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An ecological analysis of the incidence of invasive squamous cell carcinoma of the cervix in Hispanic women in the United States

Kristy K. Ward, M.D.¹, Angelica M. Roncancio, Ph.D.², Miguel Angel Cano, Ph.D.³, and Steven C. Plaxe, M.D.¹

¹Rebecca and John Moores UCSD Cancer Center, Department of Reproductive Medicine, Division of Gynecologic Oncology, La Jolla, CA- KKW

²The University of Texas School of Public Health, Center for Health Promotion and Prevention Research, Houston, TX

³The University of Texas MD Anderson Cancer Center, Department of Health Disparities Research, Houston, TX

Abstract

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 17 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 versus low percent language isolation, 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); among those 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.

Keywords

Hispanic; Latina; Cervical cancer; county characteristics; language isolation; education; income

Address correspondence and reprint requests to: Kristy K. Ward, M.D., UCSD Moores Cancer Center, Department of Reproductive Medicine, 3855 Health Sciences Dr., #0987, La Jolla, CA 92093-0987, Tel.: +1 (858) 822-6199, fax: +1 (858) 822-6319, kristy.kay.ward@gmail.com.

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 U.S. women¹. 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 U.S., suggesting that disparities in incidence are likely secondary 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 U.S., 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 *Health 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 SEM posit that behavior is ultimately a product of individual level factors (personality characteristics, education level, SES) and environmental level factors (the community of residence and cultural factors).¹³

Prior research on individual level factors has demonstrated that indicators of socioeconomic status, 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 indicates that the potential effects of environment level factors on cervical cancer incidence should also be examined. Specifically, researchers should consider the effects of residing in a community with low versus high income, low versus high educational attainment, and residing in a community where the majority of individuals speak English versus 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.¹⁸ 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 U.S. Census Bureau began collecting data on a household's inability to communicate in English (i.e., linguistic isolation) in the 1990 census when it became clear that this was a barrier to communicating with government agencies and receiving medical

and social services.¹⁹ A household is considered linguistically isolated if all members age 14 years and older 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.²⁰ 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.

The objective of this study was to examine the direct effects of the environmental or community factors (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 examine the interaction of language isolation with county education level and county 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 versus low percent language isolation (sample median: 0–9.72% v. 9.73–33.89), percent of Hispanics with less than a high school education (sample median: 2.53–54.40% v. 54.41–90.91%) and percent of Hispanic families below the poverty level (sample median: 0–20.79% v. 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 Std Population standard; confidence intervals are 95% for rates. Confidence intervals around each proportion were calculated using Bayes' method.²¹ 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 v. 8.9), low levels of education (10.8 v. 8.9) or low levels of income (11.0 v. 8.7). Table 1 provides additional information including confidence intervals.

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). 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 provides additional information.

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. However, the incidence of cervical cancer among Hispanic women residing in High LI counties become more similar among women residing in counties with high education levels, regardless of county income level. Table 3 provides additional information.

CONCLUSIONS

We found that among Hispanic women, county level characteristics influence the incidence of cervical cancer. Those Hispanic women residing in the counties with the worst characteristic profiles (i.e., high percent of language isolation, 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 (i.e., low percent of language isolation, 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^{22–25} 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 This includes the reduction of 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. 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.^{26–27} 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.^{17,28–29} 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 hinder receiving timely screening for cervical cancer.³⁰ 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. This will elucidate how these factors may interact to predict squamous cell carcinoma incidence among Hispanic women.

In order to better understand the relationship between county-level language isolation, county-level income, and county-level education we separated the sample by Hispanic women living in low language isolated counties from those living in high language isolated counties. Once separated, we examined the incidence rates of squamous cell carcinoma of the cervix for different combinations of income and education (i.e., high income and high education; high income and low education; low income and high education; and low income and low education). In both low language isolated counties and high language isolated 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 this 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. For example, we should examine what resources are available or lacking in these counties that affect the incidence squamous cell carcinoma among Hispanic women. Such information can inform the development of efficacious community-level interventions to increase cervical cancer screening and improve treatment in counties with the worst profiles, as this may have the greatest impact on the cancer incidence for the overall population.

Despite the similar pattern of high and low incidence rates by level of language isolation, the incidences of squamous cell carcinoma of the cervix are higher among Hispanic women residing in high language isolated counties. This finding highlights the importance of language isolation on a community level and suggests the need for further investigation. This is the first paper to report the association between LI and the incidence of squamous cell carcinoma of the cervix among Hispanic women. Since language has previously been identified as a barrier to Hispanic women's access to cervical cancer screening,³¹ our findings are not surprising. The majority of Hispanic women in the population live in counties with higher levels of language isolation. This finding lends strength to the argument for more cultural and language specific community level interventions.^{32–33}

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 U.S. Census, there is a potential for misclassification bias due to entry variation among sites. This study excludes 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 the 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 language isolation, income, and education magnify the disparity. By identifying the environmental-level factors related to the incidence of cervical cancer, we can focus on improving 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. We have found that county characteristics, in addition to individual characteristics, are important in risk of cervical cancer in Hispanic women, making it plausible that community-level public policy interventions might be effective in reducing the unequal burden of cervical cancer in this population.

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Table 1
 Incidence of Squamous Cell Carcinoma of the Cervix among Hispanic Women by County Characteristics

| County Variable | Rate | Lower CI | Upper CI | Count | 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 | 10.6 | 11.5 | 2,779 | 33,820,595 |
| High | 8.7 | 8.4 | 9.1 | 2,742 | 41,107,823 |

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 | Count | Population |
|--------|-----------|------|----------|----------|-------|------------|
| High | High | 8.6 | 8.2 | 9 | 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 | 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 | Count | 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 |