RESEARCH

Hysterectomy-corrected Cervical Cancer Incidence Reveal Larger Racial Disparities in Texas 2012-2014

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ABSTRACT

The purpose of this study was to determine the race specific age-standardized and age-specific annual Texas cervical cancer incidence after correcting for hysterectomy prevalence. A registry-based cross-sectional study design using Texas State level data for the years 2012-2014 was used to evaluate cervical cancer incidence after applying a correction for hysterectomy and examined racial disparities by age and race. We merged into a single database annual age- and race-stratified hysterectomy prevalence, cervical cancer incident case counts, population at-risk denominators and US Census 2000 population weights using the Behavioral Risk Factor Surveillance System (BRFSS) and Texas Cancer Registry (TCR), and used these data to estimate hysterectomy-corrected, age-standardized and age-specific cervical cancer incidence. Significant differences in hysterectomy prevalence by race were seen. For women aged 35-44 years, hysterectomy rates were highest in non-Hispanic whites. Among non-Hispanic blacks and Hispanics, the prevalence of hysterectomy peaked between the ages of 55 and 64 years, but thereafter continued to increase dramatically with age but only in non-Hispanic whites. The largest adjustment between corrected and uncorrected cervical cancer rates (17.1%) was in non-Hispanic white women followed by Hispanics (4.1%) and non-Hispanic blacks (3.6%). Failing to correct reported cervical cancer rates underestimates the true burden of disease. Hysterectomy prevalence in Texas also suggest disparities in access to care based on race. These findings provide further evidence-based information to develop more effective region and ethnic specific cervical cancer prevention programs using unbiased estimates of disease burden.

KEYWORDS: Disparities, Racial, Cervical, Cancer

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Introduction

The Centers for Disease Control and Prevention (CDC) United States (US) Cancer Statistics Data Visualization Tool shows that for the years 2011-2015, the incidence of cervical cancer was the highest for Hispanic females between the age of 40-45 residing in Southern states [1]. Though ostensibly valid, this conclusion is subject to underlying bias. Women who have undergone surgical removal of the cervix and uterus (hysterectomy) are no longer at risk for developing cancers in these organs and should therefore be excluded from the denominator when estimating incidence [2]. Yet current reports of cervical cancer incidence in the US use uncorrected rates, potentially masking cervical cancer disparities [3]. Similar studies in some states and in other countries show underestimation of cervical cancer burden among whites and blacks using this correction but were unable to evaluate the effect in Hispanics due to insufficient sample sizes [4]. A study using Massachusetts state level data reported that age standardized, corrected cervical cancer incidence among Hispanics resulted in a 28.3% increase from uncorrected rates compared to a 17.1% increase in non-Hispanic whites [5,6]. Furthermore, geographic setting in the US, regardless of race, points to women in Southern regions having both higher cervical cancer incidence and mortality rates than their counterparts in other US regions [7]. Thus, Texas state-level data provides the opportunity to evaluate the effect of correction on cervical cancer incidence among a large Hispanic population in a Southern region of the US. The purpose of this paper is to determine the age-standardized and age-specific annual hysterectomy corrected-cervical cancer incidence using Texas State level data for the years 2012-2014 and evaluate disparities by age and race.

Materials and Methods

A registry-based cross-sectional design using the Texas Cancer Registry (TCR) cervical cancer incidence data and the Behavioral Risk Factor Surveillance System (BRFSS) data was used to arrive at age-specific and age-standardized hysterectomy corrected cervical cancer incidence. At the time of data access, the only complete and valid years with both cervical cancer incidence and hysterectomy prevalence data limited our analysis to only 2012-2014. The TCR Institutional Review Board deemed this study exempt from review since it did not involve human subjects and only used publicly available de-identified information.

Data Sources and Linkage

Cervical Cancer incidence

State cancer registries are passive surveillance systems to which all state health care facilities that diagnose or treat cancer patients must report their cases to. For this study we obtained a limited-use cancer incidence dataset from the Texas Cancer Registry (TCR). Using the proprietary software SEER*Stat version 8.3.5 to open the limited-use dataset, we extracted the crude and adjusted cervical cancer incidence, counts, population at risk, and US 2000 Standard Population age- and race- stratified for the years 2012-2014 [8]. Only women 18 years or older with primary ICD-O-3 site codes C53.0 Cervix Uteri excluding 9050-9055, 9140, 9590-9992 (morphological codes related to lymphoma and leukemias) were included in this analysis. The samples obtained for all three years had their own sample sizes and weights.

Hysterectomy prevalence

The Behavioral Risk Factor Surveillance System (BRFSS) established in 1984, is an annual population-based health-related telephone survey performed in all 50 states [9]. Each state randomly samples their area and collects information regarding health-related risk behaviors, chronic health conditions and use of preventive services in non-institutionalized adults. In 1988 the question "Have you ever had a hysterectomy?" was added and administered for the Texas survey of every even numbered year [9]. After obtaining access to the SAS datasets for the Texas BRFSS surveys for the years 2012 and 2014, we extracted survey-weighted, stratum-equivalent age- and race-stratified hysterectomy prevalence for each year using SAS 9.4. Hysterectomy prevalence estimates for the year 2013 were calculated using the weighted average of the flanking years.

Data Merge

The annual age- and race-stratified hysterectomy prevalence (*hx*) from BRFSS, cervical cancer incident case counts (*n*), population at risk denominator (*p*) and US Census 2000 population weights from TCR were merged into an Excel worksheet. The hysterectomy corrected population at risk denominator (p_c) was calculated in Excel using the following formula:

$$p_c = p * (1 - hx)$$

Statistical Analysis

Hysterectomy prevalence estimates were obtained using STATA 15 and graphs and trends created using R Studio. Age-standardized and age-specific corrected and uncorrected incidence, 95% confidence intervals (95%CI), rate ratios and p-values were produced using PROC STDRATE command in SAS 9.4. Direct standardization using the US Census 2000 population weights for both corrected and uncorrected estimates. Tiwari, Cleg and Zou methodology for efficient interval estimation for cancer rates used in SEER*Stat was used to produce our estimates using SAS [10].

Results

Hysterectomy Prevalence

For 2014, 7,933 women answered the survey's hysterectomy question, 28.1% were Hispanic, 63.7% non-Hispanic white, and 8.2% were non-Hispanic black.

Overall the prevalence of hysterectomy for women ≥18 years of age was 22.74 per 100,00 (95% CI, 21.2%-23.3%). Figure 1 shows the age-specific estimates of hysterectomy prevalence by three races (NH white; NH black; and Hispanic). Hysterectomy prevalence increased with age for all races but diverged markedly beginning at the 45-54 year age category and older. In women over age 65, the hysterectomy prevalence rates were significantly higher among non-Hispanic white women, compared with non-Hispanic black ($p = 0.021$) and Hispanics ($p = 0.035$).

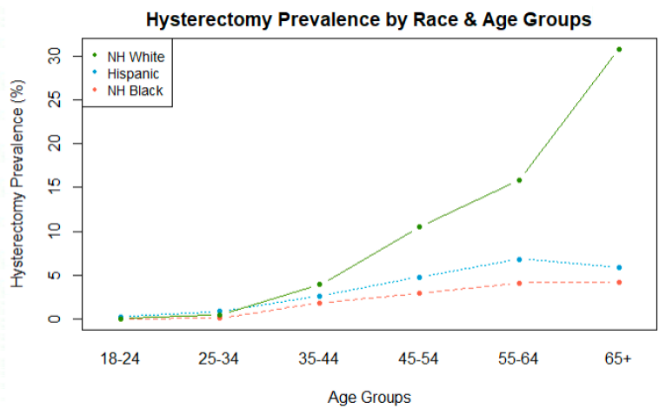

Figure 1. Line plot of Texan women hysterectomy prevalence per 100 by age group and race in 2012-2014. There is a marked difference in women with hysterectomies depending on their race and

age. NH white women have higher hysterectomy prevalence than Hispanic and NH black women and is most distinctly observed in age groups older than 35. (NH: non-Hispanic)

Age-specific and age-standardized Cervical Cancer Incidence

For the year 2012, 12,509,180 women consisted of 39.6% Hispanic, 47.6% non-Hispanic whites and 12.8% non-Hispanic blacks similar to 2013. For the 12,890,550 women in 2014, 40.2% were Hispanic, 46.8% non-Hispanic white and 13.0% non-Hispanic black.

Age-specific cervical cancer (CC) incidence was highest for Hispanics for most excluding 18-24 and 65+ age categories, followed by non-Hispanic blacks and then non-Hispanic whites, even after correction for hysterectomy. Table 1 shows that correction for hysterectomy increased CC incidence in all three categories. The most noteworthy change after correction was in non-Hispanic white women 65+ with a 46% increase in CC incidence.

Table 1. Uncorrected and Corrected Age-specific cervical cancer incidence and percentage increase (Rate per 100,000)

	Non-Hispanic white			Non-Hispanic black			Hispanic		
	Uncorrected Rate	Corrected Rate	% Increase	Uncorrected Rate	Corrected Rate	% Increase	Uncorrected Rate	Corrected Rate	% Increase
18-24	1.1	1.1	0	0.8	0.8	0	0.6	0.6	0
25-34	9.4	9.5	1	6.1	6.1	0	10.5	10.6	1
35-44	14.6	15.2	4	10.4	10.6	2	15.4	15.9	3.2
45-54	10.2	11.4	10.5	14.5	15.0	3.4	16.6	17.4	4.8
55-64	9.4	11.2	19	16.5	17.3	4.8	16.6	17.8	7.2
65+	6.3	9.2	46	20.8	21.8	4.8	14.5	15.4	6.2

Age-standardized cervical cancer incidence increased in all races after correction for hysterectomy and was highest among Hispanics overall, both before and after correction. Table 2 shows the age-standardized cervical cancer incidence and 95% confidence intervals by race before and after the correction.

Table 2. Age-standardized Cervical Cancer Incidence, Uncorrected and Corrected for the Prevalence of Hysterectomy for NH white, NH black, and Hispanic 2012-2014 (Rate per 100,000)

	UNCORRECTED						CORRECTED					
	NH white		NH black		Hispanic		NH white		NH black		Hispanic	
	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
2012	8.7	[7.9,9.6]	12.1	[10.8,15.0]	11.8	[10.6,13.0]	9.7	[8.8,10.7]	13.3	[11.1,15.5]	12.3	[11.0,13.6]
2013	8.5	[7.6,9.3]	9.9	[8.1,11.7]	12.4	[11.2,13.6]	9.4	[8.5,10.3]	10.2	[8.4,12.0]	12.9	[11.6,14.2]
2014	8.7	[7.9,9.6]	10.3	[8.5,12.2]	12.3	[11.1,13.5]	9.9	[8.9,10.8]	10.7	[8.8,12.6]	12.8	[11.6,14.0]
Overall	8.2	[8.2,9.2]	11.0	[9.9,12.1]	12.2	[11.5,12.9]	9.6	[9.1,10.2]	11.4	[10.2,12.5]	12.7	[11.9,13.4]

Corrected rate ratio comparing rates between overall Hispanics and NH whites (reference group) was 1.31 (p <0.0001) and uncorrected was 1.40 (p <0.0001). The difference between NH whites and Hispanic incidence decreased after correction but remained significant. For NH blacks the rate ratio increased after correction (1.27; p<0.0001) compared with the uncorrected rate ratio (1.17; p=0.0049). Figure 2 shows the percent increase between corrected and uncorrected age-standardized cervical cancer incidence in each race. NH white rates increased the most overall with a 17.1% increase compared to 4.1% in Hispanics and 3.6% in NH blacks.

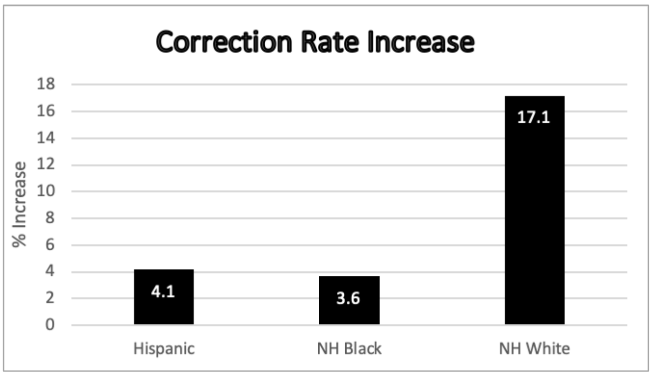

Figure 2. Bar chart of percent increase between corrected and uncorrected cervical cancer rates for each race. Although NH White had the biggest changes among the corrected and uncorrected rates Hispanics remained having the highest age-specific and age-standardized cervical cancer rates.

Discussion

Integration of national surveillance databases provide the means for correcting reported biased gynecological cancer rates. Our study revealed greater cervical cancer incidence and marked racial disparity than currently reported in Texas. Hysterectomy correction on the Texas demographic uncovered that although correction increases incidence across all races, NH whites and Hispanic women have a higher burden of cervical cancer and discrepancies in hysterectomy prevalence. Hysterectomy prevalence trends in Texas differ among NH white, NH black and Hispanic women with a higher prevalence among NH whites, among whom there is high frequency in older age groups. The difference in hysterectomy prevalence also reveals racial disparities in access to care, primarily surgery which may be elective. Cervical cancer incidence after correction increased for all races but had the highest impact on NH white women with an increase of 17.1% compared to 4.1% and 3.6% for Hispanics and NH blacks respectively. Correction of age-specific cervical cancer rates also retained the same significant differences but showed a marked increase in NH white women 65 years and older.

Cervical cancer screening and prevention has ameliorated its incidence and mortality through outreach programs. These initiatives reach out to all women considered at risk for developing cervical cancer. These women are then referred to clinics or programs that provide low-cost or free screening but fail to consider if these women have had a hysterectomy. Implementing this question in routine screening and outreach efforts can decrease the amount of unnecessary pap smears and vaccines administered as well as allowing clinics and programs to correct the gynecological cancer rates reported by them. Hysterectomy surveillance data collection in the US is ongoing but generally under-utilized and undervalued [11]. The American Congress of Obstetricians and Gynecologists (ACOG) reports hysterectomy as the second most frequently performed surgical procedure among US. women of reproductive age second only to Cesarean section [12]. This report used National Hospital Discharge Data to arrive at hysterectomy prevalence of 33 per 100,000 in 2008 and to demonstrate a steady decrease since 1980 (55.6 per 100,000). Another source of hysterectomy surveillance is BRFSS. This annual population-based surveillance system collects hysterectomy status for women over the age of 18, every even numbered year. This provides a source for continuous hysterectomy prevalence monitoring by races and states every other year that could be integrated with national or state level cancer registries to produce corrected cervical and uterine cancer rates. While adjustment of hysterectomy prevalence from BRFSS is a good approach to correct the biased rate, there are limitations in using BRFSS hysterectomy prevalence. One is that there is no specificity to the type of hysterectomy, age at surgery or reason for why the hysterectomy was performed, since it is self-reported without any surgical or medical details. The racial differences reveal bias probably due to access to care, however, this procedure may be elective and reflect social pressure as well as medical indications. The type of hysterectomy will determine whether a woman should be removed from the denominator for estimation of cervical cancer rate, as not all hysterectomies include the removal of the cervix (supracervical hysterectomy).

The strength in our method of cervical cancer hysterectomy corrected rates is contingent on the databases used. TCR and BRFSS, are samples representative of the Texas population, and provide a direct comparison. As opposed to another indirect method used for these types of analysis where they use National Hospital Discharge Data for national hysterectomy prevalence estimates and use the same prevalence to correct rates for all states [13].

Our results concur with findings of similar studies that revealed current cervical cancer incidence rates are an underestimation of disease burden especially among NH whites. The social determinant of access to health services is seen in effect in hysterectomy corrected cervical rates. Unequal access to healthcare by these races in Texas, in this case access to a physician trained to perform hysterectomies could cause the marked differences between hysterectomy prevalence's by race. Accurate, unbiased, assessment of both cervical cancer rates and racial disparities require the correction we report here. Efforts between national surveillance systems, outreach programs, and health care providers can improve screening programs by targeting women who truly are at risk as well as providing for more accurate depictions of geographical disparities of access to health care for women.

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Conflict of interest

The authors declare that no competing or conflict of interests exist. The funders had no role in study design, writing of the manuscript, or decision to publish.

Authors' contributions

Conceptualization: Isela De La Cerda and Susan P. Fisher-Hoch. Development of methodology: Isela De La Cerda and Miryoung Lee. Acquisition of Data: Isela De La Cerda. Analysis and interpretation of data: Isela De La Cerda and Miryoung Lee. Writing, review, and/or revision of the manuscript: Isela De La Cerda, Miryoung Lee, Susan P Fisher-Hoch, Kathleen Schmeler, Joseph B. McCormick. Administrative, technical, or material support: Miryoung Lee, Kathleen Schmeler, Susan P. Fisher-Hoch, Joseph B. McCormick.

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