AN ECOLOGICAL ANALYSIS OF THE INCIDENCE OF INVASIVE SQUAMOUS CELL CARCINOMA OF THE CERVIX IN HISPANIC WOMEN IN THE UNITED STATES

Purpose: To evaluate the relationship between county-level characteristics and the incidence of invasive squamous cell carcinoma of the cervix among Hispanic women.

Methods: The Surveillance, Epidemiology and End Results (SEER) Program's 18 registries from 2000–2009 were queried. Average annual age-adjusted incidence rates for invasive squamous cell carcinoma of the cervix among Hispanic women were calculated. Patients were then stratified by residence in a county with high vs low percent language isolation (LI), income, and education levels.

Results: Among Hispanic women living in high LI, the highest incidence of cervical cancer was found among women residing in counties with low incomes and low education levels (11.3; CI: 10.8–11.8).

Conclusions: County-level characteristics are associated with cervical cancer incidence in Hispanic women. A more precise understanding of contributing socioeconomic factors such as language may facilitate the design of targeted research studies and interventions, and community-level public policy interventions might be effective in reducing the unequal burden of cervical cancer in Hispanic women in the United States. (*Ethn Dis.* 2014;24[2]:243–247)

Key Words: Hispanic, Latina, Cervical Cancer, County Characteristics, Language Isolation, Education, Income

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INTRODUCTION

In the United States, Hispanic women carry a disparate burden of cervical cancer. The age-adjusted incidence of cervical cancer for Hispanic women is 12.7 per 100,000 as compared to 8.2 per 100,000 for all US women.[1] The use of timely screening including the Pap smear and now HPV testing has drastically reduced the incidence of squamous cell carcinoma of the cervix in the United States, suggesting that disparities in incidence may be attributed to barriers to receiving these highly efficacious prevention methods.[2–5]

The majority of research in this area has primarily focused on identifying the individual level factors that predict the incidence of cervical cancer in Hispanic women, but few researchers have focused on the relationship between environment and the incidence of cervical cancer in this population.[6–8] This is a significant gap given that individuals do not exist in a vacuum and as such their health outcomes may result from interactions between individual behavioral decisions and the environment in which they live. Therefore, to better understand the high incidence of cervical cancer among Hispanic women in the United States, we must develop a theoretical model that identifies both the individual level predictors along with environmental predictors. This will help inform the development and refinement of multilevel interventions as called for in the Institute of Medicine's *Healthy People 2010*.[9]

Predominant behavioral theories such as Social Cognitive Theory[10] and the Health Belief model[11] suggest that health behaviors and health outcomes are primarily under an individual's control. Social ecological models (SEM) of behavior, on the other hand, hypothesize that individuals and their environments are inextricably linked and together provide a more comprehensive explanation of behavioral outcomes.[12] Furthermore, SEM posit that behavior is ultimately a product of individual level factors (ie, personality characteristics, education level, socioeconomic status [SES]) and environmental level factors (eg, the community of residence and cultural factors).[13]

Prior research on individual level factors has demonstrated that indicators of SES, such as low income and educational attainment may be associated with a higher incidence of cervical cancer among Hispanic women;[14–16] and language spoken is also a barrier to cervical cancer screening.[17] Nonetheless, SEM indicate that the potential effects of environment level factors on cervical cancer incidence should also be examined. This may be of particular importance in the Hispanic population where there is a tendency, especially among immigrants, to settle in an area with a high concentration of Hispanics (primarily Spanish-speaking), also known as an ethnic enclave, in order to facilitate their transition into US culture.[18] Some researchers have found that Hispanics residing in ethnic enclaves suffer lower mortality rates, report better general health, and suffer lower overall disease prevalence compared to Hispanics who do not reside in ethnic enclaves.[19,20] However, other researchers have found that Hispanics residing in ethnic enclaves are at greater

risk of depression[21] and receive poorer quality hypertension care[22] than Hispanics who do not reside in ethnic enclaves. In addition, researchers have found that Hispanics living in ethnic enclaves have limited access to health care specialists.[23–24] Given that these conflicting findings may impact the health outcome under investigation, researchers should consider the effects of residing in a community with low vs high income, low vs high educational attainment, and residing in a community where the majority of individuals speak English vs Spanish on the incidence of cervical cancer in Hispanic women.

The availability of large cancer registries such as the Surveillance, Epidemiology and End Results (SEER) database help researchers examine these research questions.[24] The SEER database provides county-level information on the Hispanic women diagnosed with cervical cancer that includes: county income level, county educational level, and county language isolation level. The US Census Bureau began collecting data on a household's inability to communicate in English (ie, linguistic isolation) in 1990 census when it became clear that this was a barrier to communicating with government agencies and receiving medical and social services.[25] A household is considered linguistically isolated if all members aged ≥14 years speak a non-English language and also have difficulty with the English language. The SEER database provides the language isolation level all of the counties in which individuals who have been diagnosed with cancer reside. Previous research has found that language isolation (LI) is associated with malignancies such as colorectal and lung cancer.[26] As such, it may also be associated with the incidence of cervical cancer among Hispanic women. To our knowledge, researchers have not yet examined the relation between these environmental factors and the incidence of cervical cancer among Hispanic women.

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ronmental or community factors (ie, language isolation, county education level, and county income level) on the incidence of invasive squamous cell carcinoma of the cervix in Hispanic women. In addition to the direct effects of the community factors on the incidence of cervical cancer, we also examined the interaction of LI with county education and income level to determine their combined association with the incidence of invasive squamous cell carcinoma of the cervix in Hispanic women.

METHODS AND STATISTICS

The SEER Program's 18 registries from 2000–2009 were queried and average annual age-adjusted incidence rates and 95% confidence intervals per 100,000 Hispanic women for invasive squamous cell carcinoma of the cervix were calculated using SEER*Stat 7.0.5 (Silver Spring, MD). Patients were evaluated by residence in a county with high vs low percent LI (sample median: 0–9.72% vs 9.73–33.89%), percent of Hispanics with < high school education (sample median: 2.53–54.40% vs 54.41–90.91%) and percent of Hispanic families below the poverty level (sample median: 0–20.79% vs 20.80–73.33%). Counties were then grouped by language isolation (low LI and high

LI) and incidence rates were calculated for women residing in: high income and high education counties, high income and low education counties, low income and high education counties, and low income and low education counties.

Rates are per 100,000 and age-adjusted to the 2000 US population standard; confidence intervals are 95% for rates. Confidence intervals around each proportion were calculated using Bayes' method.[27] This study was approved by the Institutional Review board of the University of California, San Diego, Medical Center.

RESULTS

From 2000–2009, 5,534 Hispanic women with squamous cell carcinoma of the uterine cervix were registered in SEER. Incidence rates were highest among those living in counties with high levels of LI (10.7 vs 8.9), low levels of education (10.8 vs 8.9) or low levels of income (11.0 vs 8.7) (Table 1).

Counties were then stratified by language isolation (low LI and high LI) and incidence rates were calculated for education and income. Among Hispanic women living in low LI, the highest incidence of cervical cancer was found among women is among women residing in counties with low incomes and a low education levels (11.0; CI: 9.5–12.6). This was followed by residence in low income counties with high education levels (9.9; CI: 8.9–11.1). The lowest incidence of cervical cancer was found among Hispanic women residing in counties with high incomes and low education levels (8.2; CI: 6.5–10.1). This was followed by residence in high income counties with high education levels (8.6; CI: 8.2–9.0). These findings indicate that in low language isolated counties, county income level has a greater impact on the incidence of squamous cell carcinoma of the cervix among Hispanic women than county education level (Table 2).

Table 1. Incidence of squamous cell carcinoma of the cervix among Hispanic women by county characteristics

County Variable	Rate	Lower CI	Upper CI	*n*	Population
Language isolation					
Low	8.9	8.5	9.2	2,624	39,154,434
High	10.7	10.3	11.1	2,910	35,947,063
Education					
Low	10.8	10.4	11.3	2,774	35,594,536
High	8.9	8.5	9.2	2,747	39,333,882
Income					
Low	11.0	10.6	11.5	2,779	33,820,595
High	8.7	8.4	9.1	2,742	41,107,823

Hispanic women residing in the counties with the worst characteristic profiles (ie, high percent of LI, low levels of income and education) have a significantly higher incidence of cervical cancer compared to Hispanic women who live in counties with the best characteristic profiles…

Among Hispanic women living in high LI, the highest incidence of cervical cancer was found among women residing in counties with low incomes and low education levels (11.3; CI: 10.8–11.8). This was followed by residence in high income counties with high education levels (9.8; CI: 8.8–10.8). The lowest incidence of cervical cancer was found among Hispanic women residing in counties with high incomes and low education levels (9.2; CI: 8.1–10.3). This was followed by residence in low income counties with high education levels (9.4; CI: 7.6–11.5). These findings indicate that in high language isolated counties, county income level appears to have a greater influence on the incidence of squamous cell carcinoma of the cervix among Hispanic women residing in counties with low education levels (Table 3).

CONCLUSIONS

We found that among Hispanic women, county-level characteristics influence the incidence of cervical cancer.

Hispanic women residing in the counties with the worst characteristic profiles (ie, high percent of LI, low levels of income and education) have a significantly higher incidence of cervical cancer compared to Hispanic women who live in counties with the best characteristic profiles (ie, low percent of LI, high levels of income and education). This finding is consistent with previous research on the influence of county-level factors on the incidence of other types of cancer[28–31] and supports the idea that it is important to develop social ecological models that explain cervical cancer incidence. This will allow us to develop effective multilevel interventions to reduce the incidence of cancer,[9] including invasive squamous cell carcinoma of the cervix among Hispanic women.

In addition to making important observations about the population as a whole, many of these county characteristics may also serve as proxies for individual characteristics. Several demographic individual level factors have been linked to cervical cancer incidence in Hispanic women. For example,

annual household income has been found to be inversely related to being diagnosed with cervical cancer among Hispanic women.[32–33] In addition, Hispanic women with higher levels of educational attainment are also less likely to be diagnosed with cervical cancer than women with lower levels of educational attainment.[32–33] This may be due, in part, to women with lower levels of educational attainment lacking both the knowledge and the financial resources necessary to receive timely cervical cancer screening. Finally, Hispanic women who do not speak English are less likely to undergo regular screening and thus more likely to be diagnosed with cervical cancer compared to Hispanic women who speak English.[17,34–35] In sum, all of these individual level factors are thought to increase the risk of being diagnosed with cervical cancer in this population because they are barriers to care that may

Table 2. Cervical squamous cell carcinoma incidence in Hispanic women residing in counties with low language isolation by income and education levels

Income	Education	Rate	Lower CI	Upper CI	*n*	Population
High	High	8.6	8.2	9.0	1,943	29,473,264
High	Low	8.2	6.5	10.1	103	1,943,219
Low	High	9.9	8.9	11.1	336	4,328,040
Low	Low	11.0	9.5	12.6	229	3,236,856

Table 3. Cervical squamous cell carcinoma incidence in Hispanic women residing in counties with high language isolation by income and education levels

Income	Education	Rate	Lower CI	Upper CI	n	Population
High	High	9.8	8.8	10.8	374	4,337,625
High	Low	9.2	8.1	10.3	322	5,353,715
Low	High	9.4	7.6	11.5	94	1,194,953
Low	Low	11.3	10.8	11.8	2,120	25,060,746

hinder receiving timely screening for cervical cancer.[36] Our study supports previous research demonstrating the influence of income, education, and language spoken on being diagnosed with cervical cancer. However, our findings highlight that environmental/community level factors also influence the incidence of squamous cell carcinoma among Hispanic women. Future research should examine the influence of language, income and education, on the incidence of invasive squamous cell carcinoma of the cervix on both an individual and environmental level in a single study. For example, does an English-speaking woman living in a predominately Spanish speaking, low income, and low education environment have similar cancer risk as a Spanish-speaking woman?

In order to better understand the relationship between county-level LI, county-level income, and county-level education we separated the sample by Hispanic women living in low LI counties from those living in high LI counties. Once separated, we examined the incidence rates of squamous cell carcinoma of the cervix for different combinations of income and education (ie, high income and high education; high income and low education; low income and high education; and low income and low education). In both low LI counties and high LI counties, the highest incidences of squamous cell carcinoma were found among Hispanic women residing in both low income and low education counties. This emphasizes the combined influence of income and education on the incidence of squamous cell carcinoma among Hispanic women. Further, the lowest

incidences were found among those women residing in high income and low education counties. This pattern implies that, regardless of language isolation, county income may play a larger role than education in the incidence of squamous cell carcinoma of the cervix. To our knowledge ours is the first study to examine these factors in this population. Future research should investigate the reasons why different combinations of county characteristics influence the incidence of invasive squamous cell carcinoma of the cervix in Hispanic women.

Despite the similar pattern of high and low incidence rates by level of LI, the incidences of squamous cell carcinoma of the cervix are higher among Hispanic women residing in high LI counties. This finding highlights the importance of LI on a community level and suggests the need for further investigation. Since language has previously been identified as a barrier to Hispanic women's access to cervical cancer screening,[37] our findings are not surprising; This finding lends strength to the argument for more cultural and language specific community level interventions.[38–39]

There are limitations to research utilizing registry data. Since these data are observational, conclusions regarding causality cannot be made. We are also limited by the absence of certain potentially meaningful variables in the SEER database; therefore, we are unable to assess language, income, or education on an individual level. In addition, we are not able to control for other known risk factors for cervical cancer such as sexual history, HPV status, or medical history. With large registry data such as SEER and the US

Census, there is a potential for misclassification bias due to entry variation among sites. This study excluded women with adenocarcinomas, as there is not a highly effective method of screening for this cell type; therefore, is not as influenced by factors that impact receipt of care. Despite these limitations, the large size and geographical diversity of the sample strengthen our study's generalizability.

With increasing acceptance of cervical cancer screening, the mortality rate from cervical cancer in the United States has been decreasing. Hispanic women have a disproportionately high risk of cervical cancer, and county-level factors such as LI, income, and education magnify the disparity. By identifying the environmental-level factors related to the incidence of cervical cancer, we can focus on reducing barriers to care associated with county of residence. This will allow us to improve access to screening, thereby further reducing disparities in the incidence of cervical cancer.

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AUTHOR CONTRIBUTIONS

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