Nativity and Neighborhood Characteristics and Cervical Cancer Stage at Diagnosis and Survival Outcomes Among Hispanic Women in California

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Objectives. We examined stage of diagnosis and survival after cervical cancer among Hispanic women, and their associations with Hispanic nativity, and explored whether neighborhood socioeconomic status (SES) and residence in a Hispanic enclave modify the association of nativity with stage and survival.

Methods. We used California Cancer Registry data (1994–2009) to identify 7958 Hispanic women aged 21 years and older with invasive cervical cancer. We used logistic and Cox proportional hazards models to estimate the associations between stage and mortality with nativity, neighborhood factors, and other covariates.

Results. Foreign-born women had similar adjusted relative odds of being diagnosed with stages II through IV (vs stage I) cervical cancer compared with US-born Hispanic women. However, among foreign-born women, those in low-SES–low-enclave neighborhoods were more likely to have late-stage disease than those in high-SES–low-enclave neighborhoods (adjusted odds ratio = 1.91; 95% confidence interval = 1.18, 3.07). Foreign-born women had lower cervical cancer mortality (adjusted hazard ratio = 0.67; 95% confidence interval = 0.58, 0.76) than US-born women, but only in high enclaves.

Conclusions. Among Hispanic women, nativity, neighborhood enclaves, and SES interact in their influence on stage and survival of cervical cancer. (*Am J Public Health.* 2015;105:538–545. doi:10.2105/AJPH.2014.302261)

Despite advances in early detection, cervical cancer remains the second most-common cancer worldwide and the third most-common gynecologic malignancy in the United States,[1,2] with an age-adjusted incidence rate of 7.8 per 100 000 and mortality rate of 2.3 per 100 000 from 2007 to 2011.[3] Notably, although the incidence of cervical cancer is higher among Hispanic women (10.2 per 100 000) than among Asian/Pacific Islander (6.4), African American (9.4), and non-Hispanic White (7.8) women, mortality rates among Hispanic women are comparable with those of other groups (2.8 per 100 000).[3–5]

Compared with women of other racial/ethnic groups, studies consistently show a survival advantage for Hispanic women after control for stage at diagnosis and other clinical and sociodemographic characteristics[2,6–13]; this observation of lower mortality among Hispanics compared with non-Hispanic Whites is consistent with the "Hispanic paradox."[14,15] Previous studies further suggest that the paradox applies in particular to Hispanic immigrants, particularly immigrants born in Mexico.[15] A recent analysis of national data from the Surveillance, Epidemiology, and End Results (SEER) program found that foreign-born Hispanic women had lower survival than US-born Hispanic women for early-stage disease, but better survival for late-stage disease.[16,17] However, this analysis was based on imputed data for women missing place of birth, which is problematic when one considers that SEER birthplace data are not missing at random.[18–20] The observed survival advantage may also reflect higher rates of losses to follow-up among foreign-born Hispanics, causing underreporting of cervical cancer mortality in this group if significant numbers of women return to their native country once diagnosed with later-stage disease. Thus, to date, reasons for the apparent immigrant survival advantage among women with cervical cancer are poorly understood.

The "healthy immigrant effect" suggests that the Hispanic mortality advantage is greater among the foreign-born than US-born because immigrants are selected for better health[21] and have strong family and community ties that support health behaviors[22,23] and buffer against discrimination[24]; this hypothesis may explain the patterns seen for cervical cancer survival. Therefore, neighborhood characteristics including socioeconomic status (SES) and ethnic enclave (geographical areas that are culturally and ethnically concentrated and distinct from the surrounding area) may be important contributors to survival after cervical cancer diagnosis. Low-income residential ethnic enclaves may protect health by increasing residents' ability to maintain positive health behaviors such as a healthy native diet or abstention from smoking, and provide increased social support. Residents of ethnic enclave communities may also receive targeted public health services or perceive fewer barriers to care. However, ethnic enclaves tend to be of low SES and frequently have higher crime rates and may have lower availability of healthy foods, all of which are risk factors for poor health outcomes.

The disproportionate burden of cervical cancer among Hispanic women but paradoxical incidence–mortality patterns, coupled with the rapid rate at which this population is growing, underscores the need to examine diagnostic and survival differences within this population. The purpose of this study was to examine stage of diagnosis and survival after cervical cancer, and their associations with Hispanic nativity, and to explore whether neighborhood SES and residence in a Hispanic enclave modify the association of nativity with stage and survival. Understanding how individual- and neighborhood-level factors jointly and independently contribute to survival outcomes after cervical cancer among Hispanic women may help target interventions that can improve survival after cancer diagnosis, despite socioeconomic disadvantage.

METHODS

We identified invasive cervical cancer cases from the population-based California Cancer Registry (CCR). We limited the data set for this study to all invasive, microscopically confirmed cervical cancer cases (*International Classification of Disease–Oncology, 3rd Edition*[25] codes C53.0–C53.9) diagnosed among Hispanic California residents aged 21 years and older from 1994 to 2009 and reported to the CCR as of October 2011. We considered cases eligible if their registry data (from medical records) indicated Hispanic ethnicity. However, because of previously documented misclassification of Hispanics as non-Hispanics, we used the North American Association of Central Cancer Registries Hispanic Identification Algorithm[26] to improve classification by identifying cases identified as non-Hispanic who likely were Hispanic given surname, first name, and place of birth, resulting in 9219 Hispanic cases of invasive cervical cancer. We excluded cases missing stage at diagnosis (n = 721) from the stage and survival regression analyses, resulting in a final sample of 7958 cases. The cases missing stage were more likely to be older (≥ 65 years at diagnosis) and have "unknown" values for chemotherapy or radiation therapy, but were similar with regard to nativity, SES, Hispanic enclave, and marital status (data not shown). We did not further subclassify Hispanics by country of origin because of a high proportion of missing data, but census data have shown that approximately 84% of California Hispanics are of Mexican origin[27] and 9% of Central American origin.[28]

The key dependent variables were stage at diagnosis (American Joint Committee on Cancer stage I vs stages II–IV) and survival from cervical cancer. Because surgical procedure is dependent on cancer stage, and both synergistically affect survival, we created a variable combining stage and surgery. From the registry, we obtained information on vital status (routinely determined by the CCR through hospital follow-up and linkages to state and national death and other files). Survival time was censored at date of last active follow-up or on December 31, 2009, whichever came first.

Nativity and Neighborhood Measures

To classify women as either US-born or foreign-born, we used birthplace information from the registry (available for 77% of cases), or if missing, by a validated method using the first 5 digits of the patient's social security number (SSN) to determine the year the SSN was issued.[8,29] We considered women with an SSN issued before age 20 years to be US-born, and those who had received their SSN on or after age 20 years to be foreign-born. For 5.4% of cases (n = 497), SSNs were unavailable or invalid, and nativity was randomly assigned on the basis of the distribution of Hispanic cases by nativity. We determined the cut-off point of age 20 years by comparisons with self-reported nativity from interviews with 1127 Hispanic cancer patients[30] and maximization of the area under the resultant receiver operating characteristic curve. We confirmed the optimal positive predictive value of the age cut-off point by using logistic regression models with age at SSN issuance as a continuous predictor of foreign-born status. The selected cut-off point resulted in immigrant status classifications associated with 81% sensitivity and 80% specificity for detecting foreign-born status in Hispanics.

We assigned previously developed composite neighborhood measures of SES[31] and of Hispanic enclave[32] to all cases based on residential block group at date of diagnosis, which was geocoded to 1990 Census data for women diagnosed from 1994 to 1995, and to 2000 Census data for women diagnosed from 1996 to 2009. Individual-level SES was not available from the registry. Rather, we determined SES via principal component analysis of the following Census variables: education index,[33] median household income, percentage living 200% below the federal poverty level,[31] median rent, median house value, percentage blue-collar workers, and percentage of work force participants aged older than 16 years who are unemployed. We categorized the SES index according to quintiles based on the statewide distribution. The Hispanic enclave measure, also developed through principal component analysis, includes the following census variables[32]: percentage linguistically isolated, percentage linguistically isolated who speak Spanish, percentage speaking limited English, percentage Spanish-speaking who speak limited English, percentage of recent immigrants, percentage Hispanic, and percentage foreign-born.[34–38] We subsequently categorized the Hispanic enclave index scores into statewide quintiles.

Because of the high correlation between the neighborhood SES index and the Hispanic enclave index (Pearson correlation = 0.64), we created a 4-level combined variable: high SES–high enclave, high SES–low enclave, low SES–low enclave, and low SES–high enclave. Low SES constituted SES quintiles 1 and 2, whereas we defined low enclave by enclave quintiles 1, 2, and 3.

For each cervical cancer case, we obtained information routinely abstracted from the medical record,[39] including patient's age at diagnosis, race/ethnicity, birthplace, marital status, stage, tumor histology, and first-course treatment. We categorized chemotherapy, radiation, and surgery as none, any, or unknown.

Statistical Analysis

We analyzed data with Stata version 12 (StataCorp LP, College Station, TX). We performed analysis of variance and the χ^2 test to examine demographic and clinical differences by nativity status.

To assess the relationship between stage at diagnosis (local vs regional or distant) and nativity and neighborhood characteristics, we performed logistic regression analysis and calculated odds ratios (ORs) and 95% confidence intervals (CIs). We selected covariates on the basis of their independent associations ($P < .10$) with survival and effect on association (> 10% change) between nativity and stage. Each multiple logistic regression model included nativity, marital status, age group, and year of diagnosis, and either neighborhood SES or the combined SES–enclave variable.

To evaluate the association of cervical cancer–specific survival with nativity and neighborhood characteristics, we used Cox proportional hazards models and calculated hazard ratios (HRs) and 95% CIs. For deceased patients, we measured survival time in days from the date of diagnosis to the date of death from cervical cancer. Patients who died from other causes were censored at the time of death. We tested the proportional hazards assumption for all variables by visual inspection of survival curves; there were no violations of this assumption.

TABLE 1—Characteristics of Hispanic Women Diagnosed With Invasive Cervical Cancer (n = 9219), by Nativity: California Cancer Registry, 1994–2009

Characteristics	US-Born Hispanic Women (n = 2885), No. (%) or No. (Mean ±SD)	Foreign-Born Hispanic Women (n = 6334), No. (%) or No. (Mean ±SD)	P
Age at diagnosis, y	2885 (44.2 ±14.1)	6334 (49.2 ±14.0)	<.001
21–34	773 (26.8)	838 (13.2)	
35–44	956 (33.1)	1915 (30.2)	
45–54	568 (19.7)	1589 (25.1)	
55–64	265 (9.2)	970 (15.3)	
≥ 65	323 (11.2)	1022 (16.1)	<.001
Neighborhood SES, quintiles			
1 (lowest 20%)	991 (34.4)	3265 (51.6)	
2	722 (25.0)	1527 (24.1)	
3	554 (19.2)	833 (13.2)	
4	429 (14.9)	480 (7.6)	
5 (highest 20%)	189 (6.6)	229 (3.6)	<.001
Hispanic enclave, quintiles			
1 (lowest 20%)	177 (6.4)	136 (2.2)	
2	312 (11.2)	267 (4.3)	
3	518 (18.6)	563 (9.1)	
4	785 (28.2)	1358 (22.0)	
5 (highest 20%)	988 (35.5)	3846 (62.33)	<.001
Combined neighborhood SES and Hispanic enclave[a]			
High SES–low enclave	391 (14.1)	328 (5.3)	
High SES–high enclave	725 (26.1)	1130 (18.3)	
Low SES–low enclave	98 (3.5)	75 (1.2)	
Low SES–high enclave	1566 (56.3)	4637 (75.2)	<.001
Marital status			
Single never married	825 (28.6)	1988 (31.4)	
Married	1248 (43.3)	2848 (45.0)	
Separated	98 (3.4)	231 (3.7)	
Divorced	384 (13.3)	346 (5.5)	
Widowed	189 (6.6)	615 (9.7)	
Unknown	141 (4.9)	306 (4.8)	<.001
Stage at diagnosis			
1	1567 (54.3)	3061 (48.3)	
2	366 (12.7)	1051 (16.6)	
3	493 (17.1)	1080 (17.1)	
4	283 (9.8)	597 (9.4)	
Unknown	176 (6.1)	545 (8.6)	<.001
Surgery			
Yes	1924 (66.7)	3699 (58.4)	
No	954 (33.1)	2604 (41.1)	
Unknown	7 (0.2)	31 (0.5)	<.001

Continued

We assessed effect modification in several ways: (1) between patient nativity and neighborhood SES, (2) between patient nativity and the combined SES–enclave variable, (3) between patient nativity and enclave, and (4) between neighborhood SES and enclave by including cross-product terms in the multiple logistic and survival models and by conducting stratified analysis when appropriate. We considered interaction statistically significant if the *P* value on the cross-product term was less than .1.

There was minimal spatial clustering of cervical cancer cases in census block groups (95.4% of block groups had 2 or fewer cases, and 82.7% had 1 case), so we did not adjust for spatial clustering in the models.

RESULTS

Almost one third (31.3%) of the Hispanic women with cervical cancer were US-born (Table 1). A higher proportion of foreign-born women than US-born women were diagnosed at an older age and lived in low-SES–high-enclave neighborhoods. A higher proportion of US-born women had died of cervical cancer, but proportions of overall deaths were comparable between US- and foreign-born women.

Table 2 (model 1) shows that foreign-born women with cervical cancer were no more likely than US-born women to be diagnosed at regional- or distant-stage disease after we controlled for age at diagnosis, year of diagnosis, marital status, and neighborhood SES (OR = 1.04; 95% CI = 0.94, 1.15). Women with cervical cancer in the lowest-SES neighborhoods had 29% increased odds of later (II-IV)-stage disease than women in the highest-SES neighborhoods (OR = 1.29; 95% CI = 1.03, 1.63). We found an interaction between nativity and the combined SES–enclave variable; thus, in model 2 (Table 2), adjusted ORs for SES–enclave are reported separately for US- and foreign-born. Compared with foreign-born cases in high-SES–low-enclave neighborhoods, foreign-born cases in low-SES–low-enclave neighborhoods had 91% increased odds of diagnosis at a later stage (OR = 1.91; 95% CI = 1.18, 3.07), and those in low-SES–high-enclave neighborhoods had 37% increased odds of diagnosis at a later stage (OR = 1.37; 95% CI = 1.07, 1.75). Women who were married were less likely to be diagnosed at later

TABLE 1—*Continued*

Combined stage and surgery			
Stage 1, surgery yes	1420 (52.4)	2626 (45.4)	
Stage 1, surgery no	147 (5.4)	435 (7.5)	
Stage 2, surgery yes	122 (4.5)	304 (5.3)	
Stage 2, surgery no	244 (9.0)	746 (12.9)	
Stage 3, surgery yes	252 (9.3)	422 (7.3)	
Stage 3, surgery no	240 (8.9)	655 (11.3)	
Stage 4, surgery yes	67 (2.5)	150 (2.6)	
Stage 4, surgery no	216 (8.0)	447 (7.7)	<.001
Chemotherapy treatment			
Yes	882 (30.6)	2174 (34.3)	
No	1961 (68.0)	4024 (63.5)	
Unknown	42 (1.5)	136 (2.2)	<.001
Radiation treatment			
Yes	1352 (46.9)	3316 (52.4)	
No	1529 (53.0)	2996 (47.3)	
Unknown	<5 (0.1)	22 (0.4)	<.001
Histology			
Squamous carcinoma	1999 (69.3)	4650 (73.4)	
Adenocarcinoma	524 (18.2)	995 (15.7)	
Other	362 (12.6)	689 (10.9)	<.001
Grade			
1	243 (8.4)	504 (8.0)	
2	777 (26.9)	1708 (27.0)	
3	885 (30.7)	1891 (29.9)	
4	72 (2.5)	159 (2.5)	
Unknown	908 (31.4)	2072 (31.7)	.75
Died of cervical cancer			
Yes	585 (20.3)	1171 (18.5)	
No	2300 (79.1)	5163 (81.5)	.04
Vital status			
Dead	877 (30.4)	1944 (30.7)	
Alive	2008 (69.6)	4390 (69.3)	.78

Notes. SES = socioeconomic status. *P* values based on the χ^2 test.
[a]Low SES constituted quintiles 1 and 2; high SES constituted quintiles 3, 4, and 5; low enclave constituted quintiles 1, 2, and 3; high enclave constituted quintiles 4 and 5. All neighborhood SES and Hispanic enclave data are at the census block group level.

stage disease than unmarried women (OR = 0.71; 95% CI = 0.65, 0.87). Age at diagnosis was the variable most strongly associated with stage at diagnosis. We found no interactions between nativity and SES, nativity and Hispanic enclave, or neighborhood SES and Hispanic enclave.

Foreign-born Hispanic women with cervical cancer had a 27% to 28% decreased hazard of dying from cervical cancer after we adjusted for neighborhood SES (model 1) and combined SES–enclave (model 2) in addition to stage and other clinical and demographic variables (Table 3). As shown in model 1, all SES quintiles had higher hazard ratios compared with the highest SES quintile. When we combined Hispanic enclave and neighborhood SES (model 2), women in low-SES and low-enclave neighborhoods had 48% increased risk of dying compared with those in high-SES–low-enclave neighborhoods, although this finding did not reach statistical significance (HR = 1.48; 95% CI = 0.99, 2.19). Compared with women diagnosed with stage I cervical cancer, those with stages II through IV were at increased risk of death, and women who did not receive surgery were at increased risk of death compared with those who had surgery, within every category of stage. Age at diagnosis and marital status were not associated with cervical cancer–specific survival.

We detected a significant interaction between nativity and Hispanic enclave in survival models; thus, we stratified by enclave (Table 4). Notably, the protective effect of foreign birth relative to US birth (HR = 0.67; 95% CI = 0.58, 0.76) was evident only among cases living in high ethnic enclaves, and there were no survival differences by nativity among cases in low ethnic enclaves, after we controlled for covariates. Moreover, the effects of neighborhood SES were striking in the high enclave (although CIs were wide), with the lowest SES having 3.38 increased hazard of death (95% CI = 1.36, 9.06), but far weaker in low enclaves.

DISCUSSION

We examined neighborhood- and individual-level determinants of cervical cancer stage at diagnosis and survival among foreign- and US-born Hispanic women identified in the population-based CCR between 1994 and 2007. We found that although foreign-born Hispanic women with cervical cancer were more likely than US-born to be diagnosed at a later stage, this differential was no longer significant after we adjusted for age at diagnosis, marital status, and neighborhood SES, with age being the major contributor to the nativity differentials.

To our knowledge, there has been only 1 other publication reporting on the association between cervical cancer stage and Hispanic nativity. Montealegre et al. found that foreign-born Hispanic cases were significantly more likely than US-born cases to be diagnosed at late-stage disease, after they adjusted for age and histology (OR = 1.10; 95% CI = 1.05, 1.15; *P* = .003).[17] The difference in findings likely reflects differences in the nativity imputation methods among cases with missing registry birthplace, but may also be attributable to different Hispanic populations between the 2 studies, with ours based on a California population (predominantly Mexicans) and the other based on the national SEER population (mixed Hispanics). Furthermore, we found that the association between

TABLE 2—Adjusted Odds Ratios (AORs) and 95% Confidence Intervals (CIs) for Stage II Through Stage IV of Cervical Cancer Diagnosis (vs Stage I) Among Hispanic Women (n = 7958): California Cancer Registry, 1994–2009

Characteristic	Model 1, AOR (95% CI)	Model 2, AOR (95% CI)
Nativity		NA
US-born (Ref)	1.00	
Foreign-born	1.04 (0.94, 1.15)	
Neighborhood SES, quintiles		NA
1 (lowest 20%)	1.29 (1.03, 1.63)	
2	1.27 (1.00, 1.61)	
3	1.19 (0.93, 1.52)	
4	1.08 (0.83, 1.40)	
5 (highest 20%; Ref)	1.00	
Marital status		
Married	0.70 (0.64, 0.77)	0.71 (0.65, 0.87)
Not married (Ref)	1.00	1.00
Age at diagnosis, y		
21–34 (Ref)	1.00	1.00
35–44	1.27 (1.10, 1.45)	1.27 (1.12, 1.46)
45–54	2.16 (1.87, 2.49)	2.16 (1.86, 2.57)
55–64	2.89 (2.44, 3.42)	2.89 (2.43, 3.42)
≥ 65	3.09 (2.62, 3.65)	3.08 (2.61, 3.65)
US-born		
Combined neighborhood SES and Hispanic enclave	NA	
High SES–low enclave (Ref)		1.00
High SES–high enclave		1.17 (0.89, 1.54)
Low SES–low enclave		1.65 (0.94, 2.90)
Low SES–high enclave		1.17 (0.91, 1.50)
Foreign-born		
Combined neighborhood SES and Hispanic enclave		
High SES–low enclave (Ref)	NA	1.00
High SES–high enclave		1.00 (0.76, 1.32)
Low SES–low enclave		1.91 (1.18, 3.07)
Low SES–high enclave		1.37 (1.07, 1.75)

Notes. NA = not applicable; SES = socioeconomic status. Models 1 and 2 adjusted for year of diagnosis and variables listed in the table. Low SES constituted SES quintiles 1 and 2; high SES constituted SES quintiles 3, 4, and 5; low enclave constituted enclave quintiles 1, 2, and 3; and high enclave constituted enclave quintiles 4 and 5. Confidence intervals are from unconditional logistic regression models.

nativity and stage of diagnosis was modified by neighborhood SES and ethnic enclave, with foreign-born women with cervical cancer in low SES–low enclave neighborhoods having the highest risk of advanced-stage disease at diagnosis, followed by women in low-SES–high-enclave neighborhoods. Although foreign-born residents of low-SES neighborhoods who are surrounded by few immigrants may be at particularly high risk of later-stage diagnosis because of increased barriers to health care and lack of material and literacy resources, they accounted for only 1% of the immigrant cases. It is likely that decreased screening because of health access barriers contribute to this association, as 1 study among medically underserved women in California found no difference in stage at diagnosis between Hispanic and non-Hispanic women after they adjusted for screening regularity.[40] As 75% of the immigrant cases in our study lived in low-SES–high-enclave neighborhoods, future longitudinal studies are needed to further assess if specific aspects of low-SES–high-enclave neighborhoods, or of the women living in those neighborhoods, contribute to their greater likelihood of late-stage diagnosis.

With regard to cervical cancer survival, we found that foreign-born Hispanic women had a survival advantage compared with US-born Hispanic women when we controlled for stage at diagnosis and other individual-level factors. The earlier study by Montealegre et al. found that foreign-born Hispanic women had lower survival than US-born for early-stage disease, but better survival for later-stage disease.[15] As with the stage findings, the differences in findings between the 2 studies is likely attributable to differences in nativity imputation methods, but may also be attributable to different Hispanic populations and covariates included in the models. Notably, our study included small area level (block group) measures of SES and ethnic enclave, enabling us to further identify vulnerable subpopulations among California Hispanics. As such, we also found that neighborhood SES was independently associated with survival from cervical cancer. The mortality hazard was higher in women living in low-SES neighborhoods than in the highest SES quintile. Previous breast, prostate, and lung cancer studies have also found survival associations with neighborhood SES and Hispanic enclave[37,38]; however, our study is the first to show similar neighborhood results for cervical cancer.

We found that the association of nativity and neighborhood SES on survival varied by Hispanic enclave, with survival benefits among foreign-born and survival deficits for low-SES neighborhoods seen predominantly among cases living in high Hispanic enclaves. Ethnic enclaves may offer protective effects via buffering against acculturation. Studies have demonstrated that distinct cultural preferences or practices[41–44] may have favorable impacts on some health outcomes. The "low acculturation hypothesis" suggests that foreign-born Hispanic persons are less likely to engage in unhealthy behaviors, and that greater acculturation leads to a decline in positive health behaviors.[42] However, the cervical cancer survival advantage seen among foreign-born Hispanic persons, particularly those in ethnic enclaves, is more likely attributable to social factors such as acculturation, social cohesion, or collective efficacy, despite the stressors of poverty.[44,45] Such communities may also provide more public health services.[25]

TABLE 3—Adjusted Hazard Ratios (HRs) and 95% Confidence Intervals (CIs) for Relative Rates of Cervical Cancer–Specific Death in Hispanic Women (n = 7958): California Cancer Registry, 1994–2009

Characteristics	Model 1, HR (95% CI)[a]	Model 2, HR (95% CI)[a]
Nativity		
US-born (Ref)	1.00	1.00
Foreign-born	0.72* (0.64, 0.80)	0.73* (0.65, 0.82)
Neighborhood SES, quintiles		. . .[b]
1 (lowest 20%)	1.57* (1.14, 2.16)	
2	1.39 (1.00, 1.93)	
3	1.58* (1.13, 2.21)	
4	1.44* (1.01, 2.06)	
5 (highest 20%; Ref)	1.00	
Combined neighborhood SES and Hispanic enclave[c]		
High SES–low enclave (Ref)	. . .[b]	1.00
High SES–high enclave		1.20 (0.95, 1.52)
Low SES–low enclave		1.48 (0.99, 2.19)
Low SES–high enclave		1.17 (0.94, 1.46)
Marital status		
Married	0.96 (0.86, 1.07)	0.96 (0.86, 1.07)
Not married (Ref)	1.00	1.00
Cancer stage stratified by surgery		
Stage 1, surgery yes (Ref)	1.00	1.00
Stage 1, surgery no	5.14* (3.86, 6.85)	5.09* (3.81, 6.80)
Stage 2, surgery yes	4.95* (3.66, 6.69)	4.99* (3.69, 6.75)
Stage 2, surgery no	7.74* (6.04, 9.91)	7.76* (6.05, 9.95)
Stage 3, surgery yes	6.77* (5.25, 8.72)	6.74* (5.22, 8.69)
Stage 3, surgery no	19.69* (25.55, 34.94)	19.92* (15.72, 25.25)
Stage 4 surgery yes	18.79* (14.22, 24.83)	19.15* (14.49, 25.33)
Stage 4, surgery no	46.52* (36.93, 58.60)	46.22* (36.63, 58.31)
Age at diagnosis, y		
21–34 (Ref)	1.00	1.00
35–44	0.97 (0.82, 1.15)	0.96 (0.81, 1.13)
45–54	0.88 (0.73, 1.05)	0.87(0.73, 1.04)
55–64	0.90 (0.74, 1.10)	0.90 (0.74, 1.11)
≥ 65	1.04 (0.86, 1.27)	1.03 (0.84, 1.25)

Notes. SES = socioeconomic status. Confidence intervals are based on Cox proportional hazards regression models.
[a]Multivariable model adjusted for first course of treatment (chemotherapy, radiation), tumor histology (squamous cell carcinoma, adenocarcinoma, and other), year of diagnosis, and variables listed in the table.
[b]Variable not included in the model.
[c]Low SES constituted quintiles 1 and 2; high SES constituted quintiles 3, 4, and 5; low enclave constituted quintiles 1, 2, and 3; high enclave constituted quintiles 4 and 5.
*Two-sided $P < .05$.

Having an extended community of support, particularly in times of need such as a diagnosis of cancer, in addition to the preservation of healthy behaviors, may lead to improved access and use of health care, treatment adherence, and quality of life. In addition, foreign-born Hispanic persons may be more likely than US-born Hispanic persons to receive, from coethnic communities, more tangible (e.g., help with transportation to medical appointments, translations) emotional and social support that are ultimately beneficial to survival. Our composite measure of ethnic enclave included census variables on density of Hispanic persons, Hispanic immigrants, and linguistically isolated persons who speak Spanish; it may be instructive in future work to distinguish between ethnic enclaves (i.e., neighborhoods with high proportion of Hispanic persons, regardless of nativity) versus immigrant enclaves (i.e., neighborhoods with high proportion of Hispanic immigrants). Further research about the specific protective factors among foreign-born individuals living in ethnic enclaves may provide insights that may translate into effective interventions for improving survival after cervical cancer in all populations.

We evaluated the possibility that the observed lower mortality among foreign-born compared with US-born Hispanic women could be explained by differential loss to follow-up (i.e., the "salmon bias" or "reverse migration bias").[41,43,46] Of the 6398 women alive at last follow-up, 80.0% had follow-up within 2 years from the study end date. Foreign-born women were less likely to have had complete follow-up within the last 2 years (74.8%) than US-born women (91.4%). Most of the women with last follow-up more than 2 years before the study end date, considered "lost to follow-up," were stage I for both US-born (67.3% stage I, 3.3% stage IV) and foreign-born women (61.5% stage I, 6.6% stage IV). Thus, foreign-born women who are lost to follow-up may be slightly more likely than US-born women to die, but the modest differences in the stage distribution of these cases are unlikely to completely explain the survival benefit observed among foreign-born women.

Limitations and Strengths

Several study limitations should be noted. We were not able to assess potential confounding factors (comorbidities, smoking status, amount of time since immigration to the United States, and detailed treatment). Our study is also limited by possible misclassification of race/ethnicity; however, studies have shown cancer registry data to have good classification of race/ethnicity and birthplace.[19,30,47] Despite using a validated imputation method for classification of nativity for the 23% of cases with unknown birthplace, we likely have some error. However, the impact of this potential bias is likely to be minimal given the relatively high sensitivity and positive predictive value of the SSN method.

Strengths of our study include the measure of neighborhood SES at a small area level (census block group). This serves to provide context regarding the social environment in

TABLE 4—Adjusted Hazard Ratios (HRs) and 95% Confidence Intervals (CIs) Stratified by Hispanic Ethnic Enclave for Relative Rates of Cervical Cancer–Specific Death in Hispanic Women (n = 7958): California Cancer Registry, 1994–2009

Characteristics	Low Enclave, HR (95% CI)[a]	High Enclave, HR (95% CI)[a]
Nativity		
US-born (Ref)	1.00	1.00
Foreign-born	1.00 (0.78, 1.27)	0.67* (0.58, 0.76)
Neighborhood SES, quintiles		
1 (Lowest 20%)	1.72* (1.04, 2.84)	3.38* (1.36, 9.06)
2	1.42 (0.94, 2.16)	2.93* (1.09, 7.90)
3	1.33 (0.90, 1.96)	3.44* (1.27, 9.34)
4	1.32 (0.89, 1.97)	3.18* (1.14, 8.88)
5 (Highest 20%; Ref)	1.00	1.00
Marital status		
Married	0.98 (0.77, 1.25)	0.98 (0.87, 1.11)
Not married (Ref)	1.00	1.00
Cancer stage stratified by surgery		
Stage 1, surgery yes (Ref)	1.00	1.00
Stage 1, surgery no	4.42* (2.34, 8.33)	5.37* (3.89, 7.41)
Stage 2, surgery yes	4.39* (2.33, 8.29)	5.04* (3.57, 7.12)
Stage 2, surgery no	5.72* (3.32, 9.83)	8.37* (6.33, 11.06)
Stage 3, surgery yes	5.48* (3.23, 9.30)	7.26* (5.43, 9.69)
Stage 3, surgery no	17.05* (10.09, 28.81)	20.55* (15.74, 26.82)
Stage 4 surgery yes	13.50* (7.25, 25.16)	20.71* (15.14, 28.33)
Stage 4, surgery no	58.36* (35.45, 96.07)	45.88* (35.31, 59.61)
Age at diagnosis, y		
21–34 (Ref)	1.00	1.00
35–44	1.04 (0.72, 1.52)	0.97 (0.80, 1.17)
45–54	0.99 (0.67, 1.48)	0.86 (0.70, 1.05)
55–64	0.83 (0.52, 1.32)	0.91 (0.73, 1.14)
≥ 65	0.90 (0.58, 1.41)	1.09 (0.88, 1.35)

Notes. SES = socioeconomic status.
[a]Multivariable model adjusted for first course of treatment (chemotherapy, radiation), tumor histology (squamous cell carcinoma, adenocarcinoma, and other), year of diagnosis, and variables listed in the table. Low enclave constituted quintiles 1, 2, and 3; high enclave constituted quintiles 4 and 5.
*Two-sided $P < .05$.

which women with cervical cancer reside. An additional strength is the large and representative data set for a state with the largest population of Hispanic persons in the United States.[48]

Conclusions

We found variations in stage at diagnosis and survival by nativity, neighborhood SES, and Hispanic enclave, and conclude that the interactions among these exposures are exceedingly complex. Our findings point to important considerations for the role of neighborhood factors in cervical cancer outcomes among Hispanic women and call for further investigation of how neighborhood and community attributes including social support and collective efficacy may help to buffer against the otherwise negative impacts of low SES and language barriers. ■

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Contributors

N. Gomez conducted the analysis and wrote the article. S. Guendelman and K. G. Harley guided the analysis, provided critical review, and helped to write the article. S. L. Gomez secured funding support, provided the data, guided the analysis, provided critical review, and wrote the article.

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Human Participant Protection

This article was based on an analysis of de-identified data from the California Cancer Registry. Approval for human participants research was included under the Greater Bay Area Cancer Registry institutional review board protocol with the Cancer Prevention Institute of California institutional review board. This research was also approved by the institutional review board of the University of California, Berkeley.

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