0.90)	0.41 (0.19, 0.87)
US-Born	3,112 (77.5%)	164 (5.3%)	1.0 (Ref.)	1.0 (Ref.)

[1] All models compared the odds of current smoking (vs. not current smoking) by nativity and race/ethnicity.

[2] Fully-adjusted models were adjusted for continuous age at diagnosis, study, days between diagnosis and baseline survey dates, and education. Two study participants were excluded due to missing information about educational attainment.

[3] Column percentages are shown, meaning the percentages reflect those who were in the different nativity or race/ethnicity categories.

[4] Row percentages are shown, meaning the percentages reflect those who currently smoked among the different nativity or race/ethnicity categories.

[5] These models only included Pathways study participants due to lack of data availability in the LACE study.

Table 3.

Smoking Pack-Years by Nativity and Race/Ethnicity Among Women Diagnosed with Breast Cancer Who Ever Smoked, Kaiser Permanente Northern California

Characteristic	Total (n, %)[2]	Pack-Years (Median, IQR)	Estimate (95% CL)	
			Age-Adjusted	Fully Adjusted[1]
Model 1. Broad Racial/Ethnic Categories				
LACE (1997–2000) and Pathways (2005–2013) Study Cohorts (N= 2,556)				
Nativity				
Foreign-Born	307 (12.0%)	6.0 (1.4–15)	−5.12 (−7.60, −2.64)	−5.23 (−7.70, −2.75)
US-Born	2,249 (88.0%)	12 (3.0–28)	0 (Ref.)	0 (Ref.)
Race/Ethnicity				
Asian	121 (4.7%)	5.0 (1.5–10)	−5.25 (−9.05, −1.45)	−4.60 (−8.39, −0.81)
Hispanic	249 (9.7%)	5.3 (0.75–15)	−5.77 (−8.40, −3.15)	−6.79 (−9.43, −4.14)
Non-Hispanic White	2,186 (85.5%)	12 (3.5–28)	0 (Ref.)	0 (Ref.)
Model 2. More Specific Racial/Ethnic Categories [3]				
Pathways (2005–2013) Cohort (N = 1,725)				
Race/Ethnicity				
Chinese	23 (1.3%)	7.2 (0.65–14)	−4.50 (−12.53, 3.53)	−3.92 (−11.89, 4.06)
Filipina	42 (2.4%)	4.4 (1.6–9.4)	−4.02 (−10.25, 2.22)	−3.55 (−9.77, 2.67)
Mexican	104 (6.0%)	3.6 (0.49–13)	−5.97 (−9.88, −2.07)	−7.62 (−11.55, −3.68)
Other	123 (7.1%)	6.0 (1.8–19)	−2.32 (−5.95, 1.31)	−2.56 (−6.16, 1.03)
Non-Hispanic White	1,433 (83.1%)	12 (3.0–28)	0 (Ref.)	0 (Ref.)
Model 3. Nativity and Acculturation [3]				
Pathways (2005–2013) Cohort (N = 4,015)				
Model 3a. Age at Time of Immigration				
Nativity and Age at Immigration				
Foreign-Born, ≥18	127 (7.4%)	4.5 (1.0–14)	−6.01 (−9.61, −2.40)	−5.96 (−9.55, −2.38)
Foreign-Born, <18	75 (4.3%)	6.8 (1.4–18)	−2.83 (−7.46, 1.80)	−3.18 (−7.77, 1.41)
Foreign-Born, Unknown	30 (1.7%)	3.4 (0.41–12)	−9.62 (−16.64, −2.59)	−8.61 (−15.59, −1.63)
US-Born	1,493 (86.6%)	11 (3.0–27)	0 (Ref.)	0 (Ref.)
Model 3b. Years in the U.S.				
Nativity and Years in the U.S.				
Foreign-Born, 0–23	46 (2.7%)	3.9 (0.56–7.9)	−4.99 (−10.90, 0.92)	−4.39 (−10.27, 1.50)
Foreign-Born, 24–38	54 (3.1%)	3.6 (0.45–9.8)	−3.94 (−9.37, 1.49)	−3.54 (−8.93, 1.86)
Foreign-Born, ≥39	102 (5.9%)	7.3 (1.9–19)	−5.24 (−9.16, −1.32)	−5.83 (−9.72, −1.94)
Foreign-Born, Unknown	30 (1.7%)	3.4 (0.41–12)	−9.62 (−16.65, −2.59)	−8.57 (−15.55, −1.58)
US-Born	1,493 (86.6%)	11 (3.0–27)	0 (Ref.)	0 (Ref.)
Model 3c. Language of Survey Completion				
Nativity and Language of Survey Completion				
Foreign-Born, Chinese or Spanish	16 (0.9%)	0.75 (0–6.2)	−9.69 (−19.47, 0.08)	−11.56 (−21.56, −1.56)

Characteristic	Total (n, %)[2]	Pack-Years (Median, IQR)	Estimate (95% CL)	
			Age-Adjusted	Fully Adjusted[1]
Foreign-Born, English	104 (6.0%)	6.9 (1.4–16)	−4.85 (−8.79, −0.90)	−4.63 (−8.55, −0.71)
Foreign-Born, Unknown	112 (6.5%)	4.5 (1.3–14)	−5.53 (−9.36, −1.71)	−5.44 (−9.24, −1.64)
US-Born	1,493 (86.6%)	11 (3.0–27)	0 (Ref.)	0 (Ref.)

[1]Fully-adjusted models were adjusted for continuous age at diagnosis, study, days between diagnosis and baseline dates, and education in fully-adjusted models. One study participant was excluded due to missing information about educational attainment.

[2]Column percentages are shown, meaning the percentages reflect those who were in the different nativity or race/ethnicity categories among those who ever smoked.

[3]These models only included Pathways study participants due to lack of data availability in the LACE study.