



Racial Differences in the Cervical Cancer Screening Practices of Smokers and HPV-Infected Women Aged 18 To 65 Years Old

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Abstract

Background: Racial/ethnic minority women are at increased risk for cervical cancer. The objective of this study was to determine whether racial/ethnic disparities, smoking, and HPV infection disparities in cervical cancer screening participation exist among adult women aged 18 years and older in the United States, controlling for social determinants of health like level of education, income level, health status, health insurance, and marital status.

Methods: The sample included 12,186 white, Hispanic, African American, Asian, and American Indian/Alaskan Native women ages 18 to 65-years-old from the 2019 National Health Interview Survey. Bivariate and logistic regression analyses were performed to evaluate the associations between HPV infection and cigarette smoking in the past month (current, former, and never smoker) and obtaining a cervical cancer screening in the past two years (recent cervical cancer screening) controlling for sociodemographic and health variables.

Results: Sixty-two percent of respondents had recent cervical cancer screening, 32% smoked cigarettes or were former smokers, 67.9% never smoked cigarettes, and 1.2% reported being told they have an HPV infection. Former smokers were significantly more likely to have had a recent cervical cancer screening than non smokers (odds ratio (OR)) = 1.253, 95% confidence interval (CI) = 1.103-1.425). Women who self-reported having been told that they had cervical cancer had lower cervical cancer screening rates than those who did not have cervical cancer (odds ratio (OR)) = 0.676, 95% confidence interval (CI) = 0.473-0.967). Current smokers were more likely than never to have lower cervical cancer screening, regardless of their cervical cancer status. In this study, the interaction between cigarette smoking and cervical cancer screening has been observed among white and African American women.

Conclusions: To reduce cervical cancer disparities in incidence and mortality, it is essential to increase cervical cancer screening among women 18-65 years, especially among current smokers and older women.

Keywords

Smoking, Cervical cancer, Screening, Risk factors, HPV

Introduction

Cervical cancer is the fourth most common female cancer worldwide, with an estimated 570,000 new cases and 265,700 deaths per year. It is one of many health conditions that disproportionately affect women of specific racial/ethnic backgrounds [1]. Despite higher cervical cancer incidence and mortality rate reduction in recent years, Black women still have a greater cervical cancer incidence rate than Whites, with 10.4 per 100,000 vs. 7.8 per 100,000, respectively [2]. Geographic variations have been noted across the US, with the South having both the highest cervical cancer incidence and mortality rates compared to other areas [2]. Regional and racial/ethnic disparities in various health outcomes are

often associated with social determinants of health, such as education level, income level, and marital status [2]. According to the annual report on income/poverty, the south has the

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Accepted: November 25, 2023

Published online: November 27, 2023

Citation: Omba ECS, Caplan L (2023) Racial Differences in the Cervical Cancer Screening Practices of Smokers and HPV-Infected Women Aged 18 To 65 Years Old. J Cervical Cancer Res 5(1):337-344

lowest median income and highest poverty rate compared to other regions of the US [2]. In addition, the south has the highest percentage of Black residents, with about 56% of its population being black [3].

With its relatively early onset, cervical cancer mainly occurs during the reproductive ages of women, making it the most common cancer among women under the age of 45 in various countries [1]. It was once a leading cause of cancer death in US women, but its mortality rate has been reduced dramatically with the advent of the Pap smear. Cervical cancer screening is essential, and the association between cervical cancer screening and incidence has been stronger in more advanced stage cancers, with screening more effective at preventing death from cancer [4]. This might be partially due to differences in accessibility and availability of cervical cancer screening and HPV vaccination. Between 2005 and 2019, the rates of receiving timely cervical cancer screening fell overall in the US, and one cross-sectional study showed disparities among different ethnic groups of women [5].

Studies have shown that cervical cancer screening increases with education, ranging from 5% among those with no formal education to 51% among those with a college education [6]. In addition, studies have found lower cervical cancer screening rates among women who currently smoke and among Black, Hispanic, and Asian compared to white. The odds of former smokers complying with screening guidelines were not statistically different from those who never smoked [7].

I undertook this study to determine whether race, smoking, and HPV infection are associated with cervical cancer screening participation among adult women aged 18 years and older in the United States, controlling for social determinants of health like level of education, income level, marital status, health insurance, and health status using data from the 2019 National Health Interview Survey. We hypothesized significant associations between race, smoking, and HPV infection and participation in cervical cancer screening among adult women 18-65 years when controlling for socioeconomic determinants of health.

Methods

Data Source

A secondary analysis of National Health Interview Survey (NHIS) data from 2019 was performed. The study variables included the outcome variable cervical cancer screening, the exposure variables race, cigarette smoking, and HPV infection, and potential confounding variables such as age, level of education, income level, marital status, health insurance, and health status.

Independent variables

Race: Race was categorized as White, African American, Asian, and Native American/Alaskan Native. Women who reported belonging to multiple races were also included.

Cigarette smoking: This variable was a categorical variable that included the following four categories: Current smoker, former smoker, and never smoker.

HPV infection: Cervical cancer status was used to evaluate the HPV infection. Two tests are standard during cervical cancer screening: The PAP test and the HPV test. The NHIS questions included whether the woman got the HPV test at the most recent cervical cancer screening.

Dependent variable

Cervical cancer screening: The NHIS questions on cervical cancer included whether the woman ever had a cervical cancer screening, the most recent cervical cancer test, whether she had an HPV and PAP test at the most recent screening, the reason for her last test (part of a routine check-up, because of problem, follow-up or other), and the age she was diagnosed with cervical cancer.

Covariates

Age: The study sample included adult women aged 18-65 years. This variable was categorical and grouped into 5 categories: 18-29 years, 30-39 years, 40-49 years, 50-59 years, and 60+ years.

Highest education level: The NHIS question included the level of education of the respondent. The variable categories ranged from never attended school to a master's degree or higher.

Income: The NHIS question related to income was whether the respondent received her wages. This variable was categorical and was divided into four categories following the US. News & World Report: Poor or near-poor, lower-middle-class, middle class, and upper-middle class.

Marital status: The NHIS question on marital status asked, "Are you now married, living with your partner together as an unmarried couple, or neither?"

Health insurance: Participants were asked, "Are you covered by any health insurance or other kind of health care plan?" The variable was divided into two categories: Yes or no.

Health status: Participants were asked, "Would you say your health, in general, is excellent, very good, good, fair, or poor?" The NHIS question on health status was operationalized by a five-level ordinal variable of the respondent's general health rating.

Study population

Inclusion/exclusion criteria: The study subjects were respondents to the National Health Interview Survey (NHIS). At the interview, the target population was civilian, non institutionalized people residing within the 50 states and the District of Columbia. Individuals with no fixed household addresses were excluded.

Statistical analysis

Program (SPSS): A t-test is a statistical test used to compare the means of two groups. The t-test was used to assess the normality of the distribution of investigated parameters. All parameters in our study were distributed normally. Data were expressed as mean \pm standard deviation. A two-tailed t-test tested differences. Pearson's correlation was used to analyze the association between all studied parameters. The values $P < 0.05$ were considered statistically significant. All statistical

analyses were done using SPSS V.27 statistical software.

Bivariate analysis: Chi-square tests evaluated the associations between race, smoking status, HPV infection, and various co variables with cervical cancer screening participation. The variables significantly associated with cervical cancer screening participation ($P < 0.05$) were included as potential confounders in the multiple logistic regression analyses. Stratified analyses were performed to evaluate the association between cigarette smoking and screening, stratified by HPV infection.

Multivariate analysis: Multiple logistic regression analyses were performed to evaluate the associations of cigarette smoking and HPV infection with cervical cancer screening participation, controlling for potential confounders. Model 1 included age, cigarette smoking, and HPV infection. Model 2 added significantly associated variables and all potential confounders to Model 1. Model 3 added a smoking-by-HPV infection interaction term to Model 2. To further analyze the ethnic and racial differences and evaluate the variations within races, these analyses were repeated within each race group to determine whether the same associations between cigarette smoking, HPV infection, and recent cervical cancer screening were observed separately for whites and other races.

Results

Sample characteristics

The study subjects included 12,186 White, Hispanic, African American, Asian, and AI/AN women 18-65 years and older. As shown in Table 1 nearly, 62% of the respondents

Table 1: Characteristic of study sample: 12,186 women respondents ages 18-65 years, 2019 National Health Interview Survey.

Characteristic	Sample size	Percentage
Cervical cancer screening status	11,926	
Screening in the past 2 years	7375	61.8
Screening in 2 years+	2756	23.1
Never had screening	1795	15.1
Have cervical cancer (diagnosis)	12,167	
Yes	152	1.2
No	12,015	98.8
Smoking status	11,878	
Currently smoker	1757	14.8
Former smoker	2053	17.3
Never smoker	8068	67.9
HPV test at recent screening	8355	
Yes	3918	46.9
No	4437	53.1
PAP test at recent screening	10046	
Yes	9561	95.2
No	485	4.8
Mean age in years (SD)	43.5	
Age in decades	12,186	

reported that they had a cervical cancer screening in the past two years, and 23.1% said that they had a screening more than two years ago. About 1.2% of the women reported being told they had cervical cancer, and 84.9% reported ever having a cervical cancer screening. About 14.8% currently smoked cigarettes, 17.3% were former smokers, and 67.9% never smoked cigarettes. More than 95% of respondents had a Pap test at a recent screening, and 46.9% reported receiving an HPV test at a recent cervical cancer screening. The mean age of the sample was 43.5 years (standard deviation was 13.5 years), 63.6% were white, 16.3% were Hispanic, and 13.2% were African American. Nearly 70% were college-educated or higher, and 59.7% had an annual income of \$50,000 or more.

18-29 years	2330	19.1
30-39 years	2783	22.8
40-49 years	2418	19.8
50-59 years	2709	22.2
60+ years	1946	16
Race	11,924	
White	7586	63.6
Hispanic	1945	16.3
African-American	1570	13.2
Asian	725	6.1
AIAN	98	
Educational level	12,116	
High school or less	1172	9.7
High school graduate	2500	20.6
Some college	3775	31.2
Bachelors' degree	2891	23.9
Master +	1773	14.6
Income	12,186	
Poor or near poor 0 - \$34,999	3418	28
Lower-Middle class \$35,000 - \$49,999	1492	12.2
Middle class \$50,000 - \$99,999	3755	30.8
Upper Middle class >= \$100,000	3521	28.9
Marital status	11,857	
Separated/Divorced	2220	18.7
Married	5772	48.7
Single/Never married	3444	29
Widowed	421	3.6
Health insurance	12,173	
Yes	11,157	91.7
No	1016	8.3
Health status	12,175	
Excellent	3164	26
Very good	4210	34.6
Fair	1236	10.2
Poor	390	3.2

Almost 92% of respondents reported having health insurance through employment or the government. Nearly 87% of respondents rated their health as good or better, and only 3.2% rated their health as poor.

Characteristics of women who had a recent cervical cancer screening

As shown in Table 2 former and never smokers were

more likely to have had a recent screening (within the past two years) than current smokers. Women who had been told they had cervical cancer were slightly less likely to have had a recent screening than those who were not told they had cervical cancer, but the difference was not statistically significant. Women 30-39 were the most likely to have had a recent screening, while those 60 and above were the least likely. Race was also associated with having had a recent

Table 2: Factors associated with cervical cancer screening among 12186 women ages 18-65 years, 2019 National Health Interview Survey.

	Screening in the past 2 years	Screening in the past 2 years	Screening 2+ years ago	Screening 2+ years ago	Never had screening	Never had screening	P-value
	n	%	n	%	n	%	
Characteristic							
Smoking status							< 0.001
Currently smoker	919	52.9	572	32.9	245	14.1	
Former smoker	1237	60.8	619	30.4	178	8.8	
Never smoker	5098	64.1	1528	19.2	1326	16.7	
Have cervical cancer							< 0.001
Yes	89	58.6	60	39.5	3	2	
No	7278	61.9	2694	22.9	1790	15.2	
HPV test at recent screening							< 0.001
Yes	3158	80.8	751	19.2			
No	2944	67	1452	33			
PAP test at recent screening							< 0.001
Yes	7032	74	2473	26			
No	252	53.5	219	46.5			
Mean age in years (SD)	42.7		48.99		38.29		
Age in decades							< 0.001
18-29 years	1339	58.8	233	10.2	707	31	
30-39 years	1974	72.5	473	17.4	276	10.1	
40-49 years	1576	66.3	538	22.6	264	11.1	
50-59 years	1550	58.5	801	30.2	297	11.2	
60 + years	936	49.3	711	37.5	251	13.2	
Race							< 0.001
White	4579	61.5	2025	27.2	844	11.3	
Hispanic	1124	59.3	308	16.3	463	24.4	
African-American	1034	67.9	245	16.1	243	16	
Asian	426	60.2	100	14.1	182	25.7	
AIAN	50	53.2	23	24.5	21	22.3	
Educational level							< 0.001
High school or less	545	48.4	262	23.3	318	28.3	
High school graduate	1339	55.1	584	24	507	20.9	
Some college	2198	59.1	943	25.4	576	15.5	
Bachelors' degree	1999	70.4	586	20.6	256	9	
Master +	1263	72.1	370	21.1	119	6.8	
Income							< 0.001

Poor or near poor 0 - \$34,999	1741	52.6	823	24.8	749	22.6	
Lower-Middle class \$35,000 - \$49,999	850	58.3	358	24.5	251	17.2	
Middle class \$50,000 - \$99,999	2343	63.5	872	23.6	474	12.8	
Upper Middle class >= \$100,000	2441	70.4	703	20.3	321	9.3	
Marital status							< 0.001
Separated/Divorced	1292	58.8	670	30.5	235	10.7	
Married	3741	65.7	1366	24	586	10.3	
Single/Never married	2005	59.1	521	15.4	868	25.6	
Widowed	203	49	153	37	58	14	
Health insurance							< 0.001
Yes	6969	63.8	2432	22.2	1530	14	
No	403	40.7	323	32.7	263	26.6	
Health status							< 0.001
Excellent	2053	66.2	556	17.9	493	15.9	
Very good	2677	64.5	907	21.8	568	13.7	
Good	1833	59.3	772	25	485	15.7	
Fair	620	51.6	388	32.3	194	16.1	
Poor	188	50.1	132	35.2	55	14.7	

screening test, with African Americans being most likely to have had a recent screening, followed by Whites. The likelihood of recent cervical cancer screening increased with higher education and higher income levels. Those married and had health insurance and rated their health as excellent or very good were more likely to have received recent cervical cancer screening.

Multiple logistic regression analyses of factors associated with cervical cancer screening

The results from the multiple logistic regression analyses on cervical cancer screening in the past two years are shown in Table 3. Cigarette smoking status, cervical cancer diagnosis, and race were significantly associated with recent cervical cancer screening when adjusting only for age (**Model 1**), age, and other co variables (**Model 2**). Former smokers were significantly more likely to have had a recent cervical screening than those who never smoked. Women who were told that they had cervical cancer were less likely to have had a recent cervical screening than those not diagnosed. The results of the stratified analyses showed that women who currently smoked cigarettes were significantly less likely to have had a recent cervical cancer screening than never smokers, and those who had been told that they had cervical cancer were substantially less likely than those who hadn't had the disease to have had a recent cervical cancer screening. Other variables showing significant associations with recent cervical cancer screening were age, race, education, and health status. Younger women were more likely than older women to have had recent cervical cancer screening (odds ratio (OR) = 1.349, 95%CI = 1.297-1.402). Women with college and more

education were more likely than those with low education levels to have had a recent cervical cancer screening (odds ratio (OR) = 1.346, 95% CI = 1.056-1.716) with a significance of (P = 0.01).

Analyses were conducted separately among white and African American women

Analyses within race subgroups were performed. Among white women, 1292 (17.4%) currently smoked cigarettes, 114 (1.5%) had been told that they have cervical cancer, and 42 (38.5%) belonged to both smoking cigarettes and having cervical cancer groups. Among African American women, 211 (14%) smoked cigarettes, 10 (0.6%) had been told that they had cervical cancer, and 2 (20%) belonged to both smoking cigarettes and having cervical cancer groups. Among whites, women who were non-smokers were more likely than current smokers to have had a recent cervical cancer screening (OR = 1.612, 95% CI = 1.347-1.930), controlling for age and cervical cancer status (**Model 1**). Similar results were found when adjusting for other co variables in **Model 2**. Black women who were told that they had cervical cancer were more likely not to have a recent cervical cancer screening (OR = 0.536, 95%CI = 0.440-0.652), whereas white women who were told that they had cervical cancer were more likely to have a recent cervical cancer screening (OR = 1.739, 95%CI = 1.433-2.111), controlling for the co variables in **Model 2**. The interaction between cigarette smoking and cervical cancer in the recent cervical cancer screening has been observed among white and African American women.

Table 3: Results of multiple logistic regression analyses on cervical cancer screening among 12186 women ages 18-65 years, 2019 Health Interview Survey.

	OR	95% CI	P-value
Model 1			
Age (18-29 vs. 50-59)	1.472	1.419-1.526	< 0.001
Race (Black AA vs. Whites)	0.575	0.483-0.685	< 0.001
Smoking status (Former vs. never smoker)	1.253	1.103-1.425	< 0.001
Cervical cancer status	0.676	0.473-0.967	0.001
Model 2			
Age (18-29 vs. 50-59)	1.34	1.283-1.400	< 0.001
Smoking status (Former vs. never smoker)	1.17	1.010-1.355	< 0.001
Race (Black AA vs. Whites)	0.536	0.440-0.652	< 0.001
Cervical cancer status	0.709	0.470-1.070	< 0.001
High income	1.34	1.120-1.605	< 0.001
High educational level	1.27	0.995-1.622	< 0.001
Marital status (Married vs. non-married)	1.128	0.834-1.526	< 0.001
Health insurance	0.379	0.306-0.469	0.001
Health status (Excellent vs. poor)	1.361	0.969-1.911	< 0.001
Interaction: smoking and diagnosis is cervical cancer	3.9	2.134-5.234	0.001
Model 3			
Age (18-29 vs. 50-59)	1.349	1.297-1.402	0
Smoking status (current smoker vs. never smoker)	0.534	0.461-0.619	0
Race	0.619	0.517-0.741	0
Cervical cancer status	0.771	0.402-1.479	< 0.001
High income	1.427	1.1195-1.703	< 0.001
Educational level	1.346	1.056-1.716	< 0.001
Marital status	1.12	0.827-1.517	< 0.001
Health insurance	0.38	0.307-0.471	0.001
Interaction: smoking and diagnosis cervical cancer	3.9	2.134-5.234	0.001

Discussion

The goal of this study is to determine whether race, smoking, and HPV infection are associated with cervical cancer screening participation among adult women aged 18 years to 65 years in the United States, controlling for social determinants of health like level of education, income level, marital status, health insurance, and health status. One of the key findings was that about 62% of the respondents reported having had a cervical cancer screening in the past two years. White women who were never smokers were more likely to have had a recent cervical cancer screening in the past two years than current smokers. In addition, women who were former smokers were more likely to have had a cervical cancer screening in the past two years than never smokers. These findings were similar to a previous study that found that at the same time, smokers perceived a relative risk of other health conditions such as heart disease and hypertension to be greater than non-smokers; they did not perceive themselves to be at higher risk of cervical cancer [8].

Previous studies have shown consistent associations between cigarette smoking and cervical cancer status with

cervical cancer screening rates [9,10]. Possible explanations for the previous study's association between cigarette smoking and cervical cancer screening include that in the last literature, women were less likely to know about the link between smoking and cervical health, with only 30% reported having their smoking status assessed and 34% of smokers being advised to stop smoking [8]. Interventions to increase the understanding of this link may help raise the cervical cancer screening rates among current smokers.

In this study, African American women diagnosed with cervical cancer were significantly less likely to have had a recent cervical cancer screening than white women. As in previous studies, the differences in perceived susceptibility to cervical cancer screening among African American women led to lower cervical cancer screening. [11]. The literature finding shows that racial health disparities have existed and persisted across the different levels of socioeconomic status. A possible explanation for these racial differences in health maybe belonging to the other socioeconomic groups, promoting certain women belonging to one class to access resources such as health insurance, physicians, and health

care to benefit from preventive treatments like screening when needed.

The association between reduced cervical cancer screening for cervical cancer women had not been previously reported in the past. A possible explanation of this finding could be that women diagnosed with cervical cancer and who were treated successfully didn't think they were at risk of developing the disease again and therefore did not comply with screening recommendations.

Another finding of the current study was an association between educational levels and cervical cancer screening. Women who were more educated were more likely than those with lower academic levels to have had a recent cervical cancer screening. This finding is similar to those of previous studies (refs.) It is quite possible that highly educated women had better access to resources and information to improve their overall health [12]. Education promotes a better understanding of health behaviours and provides individuals with resources, strategies, and information that can be used to promote better health outcomes. The more educated women may have already been aware of cervical cancer and its common risk factors and the different ways to promote its prevention.

The current study found that younger women between 18-29 years were significantly more likely than older women above 50-years-old to have had a recent cervical cancer screening. Respondents are aged 50-59 years and 60 and above were the least likely to have had a recent cervical cancer screening. These findings show a non-compliance with the guidelines of professional organizations such as the American Society for Colposcopy and Cervical Pathology (ASCCP), the American Society for Clinical Pathology (ASCP), and the U.S. Preventive Services Task Force (USPSTF) which recommend routine cervical cancer screening among women in these age groups [13]. One potential explanation for a lower cervical screening among older women could have been the lack of cervical cancer screening recommendations, as previous studies have shown [14]. Although all current guidelines, such as those of the US Preventive Services Task Force, recommend that screening should continue beyond the age of 65, it is possible that some older women are not being recommended by their care providers to get screened for cervical cancer as they get closer to 65 [14]. This could be due to the low incidence rate of cervical cancer among women aged 65 and older [14].

The strengths of this study included its large population-based sample of white, Hispanic, and African American women aged 18-65 years. Previous studies have not included 20-29 year-olds, but women aged 20-29 represent 21% of cervical cancer cases [15]. In addition, the multiple logistic regression analyses in this study controlled for variables such as educational level, income, and race associated with cervical cancer screening in previous studies [9,10,12].

A limitation of this study was the low percentage of women with a history of cervical cancer, as more than 95% reported not having been diagnosed with cervical cancer. The small number of women with a history of cervical cancer

might have made it challenging to determine the validity of interaction between HPV infection and cervical cancer screening in women aged 18-65 years-old in this study due to a potential type II error occurring. Another potential limitation of the study was using self-reported data, especially about cervical cancer screening. Another limitation is that the National Health Interview Survey did not include other health behaviours such as alcohol consumption, barriers to cervical cancer screening such as a lack of health insurance, and the patient-physician interaction, which have been associated with compliance with cervical cancer screening [16,17].

Future research should focus on the HPV vaccine and its association with cervical cancer screening when studying behavioural factors associated with cervical cancer screening and examine the relationship among these variables (HPV vaccine and cervical cancer screening) among minority women and within different regions in the country. This could show a variation in the South since they have the highest cervical cancer incidence and mortality rates compared to other areas.

Conclusion

This study highlights the need to increase cervical cancer screening among women smokers aged 50 years and older since reduced cervical cancer screening was associated with current smoking and older age. Usually asymptomatic, regular screening can significantly improve the chances of early detection and successful pre-cervical cancer and cervical cancer [18]. Therefore, intervention programs and physicians need to be targeting women at high risk, such as those currently smoking and older age. Also, programs aimed at conducting screening should include addressing the relationships between health behaviours such as smoking and cancer prevention to improve future screening future compliance. Physicians should emphasize promoting smoking cessation and cancer screening for women who smoke and are 50 years and older for better health outcomes.

CRedit Authorship Contribution Attachment

Ertha C Sefu Omba: Writing-original draft. Lee Caplan: Writing- review & editing

Declaration of Competing Interest

The authors declare no conflict of interest

Acknowledgment

This study was supported in part from the Master of Medical Sciences program during the Culminating Project Experience. The content is solely the authors' responsibility and does not necessarily represent the official views of the NIH.

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DOI: 10.36959/749/525