



Does Age Affect the Association between Race/Ethnicity and HPV Screening: A Retrospective Cohort Study of United States Women

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Abstract

Many studies have demonstrated disparities in awareness of and knowledge about human papillomavirus (HPV) among young, immigrant, and minority populations. Yet, there is a lack of existing research that has investigated the role of race/ethnicity and HPV screening, and how it varies by age. The purpose of this study was to evaluate this association using 2016 Behavioral Risk Factor Surveillance System (BRFSS) data. This study included 120,646 women who self-reported information on race/ethnicity, HPV screening, and age. Logistic regression was used to obtain odds ratios (OR) and 95% confidence intervals (CIs). A stratified analysis was conducted to determine if age modified the race/ethnicity and HPV screening association. After adjustment, non-Hispanic Black and Multiracial women had statistically significant increased odds of receiving HPV screening as compared to non-Hispanic white women (OR 1.20; 95% CI 1.11, 1.29 and OR 1.58; 95% CI 1.33, 1.88, respectively). There was no association between Hispanic race/ethnicity and HPV screening (OR 1.02; 95% CI 0.95, 1.09). The findings of this study provide evidence that age modifies the association between race/ethnicity and HPV screening. Among the oldest categories of women, non-Hispanic Black, Multiracial, and Hispanic women had increased odds of HPV screening. Conversely, among the youngest categories of women, non-Hispanic Other and Hispanic had decreased odds of HPV screening. Public health interventions and health care providers may need to focus on specific minority subgroups to increase HPV screening in certain sub age categories.

Keywords

human papillomavirus; HPV screening; race/ethnicity; age; women

Cover Page Footnote

This study protocol was determined to be exempt by UNC Charlotte's Institutional Review Board. The authors have no known conflicts of interest and the contents of this manuscript have not been published elsewhere. Additionally, all authors have met all criteria for authorship.



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ABSTRACT

Many studies have demonstrated disparities in awareness of and knowledge about human papillomavirus (HPV) among young, immigrant, and minority populations. Yet, there is a lack of existing research that has investigated the role of race/ethnicity and HPV screening, and how it varies by age. The purpose of this study was to evaluate this association using 2016 Behavioral Risk Factor Surveillance System (BRFSS) data. This study included 120,646 women who self-reported information on race/ethnicity, HPV screening, and age. Logistic regression was used to obtain odds ratios (OR) and 95% confidence intervals (CIs). A stratified analysis was conducted to determine if age modified the race/ethnicity and HPV screening association. After adjustment, non-Hispanic Black and Multiracial women had statistically significant increased odds of receiving HPV screening as compared to non-Hispanic white women (OR 1.20; 95% CI 1.11, 1.29 and OR 1.58; 95% CI 1.33, 1.88, respectively). There was no association between Hispanic race/ethnicity and HPV screening (OR 1.02; 95% CI 0.95, 1.09). The findings of this study provide evidence that age modifies the association between race/ethnicity and HPV screening. Among the oldest categories of women, non-Hispanic Black, Multiracial, and Hispanic women had increased odds of HPV screening. Conversely, among the youngest categories of women, non-Hispanic Other and Hispanic had decreased odds of HPV screening. Public health interventions and health care providers may need to focus on specific minority subgroups to increase HPV screening in certain sub age categories.

Keywords: Human Papillomavirus; HPV Screening; Race/Ethnicity; Age; Women

INTRODUCTION

Human papillomavirus (HPV) is the most common sexually transmitted infection in the United States (Ford, 2011). Nearly 80 million Americans are infected with at least one strain of HPV; however, not all types of HPV cause cancer (Blake et al., 2015). At least 12 high-risk virus types have been identified to cause cancer; yet, two types (HPV 16 and 18) account for 70% of all cervical cancer cases (Blake et al., 2015). These high-risk HPV infections may persist and increase the risk of developing cervical cancer, contributing to a rate of more than 12,000 new cases annually, with 4,000 deaths per year (Blake et al., 2015; Castellsague et al., 2009). If found early, screening

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can prevent most cervical cancers through a preferred method called “co-testing,” a procedure that combines a Papanicolaou (Pap) test and HPV DNA test to detect early cervical cancers or pre-cancers (American Cancer Society, 2016). It is recommended all women begin cervical cancer testing at age 21; however, a HPV test is not recommended for women aged 21-29 as the results are not regarded as significant as in women aged from 30-65 (American Cancer Society, 2018). Thus, in 2018, three updated options were recommended as screening guidelines for women aged 30-65: (a) high-risk HPV testing alone every 5 years, (b) co-testing every 5 years, or (c) Pap testing alone every 3 years (American Cancer Society, 2018; National Cancer Institute, 2019).

In 2014, Hispanic women had the highest rate of developing cervical cancer, followed by non-Hispanic Black and non-Hispanic White women (Centers for Disease Control and Prevention, 2017d). Similarly, non-Hispanic Black and Hispanic women were more likely to die from cervical cancer than non-Hispanic White women (Blake et al., 2015). Subsequently, in 2016, cervical cancer incidence and mortality rates in non-Hispanic Black women were 38% and 105% higher, and in Hispanic women 70% and 52% higher compared to non-Hispanic White women, respectively (Bond et al., 2016). Thus, the relationship between race, ethnicity, and HPV screening becomes salient among minority populations, given cervical cancer incidence and mortality rates are considerably lower among non-Hispanic White women.

Published guidelines from the American Cancer Society (ACS), the American Society for Colposcopy and Cervical Pathology (ASCCP), the American Society for Clinical Pathology and Screening (ASCP), and the American Congress of Obstetricians and Gynecologists (ACOG) recommend routine HPV screening be discontinued for average-risk women aged >65 years after three consecutive negative cytology results or two consecutive negative co-test results within the previous 10 years (CDC, 2017e; Elit, 2014; White et al., 2017). However, in 2014, of all new cervical cancers, 20% occurred in women 65 years old and older, and these women accounted for 34% of the deaths related to cervical cancer (Elit, 2014). Although, the frequency of new HPV infections decline with age, women aged 25-55 remain at risk of obtaining an oncogenic HPV strain (Poppe et al., 2010). Therefore, age itself may need to be reconsidered, given high cervical cancer incidence rates, increases in life expectancy, and different human papillomavirus exposures by birth cohort (White et al., 2017).

Research on the association between race/ethnicity, HPV screening, and age among United States women aged 18-64 is sparse. Many studies have demonstrated disparities in awareness of and knowledge about HPV among young, immigrant, and minority populations (Ford, 2011; Blake et al., 2015). Similarly, prior studies have investigated the perceptions, behaviors, and impact of ethnicity among adolescent and young women aged 15-25 regarding the HPV vaccination (Bond et al., 2016; Castellsague et al., 2009; Sadry et al., 2013). Yet, there is a lack of existing research that has investigated the role of race/ethnicity and HPV screening, and how it varies by age. Therefore, the purpose of this study is to assess the relationship between race/ethnicity and HPV screening, and to evaluate whether age modifies this association using population-based data from the Behavioral Risk Factor Surveillance System (BRFSS).

METHODS

Study Population and Design

This secondary data analysis used data from the 2016 Behavioral Risk Factor Surveillance System (BRFSS). This study protocol did not require approval by UNC Charlotte’s Institutional Review Board, given the study used publicly available, de-identified data. BRFSS is a large,

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national survey initiated in 1984 by the Centers for Disease Control and Prevention (CDC) to target and build health promotion activities (CDC, 2014a). Detailed information on BRFSS methodology has been reported elsewhere (Lachan et al., 2016).

Briefly, the telephone-administered BRFSS survey collects information on more than 400,000 adults each year (CDC, 2014a). The survey is conducted using Random Digit Dialing (RDD) techniques on both landlines and cell phones. Adults 18 years or older are asked to participate in the survey without monetary compensation (CDC, 2017a). The number of interviews within each state vary based on funding and the size of regions. In 2016, the average response rate for landline and cell phone samples were 46.7% (CDC, 2015).

The questionnaire consists of three parts: (1) the core component, consisting of the fixed core, rotating core, and emerging core, (2) optional modules, and (3) state-added questions (CDC, 2014a). BRFSS personnel are required to ask core component questions without modification in wording, however, the modules are optional (CDC, 2014a). The fixed core is a standard set of questions asked by all states that includes questions on demographic characteristics, plus current health behaviors. The rotating core is two distinct sets of questions, asked in alternating years by all states, addressing different topics; while, the emerging core is a set of five questions that are added to the fixed and rotating cores, focusing on prominent issues (CDC, 2014a). In 2012, the United States Preventive Services Task Force (USPSTF) recommendations included the HPV test for cervical cancer screening (CDC, 2014b). Thus, questions on HPV testing were included as a separate optional module on the 2014 BRFSS questionnaire and then added to the breast and cervical screening module the subsequent year (CDC, 2014b). Both questions about the Pap and HPV test were added to the core component of the questionnaire in 2016 to assess Pap and HPV screening.

In 2016, 486,303 respondents provided BRFSS data (Figure 1). Men (n=210,606) and individuals who refused to disclose their gender (n=66) were excluded from this analysis. In addition, women who did not report their race/ethnicity (n=4,212), did not know if they ever had a HPV screening exam and/or refused to answer that question (n=75,871), and women who were 65 or older and/or refused to disclose their age (n=74,902) were excluded from the analysis. Thus, 120,646 women remained.

Measurement of Race/Ethnicity

The main exposure was race/ethnicity. Participants self-reported their race/ethnicity, and it was categorized by BRFSS personnel as: 'White only, Non-Hispanic', 'Black only, Non-Hispanic', 'Other race only, Non-Hispanic', 'Multiracial, Non-Hispanic', 'Hispanic' or 'Don't know/Not sure/Refused'.

Measurement of HPV Screening

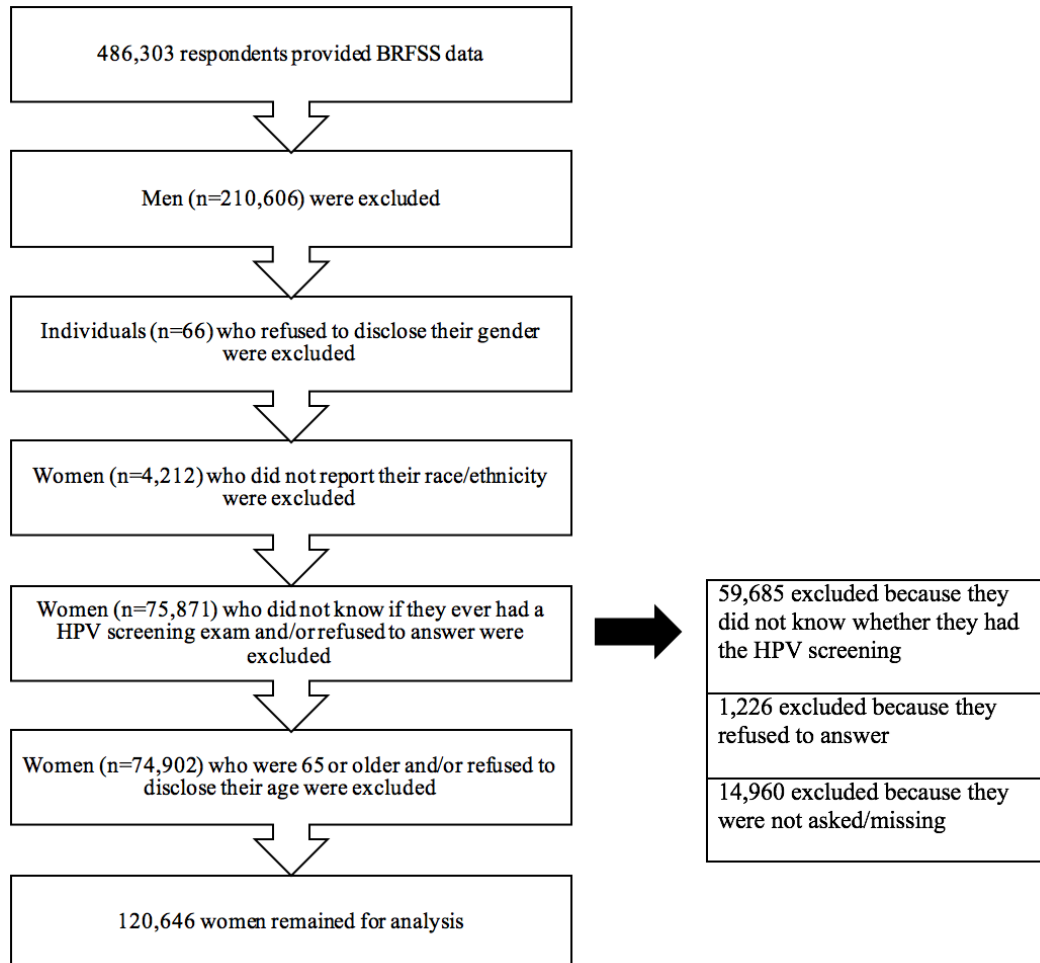
The main outcome was HPV screening. Participants were asked: "An HPV test is sometimes given with the Pap test for HPV screening. Have you ever had an HPV test?" (CDC, 2017h). The response choices were 'Yes', 'No', 'Don't know/Not Sure' or 'Refused'. An answer of 'yes' meant the person did have the outcome (HPV test). If the participant answered, 'don't know/not sure' or 'refused' then she was excluded.

Measurement of Age

Participants were asked: "What is your age?" (CDC, 2014a). Participants self-reported their age, and it was categorized in five-year age categories (CDC, 2017h; Maldonado & Greenland, 1993). These categories were: 18-24 years, 25-29 years, 30-34 years, 35-39 years, 40-44 years, 45-49 years, 50-54 years, 55-59 years, 60-64 years, 65-69 years, 70-74 years, 75-79 years, 80 or older

or ‘Don’t know/Refused/Missing’. If a participant answered 65 or older or refused to disclose her age then she was excluded.

Figure 1. Exclusion Criteria for the Association Between Race/Ethnicity and HPV Screening Modified by Age; BRFSS 2016



Measurement of Potential Confounding Factors

Based on a review of the literature, possible confounders of the race/ethnicity and HPV screening association include: healthcare coverage, education, income, marital status, and number of children in household (Ford et al., 2011; Blake et al., 2015). Information on these variables was self-reported by participants.

Statistical Analysis

Frequencies and percentages were used to describe the study population. Logistic regression was used to obtain odds ratios (OR) and 95% confidence intervals (CIs) to provide an unadjusted measure of the association of race/ethnicity and HPV screening, and to identify other factors associated with HPV screening. Prior to constructing the multivariate model, collinearity diagnostics were considered to assess correlation between predictor variables, but no evidence of

multicollinearity was found (Kleinbaum et al., 1998; Hosmer et al., 2000). Multivariate logistic regression was used to calculate adjusted ORs and 95% CIs of the association between race/ethnicity and HPV screening, while controlling for potential confounders. If a potential confounding variable changed the magnitude of the OR estimate by at least 10%, it was considered a confounder of the association between race/ethnicity and HPV screening (Maldonado & Greenland, 1993). Ultimately, marital status, healthcare coverage, and income were confirmed as confounders in this analysis. A stratified analysis was conducted to determine if age modified the race/ethnicity and HPV screening association. A test of homogeneity was used to assess heterogeneity across strata. Due to the complex sampling design used by BRFSS, SAS-callable SUDAAN was used in all analyses.

RESULTS

Demographic Characteristics of Study Population

Less than half of women reported having been screened for cervical cancer (46.67%). Most of the sample participants were between the ages of 18 and 39 years (50.24%), married (47.49%), reported an income of < \$50,000 (46.07%), and had at least some college education (62.33%) (Table 1). Most participants were non-Hispanic White (58.59%) followed by Hispanic (19.23%) and non-Hispanic Black (13.53%).

Overall, the estimated HPV screening prevalence for all women was 35.9% (data not shown in table). HPV screening prevalence rates were highest for Multiracial women and lowest for non-Hispanic Other women (Multiracial: 45.5%, non-Hispanic Black: 39.4%, non-Hispanic White: 36.6%, Hispanic: 34.3%, and non-Hispanic Other: 26.3%). Further, HPV screening prevalence rates were highest among younger women who were 25-34 years of age (Ages: 18-24, 28.2%; 25-29, 50.4%; 30-34, 50.6%; 35-39, 45.8%; 40-44, 40.4%; 45-49, 37.4%; 50-54, 29.6%; 55-59, 25.0%; 60-64, 20.5%).

Women who reported being non-Hispanic Black (OR 1.10; 95% CI 1.02, 1.18) and Multiracial (OR 1.47; 95% CI 1.24, 1.73) had increased odds of HPV screening, while non-Hispanic Other (OR 0.58; 95% CI 0.51, 0.65) and Hispanic women (OR 0.85; 95% CI 0.79, 0.91) had decreased odds of HPV screening as compared to non-Hispanic White women. In general, younger women had increased odds of HPV screening as compared to women aged 60-64, with the odds being highest among women aged 30-34 (OR 4.72; 95% CI 4.26, 5.24). Further, women who were never married had statistically significant decreased odds of HPV screening as compared to women who were married (OR 0.87; 95% CI 0.83, 0.92). Women without healthcare coverage had a 32% decreased odds of receiving HPV screening as compared to women who had healthcare coverage (OR 0.68; 95% CI 0.63, 0.73).

Adjusted Association between Race/Ethnicity and HPV Screening

After adjustment for marital status, healthcare coverage, and income, the association between non-Hispanic Black and Multiracial race/ethnicity and HPV screening increased in magnitude and remained statistically significant (OR 1.20; 95% CI 1.11, 1.29 and OR 1.58; 95% CI 1.33, 1.88, respectively; Table 2). The association between non-Hispanic Other race/ethnicity and HPV screening remained unchanged after adjustment (OR 0.61; 95% CI 0.54, 0.69); while the association between Hispanic race/ethnicity and HPV screening was attenuated and no longer statistically significant (OR 1.02; 95% CI 0.95, 1.09).

Adjusted Association between Race/Ethnicity and HPV Screening Stratified by Age

The stratified analysis indicated age was an effect modifier of the race/ethnicity and HPV screening association (test for homogeneity $p < 0.001$; Table 3). In general, among younger women there were no clear associations between non-Hispanic Black or Multiracial race/ethnicity and HPV screening. However, among the youngest categories of women, non-Hispanic Other and Hispanic race/ethnicity was associated with statistically significant decreased odds of HPV screening. For example, among women 18-24 years of age, non-Hispanic Other women had nearly a 60% decreased odds of HPV screening as compared to non-Hispanic White women (OR 0.43; 95% CI 0.31, 0.60) and Hispanic women had 22% decreased odds of HPV screening (OR 0.78; 95% CI 0.64, 0.95). Among the oldest category of women (i.e. 60-64 years of age), there was no clear association between non-Hispanic Other race/ethnicity and HPV screening (OR 1.40; 95% CI 0.77, 2.57) while the other racial/ethnic groups had statistically significant increased odds of HPV screening. Specifically, in this oldest age group, non-Hispanic Black and Hispanic women had approximately 30% increased odds of HPV screening as compared to non-Hispanic White women (OR 1.29; 95% CI 1.05, 1.58 and OR 1.33; 95% CI 1.04, 1.71 respectively). Among women in this age group, Multiracial women had over twice the odds of HPV screening (OR 2.16; 95% CI 1.26, 3.71).

Table 1. Frequencies, Percentages, Unadjusted Odds Ratios, and 95% Confidence Intervals for the Association between Selected Characteristics and HPV Screening; BRFSS 2016

Variables	N (% ¹)	OR	95% CI
Race/ethnicity			
Non-Hispanic White	86,124 (58.59)	1.00	Referent
Non-Hispanic Black	12,575 (13.53)	1.10	1.02, 1.18
Non-Hispanic Other	6,008 (7.05)	0.58	0.51, 0.65
Multiracial	2,690 (1.60)	1.47	1.24, 1.73
Hispanic	13,249 (19.23)	0.85	0.79, 0.91
Age Category			
18-24 years	10,197 (17.65)	1.22	1.11, 1.35
25-29 years	8,994 (10.40)	4.54	4.10, 5.03
30-34 years	10,307 (12.09)	4.72	4.26, 5.24
35-39 years	10,961 (10.10)	4.07	3.68, 4.51
40-44 years	10,615 (9.71)	3.21	2.91, 3.55
45-49 years	12,729 (8.97)	2.66	2.41, 2.94
50-54 years	16,129 (10.85)	1.82	1.66, 1.99
55-59 years	19,165 (9.97)	1.33	1.21, 1.46
60-64 years	21,549 (10.26)	1.00	Referent
Marital Status			
Married	63,888 (47.49)	1.00	Referent
Divorced, widowed, separated	26,331 (16.91)	1.05	0.99, 1.11
Never married	30,032 (34.98)	0.87	0.83, 0.92
Unknown	395 (0.32)	0.83	0.58, 1.19
Income			
<\$10,000-25,000	29,527 (26.55)	0.71	0.67, 0.76
\$25,000-50,000	24,017 (19.52)	0.84	0.79, 0.90
\$50,000-75,000	16,873 (12.33)	0.86	0.80, 0.93
≥\$75,000	35,607 (27.84)	1.00	Referent
Unknown	14,622 (13.75)	0.48	0.45, 0.52
Healthcare Coverage			
Yes	109,067 (87.07)	1.00	Referent
No	11,232 (12.46)	0.68	0.63, 0.73
Unknown	347 (0.47)	0.33	0.22, 0.49
Education Level			
Some High School	8,194 (12.40)	0.55	0.50, 0.60
High School Graduate	29,666 (25.11)	0.60	0.57, 0.64
At least Some College	82,634 (62.33)	1.00	Referent
Unknown	152 (0.16)	0.51	0.28, 0.94
Number of Children in Household			
No children	71,943 (52.22)	1.00	Referent
One or more children	48,333 (47.42)	1.71	1.63, 1.79
Unknown	370 (0.36)	1.33	0.88, 2.01

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System; N, Number.

¹Indicates weighted percentage of sampling population.

Table 2. Adjusted Odds Ratios and 95% Confidence Intervals of the Association between Race/Ethnicity and HPV Screening; BRFSS 2016

Variable	Cervical Cancer Screening OR ¹	95% CI
Race/ethnicity		
Non-Hispanic White	1.00	Referent
Non-Hispanic Black	1.20	1.11, 1.29
Non-Hispanic Other	0.61	0.54, 0.69
Multiracial	1.58	1.33, 1.88
Hispanic	1.02	0.95, 1.09

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System.

¹Adjusted for marital status, healthcare coverage, and income.

Table 3. Adjusted Odds Ratios and 95% Confidence Intervals for the Association between Race/Ethnicity and HPV Screening Stratified by Age; BRFSS 2016

Variable	Non-Hispanic White	Non-Hispanic Black	Non-Hispanic Other	Multiracial	Hispanic
	OR ¹ (95% CI)	OR ¹ (95% CI)	OR ¹ (95% CI)	OR ¹ (95% CI)	OR ¹ (95% CI)
Age Category					
18-24 years	1.00 (Referent)	1.12 (0.90, 1.39)	0.43 (0.31, 0.60)	1.04 (0.72, 1.51)	0.78 (0.64, 0.95)
25-29 years	1.00 (Referent)	0.87 (0.69, 1.09)	0.30 (0.22, 0.39)	1.30 (0.85, 1.97)	0.65 (0.53, 0.79)
30-34 years	1.00 (Referent)	1.00 (0.80, 1.25)	0.47 (0.34, 0.66)	1.53 (0.73, 3.20)	0.66 (0.53, 0.80)
35-39 years	1.00 (Referent)	0.99 (0.79, 1.25)	0.60 (0.43, 0.84)	2.19 (1.37, 3.53)	0.82 (0.67, 1.01)
40-44 years	1.00 (Referent)	1.05 (0.83, 1.34)	0.55 (0.38, 0.79)	2.21 (1.26, 3.86)	1.01 (0.82, 1.24)
45-49 years	1.00 (Referent)	1.00 (0.81, 1.25)	0.66 (0.43, 1.01)	1.68 (0.94, 3.00)	0.94 (0.74, 1.19)
50-54 years	1.00 (Referent)	1.17 (0.95, 1.44)	0.66 (0.46, 0.95)	1.23 (0.75, 2.03)	1.27 (1.03, 1.57)
55-59 years	1.00 (Referent)	1.32 (1.04, 1.67)	0.51 (0.34, 0.78)	1.44 (0.69, 3.01)	1.20 (0.95, 1.51)
60-64 years	1.00 (Referent)	1.29 (1.05, 1.58)	1.40 (0.77, 2.57)	2.16 (1.26, 3.71)	1.33 (1.04, 1.71)

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System.

¹Adjusted for marital status, healthcare coverage, and income. Test of homogeneity: $p < 0.001$

DISCUSSION

In this population-based study of United States women, women who reported being non-Hispanic Black and Multiracial had statistically significant increased odds of HPV screening; while, non-Hispanic Other women had decreased odds of HPV screening as compared to non-Hispanic White women. There was no association between the Hispanic race/ethnicity and HPV screening. In addition, age was determined to be an effect modifier of the association between race/ethnicity and HPV screening.

Most findings remain consistent among United States women, although existing literature demonstrates that HPV testing as cervical cancer screening have been examined on a greater magnitude than the conventional Pap test. Previous literature examining race/ethnicity and cervical cancer screening as conventional Pap testing have been consistent with our findings in that non-Hispanic Black and non-Hispanic White women are noted to have the highest cervical cancer screening rates among ethnic groups compared to Hispanic and non-Hispanic Other women (Akers et al., 2007). However, other findings related to the Hispanic race/ethnicity and Pap test screening have been inconsistent. One study of United States women ($n = 4,992$) found the Hispanic race/ethnicity was associated with an increased odds of Pap test screening, but this finding was not statistically significant (OR 1.36; 95% CI 0.85, 2.20) (Hirth et al., 2016). Conversely, a larger

study (n=272,692) found Hispanic women had statistically significant decreased odds of HPV test screening (OR 0.54; 95% CI 0.50, 0.60) (CDC, 2017c). In our study, there was no association between the Hispanic race/ethnicity and HPV screening. The inconsistency among the Hispanic race/ethnicity and HPV screening may be attributable to the variation in sample sizes in previous studies.

To our knowledge, no other study has examined age as an effect modifier of the association between race/ethnicity and HPV screening. In our study, age modified the association between race/ethnicity and HPV screening. Among the oldest categories of women, non-Hispanic Black, Multiracial, and Hispanic women had increased odds of HPV screening. Other trends varied by ethnic subgroup. In general, non-Hispanic Other women had decreased odds of HPV screening, where almost all age groups were statistically significant. Conversely, Multiracial women had increased odds of HPV screening although findings were not statistically significant among all age groups.

Studies regarding age, race/ethnicity, Pap and HPV test screening have been conflicting. One study found young women had increased Pap test screening, and this was similar across all ethnic groups (Akers et al., 2007). Another study that used BRFSS data found being between the ages 18-44, non-Hispanic White, Hispanic, and non-Hispanic Other race/ethnicity decreased the odds of HPV test screening (CDC, 2017c). However, both studies did not evaluate age as an effect modifier. Our findings are similar to the previous study, where young non-Hispanic Other and Hispanic women had a decreased odds of HPV screening as compared to non-Hispanic White women within the same age group. This may indicate these women have low health literacy and/or lack sexual health knowledge (Bond et al., 2016; Akers et al., 2007). Specifically, among Hispanic women, where another study found this ethnic group lacked sexual health knowledge in methods to prevent cervical cancer (Bond et al., 2016).

Further, another study found that being between the ages of 45-74 increased the odds of HPV test screening after adjustment for demographic and socioeconomic factors (CDC, 2017c). While, another study demonstrated that the association between older age and Pap test screening did not differ significantly by race/ethnicity (Hirth et al., 2016). Our research is inconsistent with these previous findings, in that among women aged 60-64, non-Hispanic Black, Multiracial, and Hispanic ethnic groups had increased odds of being screened for cervical cancer by HPV testing. It is important to note that while these previous studies investigated similar associations to our study, none of them considered whether the race/ethnicity-HPV screening association differed by age. Regardless, our findings may indicate that older women are more likely to be screened for cervical cancer due to regularly scheduled healthcare visits from treating other chronic health conditions (Miles-Richardson et al., 2017).

This study has several limitations. Since the exposure and outcome variables were self-reported, misclassification is possible. While participants likely were able to self-report race/ethnicity, they may have had problems remembering or comprehending if they ever had an HPV test as this question covers an unspecified timeframe that might be erroneously linked to another disease or condition. Furthermore, some evidence suggests that certain racial/ethnic groups may be less likely to provide accurate reports of their cancer screening behavior (Burgess et al., 2008; Cronin et al., 2009). Thus, non-differential and differential misclassification of the outcome is possible. Bias by indication may have occurred as the outcome may have been confounded by whether it was part of a woman's routine healthcare screening or as a diagnostic after an abnormal Pap test. Furthermore, this study was limited to the questions asked on the BRFSS survey and also

subject to residual confounding as income values were reported missing. Thus, confounding due to known or unknown variables is possible. Selection bias is likely due to the response rate for the year of data used was 46.7% (CDC, 2015). Furthermore, many women indicated that they were unaware if they ever had HPV screening and were thus excluded from the analysis. We evaluated whether eligible women differed from ineligible women with respect to sociodemographic factors. Eligible women did differ from ineligible women with respect to income, education level, and marital status. Specifically, eligible women were in the highest income group, never married, and had at least some college education. Thus, the possibility of bias cannot be ruled out.

This study also had several strengths. While information bias cannot be ruled out, it is limited due to the highly trained BRFSS interviewers. Also, generalizability may be limited to some sample sizes since the BRFSS sampled from a large population base within the United States. Moreover, this study examined how age modified the race/ethnicity-HPV screening association among United States women, which has not been evaluated in previous research.

CONCLUSION

Findings from this study provides evidence that age does modify the association between race/ethnicity and HPV screening among women 18 years of age and older in the U.S. This study highlights the need to target non-Hispanic Other and Hispanic women to increase use of HPV test screening. Public health interventions and health care providers may need to focus on specific minority subgroups to increase HPV screening in certain sub age categories. Given the limited research on this topic, future studies should further examine the association between race/ethnicity, HPV screening, and age among a diverse population of women.

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