

UC Berkeley

UC Berkeley Previously Published Works

Title

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

Permalink

<https://escholarship.org/uc/item/1415860v>

Journal

American Journal of Public Health, 105(3)

ISSN

0090-0036

Authors

Gomez, Nicole
Guendelman, Sylvia
Harley, Kim G
[et al.](#)

Publication Date

2015-03-01

DOI

10.2105/ajph.2014.302261

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed

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

Nicole Gomez, MD, MPH, Sylvia Guendelman, PhD, MSW, Kim G. Harley, PhD, and Scarlett Lin Gomez, PhD

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 socio-demographic 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.

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)

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 health²¹ and have strong family and community ties that support health behaviors^{22,23} and buffer against discrimination²⁴; 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 Algorithm²⁶ 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 origin²⁷ 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 patients³⁰ 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 SES³¹ and of Hispanic enclave³² 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 variables³²: 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.

^aLow 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		
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)	...	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.

^aMultivariable 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.

^bVariable not included in the model.

^cLow 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.

^aMultivariable 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.^{4,8}

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. ■

About the Authors

Nicole Gomez, Sylvia Guendelman, and Kim G. Harley are with the School of Public Health, University of California, Berkeley. Nicole Gomez is also with the Department of Obstetrics and Gynecology, School of Medicine, University of California, Davis. Scarlett Lin Gomez is with the Cancer Prevention Institute of California, Fremont, and School of Medicine, Stanford, CA.

Correspondence should be sent to Scarlett Lin Gomez, PhD, Cancer Prevention Institute of California, 2201 Walnut Ave, Suite 300, Fremont, CA 94538 (e-mail: scarlett@cpic.org). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints" link.

This article was accepted August 7, 2014.

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.

Acknowledgments

This research was supported by the National Cancer Institute's Surveillance, Epidemiology, and End Results Program under a contract awarded to the Cancer Prevention Institute of California (HHSN261201000140C). The collection of cancer incidence data used in this study was supported by the California Department of Health Services as part of the statewide cancer reporting program mandated by California Health and Safety Code Section 103885; the National Cancer Institute's Surveillance, Epidemiology, and End Results Program under a contract awarded to the Cancer Prevention Institute of California (HHSN261201000140C), a contract awarded to the University of Southern California (HHSN261201000035C), and a contract awarded to the Public Health Institute (HHSN261201000034C); and the Centers for Disease Control and Prevention's National Program of Cancer Registries, under an agreement awarded to the Public Health Institute (1U58 DP000807-01).

Note. The ideas and opinions expressed herein are those of the authors, and endorsement by the State of California, the California Department of Health Services, the National Cancer Institute, or the Centers for Disease Control and Prevention or their contractors and subcontractors is not intended nor should it be inferred.

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.

References

1. *Cancer Facts & Figures 2012*. Atlanta, GA: American Cancer Society; 2012.
2. Patel DA, Barnholtz-Sloan JS, Patel MK, Malone JM Jr, Chuba PJ, Schwartz K. A population-based study of racial and ethnic differences in survival among women with invasive cervical cancer: analysis of Surveillance, Epidemiology, and End Results data. *Gynecol Oncol*. 2005;97(2):550–558.
3. SEER STAT fact sheets. Cervix-uteri. Available at: <http://seer.cancer.gov/statfacts/html/cervix.html>. Accessed March 20, 2014.
4. Horner MJ, Altekruse SF, Zou Z, Wideroff L, Katki HA, Stinchcomb DG. US geographic distribution of pre-vaccine era cervical cancer screening, incidence, stage, and mortality. *Cancer Epidemiol Biomarkers Prev*. 2011;20(4):591–599.

5. Howlander N, Noone AM, Krapcho M, et al., eds. SEER Cancer Statistics Review, 1975–2011. Bethesda, MD: National Cancer Institute; 2014. Available at: http://seer.cancer.gov/csr/1975_2011. Accessed October 1, 2014.
6. Clegg LX, Reichman ME, Miller BA, et al. Impact of socioeconomic status on cancer incidence and stage at diagnosis: selected findings from the Surveillance, Epidemiology, and End Results: National Longitudinal Mortality Study. *Cancer Causes Control*. 2009;20(4):417–435.
7. Booth CM, Li G, Zhang-Salomons J, Mackillop WJ. The impact of socioeconomic status on stage of cancer at diagnosis and survival. *Cancer*. 2010;116(17):4160–4167.
8. Keegan TH, Quach T, Shema S, Glaser SL, Gomez SL. The influence of nativity and neighborhoods on breast cancer stage at diagnosis and survival among California Hispanic women. *BMC Cancer*. 2010;10(1):603.
9. Coker AL, Desimone CP, Eggleston KS, White AL, Williams M. Ethnic disparities in cervical cancer survival among Texas women. *J Womens Health (Larchmt)*. 2009;18(10):1577–1583.
10. Eggleston KS, Coker AL, Williams M, Tortolero-Luna G, Martin JB, Tortolero SR. Cervical cancer survival by socioeconomic status, race/ethnicity, and place of residence in Texas, 1995–2001. *J Womens Health (Larchmt)*. 2006;15(8):941–951.
11. Brookfield KF, Cheung MC, Lucci J, Fleming LE, Koniari LG. Disparities in survival among women with invasive cervical cancer: a problem of access to care. *Cancer*. 2009;115(1):166–178.
12. Lim J-W, Ashing-Giwa KT. Examining the effect of minority status and neighborhood characteristics on cervical cancer survival outcomes. *Gynecol Oncol*. 2011;121(1):87–93.
13. McCarthy AM, Dumanovsky T, Visvanathan K, Kahn AR, Schymura MJ. Racial/ethnic and socioeconomic disparities in mortality among women diagnosed with cervical cancer in New York City, 1995–2006. *Cancer Causes Control*. 2010;21(10):1645–1655.
14. Markides KS, Coreil J. The health of Hispanics in the southwestern United States: an epidemiologic paradox. *Public Health Rep*. 1986;101(3):253–265.
15. Markides KS, Eschback K. *Hispanic Paradox in Adult Mortality in the United States*. *International Handbook of Adult Mortality*. Dordrecht, Netherlands: Springer; 2011.
16. Montealegre JR, Zhou R, Amirian ES, Follen M, Scheurer ME. Nativity disparities in late-stage diagnosis and cause-specific survival among Hispanic women with invasive cervical cancer: an analysis of Surveillance, Epidemiology, and End Results data. *Cancer Causes Control*. 2013;24(11):1985–1994.
17. Montealegre JR, Zhou R, Amirian ES, Scheurer ME. Uncovering nativity disparities in cancer patterns: multiple imputation strategy to handle missing nativity data in the Surveillance, Epidemiology, and End Results data file. *Cancer*. 2014;120(8):1203–1211.
18. Gomez SL, Glaser SL. Quality of cancer registry birthplace data for Hispanics living in the United States. *Cancer Causes Control*. 2005;16(6):713–723.
19. Lin SS, Clarke CA, O'Malley CD, Le GM. Studying cancer incidence and outcomes in immigrants: methodologic concerns. *Am J Public Health*. 2002;92(11):1757–1759.
20. Gomez SL, Schupp CW, Patel MRE. The Influence of Hispanic ethnicity on non-small cell lung cancer histology and patient survival: an analysis of the Surveillance, Epidemiology, and End Results database. *Cancer*. 2013;119(6):1286–1287.
21. Palloni A, Arias E. Paradox lost: explaining the Hispanic adult mortality advantage. *Demography*. 2004;41(3):385–415.
22. Portes A, Rumbaut RG. *Immigrant America: A Portrait*. Berkeley, CA: University of California Press; 2006.
23. Cagney KA, Browning CR, Wallace DM. The Latino paradox in neighborhood context: the case of asthma and other respiratory conditions. *Am J Public Health*. 2007;97(5):919–925.
24. Osypuk TL, Bates LM, Acevedo-Garcia D. Another Mexican birth weight paradox? The role of residential enclaves and neighborhood poverty in the birth weight of Mexican-origin infants. *Soc Sci Med*. 2010;70(4):550–560.
25. Surveillance, Epidemiology, and End Results Program. National Cancer Institute. Site recode ICD-O-3/WHO 2008 definition. Available at: http://seer.cancer.gov/siterecode/icdo3_dwhohome/index.html. Accessed September 29, 2014.
26. North American Association of Central Cancer Registries Race and Ethnicity Work Group. NAACCR guideline for enhancing Hispanic/Latino identification: revised NAACCR Hispanic/Latino Identification Algorithm [NHIA v2.2]. 2009. Available at: <http://www.naacr.org/LinkClick.aspx?fileticket=i6MN9F8c1eU%3D&tabid=92>. Accessed September 29, 2014.
27. Pew Hispanic Center. Demographic profile of Hispanics in California, 2009. Available at: <http://pewhispanic.org/states/?stateid=CA>. Accessed October 7, 2011.
28. Pew Hispanic Center. Survey brief: Latinos in California, Texas, New York, Florida, New Jersey. 2005. Available at: <http://pewhispanic.org/files/factsheets/10.pdf>. Accessed October 7, 2011.
29. Block G, Matanoski GM, Seltzer RS. A method for estimating year of birth using social security number. *Am J Epidemiol*. 1983;118(3):377–395.
30. Gomez SL, Glaser SL. Quality of birthplace information obtained from death certificates for Hispanics, Asians, and Pacific Islanders. *Ethn Dis*. 2004;14(2):292–295.
31. Yost K, Perkins C, Cohen R, Morris C, Wright W. Socioeconomic status and breast cancer incidence in California for different race/ethnic groups. *Cancer Causes Control*. 2001;12(8):703–711.
32. Keegan THM, John EM, Fish KM, Alfaro-Velcamp T, Clarke CA, Gomez SL. Breast cancer incidence patterns among California Hispanic women: differences by nativity and residence in an enclave. *Cancer Epidemiol Biomarkers Prev*. 2010;19(5):1208–1218.
33. Liu L, Deapen D, Bernstein L. Socioeconomic status and cancers of the female breast and reproductive organs: a comparison across racial/ethnic populations in Los Angeles County, California (United States). *Cancer Causes Control*. 1998;9(4):369–380.
34. Gomez SL, Glaser SL, McClure LA, et al. The California Neighborhoods Data System: a new resource for examining the impact of neighborhood characteristics on cancer incidence and outcomes in populations. *Cancer Causes Control*. 2011;22(4):631–647.
35. Chang ET, Yang J, Alfaro-Velcamp T, So SKS, Glaser SL, Gomez SL. Disparities in liver cancer incidence by nativity, acculturation, and socioeconomic status in California Hispanics and Asians. *Cancer Epidemiol Biomarkers Prev*. 2010;19(12):3106–3118.
36. Chang ET, Gomez SL, Fish K, et al. Gastric cancer incidence among Hispanics in California: patterns by time, nativity, and neighborhood characteristics. *Cancer Epidemiol Biomarkers Prev*. 2012;21(5):709–719.
37. Schupp CW, Press DJ, Gomez SL. Immigration factors and prostate cancer survival among Hispanic men in California: does neighborhood matter? *Cancer*. 2014;120(9):1401–1408.
38. Patel MI, Schupp CW, Chang ET, Gomez SL, Wakelee HA. How do social factors explain outcomes in non-small cell lung cancer among Hispanics in California? Explaining the Hispanic Paradox. *J Clin Oncol*. 2013;31(28):3572–3578.
39. Cancer Reporting in California System Standards. California Cancer Registry. Data Standards and Quality Control Unit. Sacramento, CA: State of California Department of Public Health; 2011;1(1):1–602.
40. Howell LP, Gurusinge S, Tabnak F, Sciortino S. Cervical cancer screening in medically underserved California Latina and non-Latina women: effect of age and regularity of Pap testing. *Cancer Detect Prev*. 2009;32(5-6):372–379.
41. Franzini L, Ribble J, Keddie A. Understanding the Hispanic paradox. *Ethn Dis*. 2001;11(3):496–518.
42. Abraido-Lanza AF, Chao MT, Flórez KR. Do healthy behaviors decline with greater acculturation?: Implications for the Latino mortality paradox. *Soc Sci Med*. 2005;61(6):1243–1255.
43. Abraido-Lanza AF, Dohrenwend BP, Ng-Mak DS, Turner JB. The Latino mortality paradox: a test of the “salmon bias” and healthy migrant hypotheses. *Am J Public Health*. 1999;89(10):1543–1548.
44. Massey D, Denton N. Spatial assimilation as a socioeconomic outcome. *Am Sociol Rev*. 1985;50(1):94–106.
45. Charles CZ. The dynamics of racial residential segregation. *Annu Rev Sociol*. 2003;29:167–207.
46. Turra CM, Elo IT. The impact of salmon bias on the Hispanic mortality advantage: new evidence from social security data. *Popul Res Policy Rev*. 2008;27(5):515–530.
47. Gomez SL, Glaser SL. Misclassification of race/ethnicity in a population-based cancer registry (United States). *Cancer Causes Control*. 2006;17(6):771–781.
48. Pew Hispanic Center. Ranking Latino populations in the states. 2013. Available at: <http://www.pewhispanic.org/2013/08/29/i-ranking-latino-populations-in-the-states>. Accessed March 20, 2014.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.