HHS Public Access

Author manuscript

Cancer Epidemiol Biomarkers Prev. Author manuscript; available in PMC 2023 July 09.

Published in final edited form as:

Cancer Epidemiol Biomarkers Prev. 2023 January 09; 32(1): 82–90.

doi:10.1158/1055-9965.EPI-22-0970.

Trends and racial/ethnic differences in predictors of cervical cancer screening among US women aged 30–64 years

Itunu O. Sokale[1,2,*], **Jane R. Montealegre**[2,3], **Abiodun O. Oluyomi**[1,2], **Aaron P. Thrift**[1,2]

[1]Department of Medicine, Section of Epidemiology and Population Sciences, Baylor College of Medicine, Houston, TX 77030, USA

[2]Dan L. Duncan Comprehensive Cancer Center, Baylor College of Medicine, Houston, TX 77030, USA

[3]Department of Pediatrics, Baylor College of Medicine, Houston, TX 77030, USA

Abstract

Background: Cervical cancer screening (CCS) participation has decreased in the United States over the last several decades, contributing to cervical cancer's sustained incidence and mortality. This study examined recent trends and racial/ethnic differences in predictors of CCS uptake among US women.

Methods: We analyzed combined data from the 2016 to 2020 Behavioral Risk Factor Surveillance System (BRFSS) and included 235,713 women aged 30–64 years without a hysterectomy. We used simple linear regression to assess trends over time and multivariable logistic regression models to evaluate racial/ethnic differences in predictors of up-to-date CCS.

Results: We found little change in CCS over the 5-year interval and screening rates disparities among racial minority women. The overall population showed stable CCS completion rates from 2016 to 2018 (84.2% versus 84.6%), and then a small dip from 2018 to 2020 (from 84.6% to 83.3%). Despite a slight decline in 2020, HPV-based testing increased significantly among all subgroups and overall, from 2016 to 2020 (from 43.4% to 52.7%). Multivariable regression models showed racial/ethnic differences in predictors of CCS. Across all racial/ethnic subgroups, older women were less likely to receive timely screening. Women who had routine check-ups had higher odds of being up to date. However, the link between CCS and socioeconomic status varied.

Conclusions: Age and racial/ethnic disparities persist in CCS, and predictors of screening vary. Notwithstanding, routine health examinations was positively associated with screening regardless of race/ethnicity.

[*]**Corresponding Author.** Itunu O. Sokale, MBBS, MPH, DrPH, Department of Medicine, Baylor College of Medicine, One Baylor Plaza, MS: BCM 307, Room 613D, Houston, TX 77030-3498, Phone: 713-798-2972, Itunu.sokale@bcm.edu.

Author Contributions: Conceptualization: I.O.S., A.P.T and JRM.; methodology: I.O.S, A.P.T; formal analysis: I.O.S.; resources: I.O.S., A.P.T, A.O.O, and J.R.M.; writing—original draft preparation: I.S.; writing—review and editing: A.P.T., J.R.M., and A.O.O.; supervision, A.P.T.; project administration, A.P.T.; funding acquisition, A.P.T. and J.R.M. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest disclosure statement. The authors declare no potential conflicts of interest

Financial disclosure: No financial disclosures were reported by the authors of this paper.

Impact: Our analyses suggest that leveraging primary care to optimize CCS uptake may reduce gaps in screening.

Keywords

Cervical cancer screening; Pap testing; HPV testing; race/ethnicity

INTRODUCTION

Cervical cancer is one of the most preventable female cancers. Population-based screening for cervical cancer has been shown to reduce incidence and mortality from the disease.[1–3] Unfortunately, despite scientific advancements in prevention and treatment, an estimated 604,000 new cases of cervical cancer were diagnosed, and 342,000 women died from the disease globally in 2020.[4] In the United States (US), approximately 14,480 women were diagnosed with cervical cancer, and more than 4,200 died from the disease in 2021.[5] Screening for high-risk human papillomavirus (HPV) infection and precancerous or early neoplastic changes in the cervix using HPV-based and cytology-based (Papanicolaou/Pap) tests presents invaluable opportunities for interventions to reduce incidence and mortality from the disease.[1–3]

In 2018, the World Health Organization (WHO) made a global call to eliminate cervical cancer by 2030 using multiple strategies, including efficient screening of 70% of all women by 35 and 45 years of age.[6] In addition, the 2018 US Preventive Services Task Force (USPSTF) guidelines recommendations include: (a) women aged 21–29 years - a Pap test alone every three years; and (b) women aged 30–65 years Pap test alone every three years, an HPV test alone every five years, or HPV/Pap co-test every five years.[7] Whereas, in 2020, the American Cancer Society (ACS) updated its cervical cancer screening (CCS) recommendations.[8] The new guidelines differ from the previously published 2012 ACS guidelines. Specifically, ACS now recommends starting CCS at age 25 instead of 21 and an HPV test every five years as the preferred screening for women aged 25 to 65. However, if this is not available, an HPV/Pap co-test every five years or a Pap test alone every three years can be used.[8]

Although CCS rates increased in the late 1980s and 1990s, [9,10] rates have decreased over the last two decades.[11] Overall, screening rates are lower among racial minority women, and this is believed to contribute to the increased mortality among racial minority groups.[12–15] In addition, factors affecting minority women, such as higher prevalence of socioeconomic disadvantages and lack of access to preventive or medical services, may contribute to CCS disparities for this vulnerable population.[16–18] However, trends in screening based on recently updated guidelines[7,8] and determinants of CCS among specific racial/ethnic subgroups remain unknown. Hence, the primary aim of this study was to examine the most recent trends in self-reported CCS utilization from 2016 to 2020 and determine predictors of CCS participation across racial/ethnic subgroups. In addition, since there are different CCS methods, we also sought to understand changes in Pap and HPV DNA testing over time. The findings of this study could help identify persisting disparities in CCS completion among

groups and inform the development of race-specific and targeted interventions to increase CCS among at-risk populations.

MATERIALS AND METHODS

Study design, Data Source, Study Sample

In this cross-sectional study, we analyzed data from the National Behavioral Risk Factor Surveillance System (BRFSS) 2016, 2018, and 2020. BRFSS is the largest annual population-based, random-digit-dialed telephone health survey of non-institutionalized, US civilian adults aged 18 years or older.[19] The surveys are conducted by the Centers for Disease Control and Prevention (CDC) in collaboration with the state health departments in all 50 states, the District of Columbia, and participating US territories.[19] BRFSS uses a complex sampling weighting method to address potential selection bias, including non-response and non-coverage. The median response rate of the surveys included in this analysis was 47.0% in 2016, 49.9% in 2018, and 47.9% in 2020. Additional details on the sampling method, response rates, data quality, weighting, methods of analysis of BRFSS have been published elsewhere.[19,20]

BRFSS collects CCS screening-related data nationally on even-numbered years. To assess trends and predictors of CCS utilization among women aged 30–64 years without hysterectomy, we pooled and analyzed data from the 2016 (n=472,318), 2018 (n=418,474), and 2020 (n=389,826) BRFSS surveys. Survey weight for each year was provided by BRFSS, and we calculated a final weight for the pooled data based on the proportion of sample size from each survey year using the methodology described by the CDC.[19] We included 235,713 women, aged 30–64 years, without previous hysterectomies, or missing outcome or selected variables (Supplementary Figure S1). This study was excluded from the institutional review board because it involved the analysis of publicly available, deidentified data, with no direct human subject contact.

Variables and Measures

The primary dependent variable was up-to-date CCS. To determine CCS utilization, respondents were initially asked: *Have you ever had a Pap test?* Then those with an affirmative answer to this question were asked: *How long has it been since you had your last Pap test?* To assess HPV testing participation, respondents were asked: *An HPV test is sometimes given with the Pap test for cervical cancer screening. Have you ever had an HPV test?* Those with a positive response were asked: *How long has it been since you had your last HPV test?.*[19]

We then considered respondents as: 1) Having up-to-date CCS if they reported a Pap test within the past three years or an HPV test within the past five years, 2) having received a Pap test, if they reported Pap testing within the past three years, and 3) having received an HPV test if they reported an HPV test within the past 5 years. Respondents who refused to answer the questions, were unsure, or had missing response to the main outcome (up-to-date CCS) were excluded from this analysis (Supplementary Figure S1). The outcomes were measured as binary variables (Yes/No).

We examined predictors of CCS within racial/ethnic subgroups, categorized as non-Hispanic Whites (NHW), non-Hispanic Blacks (NHB), Hispanic, non-Hispanic American Indians or Alaskan Natives (NH AI/AN), non-Hispanic Asians (NH Asian), and non-Hispanic Other (NHO). In addition, the NH Asian group included non-Hispanic Asians and other Pacific Islanders or Native Hawaiian, while NHO comprises non-Hispanic other races and multiracial participants.

Potential predictors of CCS were: age (30–39, 40–49, 50–64 years); marital status (married/cohabiting, not married); educational attainment (less than high school degree, high school degree or equivalent, some college or more); employment status (employed, unemployed) annual household income (less than $15,000, $15,000-$49,999, $50,000 or more, and missing (due to high proportion of missing income value)); health insurance coverage (yes, no); general health (good/better, poor/fair); personal physician (yes, no); routine check-up attendance (less than one year, one year to less than five years, greater than five years); and had a mammogram (yes, no), and survey year.

Statistical analysis

We described sample characteristics, both overall and stratified by race/ethnicity. To examine the trends in recommended CCS (up-to-date CCS, Pap testing, and HPV testing) completion, we first estimated the weighted proportion of self-reported CCS, overall, by survey year, and by race/ethnicity. Second, we examined the changes in CCS completion from 2016 to 2020, overall and by racial/ethnic groups, using simple linear regression with *t*-statistics testing the null hypothesis that there was no change in screening over time. Survey year was used as the independent variable (2016 as “1”, 2018 as “2”, and 2020 as “3”), and we adjusted for age, education, income, and health insurance which are known to influence cancer screening.[21,22] We report the corresponding t-statistic and p-value. Third, we used multivariable logistic regression modeling to assess race/ethnicity differences in predictors of CCS utilization, while controlling for survey year. We included only variables that were significant (p-value <0.05) from the bivariate logistic regression in the multivariable models. Potential interactions were assessed by fitting the interaction term between race/ethnicity and SES variables (income, education, and employment) into the model. Likelihood ratio tests of nested models with and without interaction term were performed. To assess statistical significance of differences in associations across the strata of host characteristics, we assessed the p-value for the type III analysis of effects for the interaction term. All analyses were conducted in Stata 17.0 (College Station, Texas), and accounted for the complex survey design with the calculated final survey weights, sampling units, and strata using a survey package in Stata. The significance level was set at 5% throughout the study.

Data Availability Statement

The data analyzed in this study were obtained from BRFSS and are publicly available at: https://www.cdc.gov/brfss/index.html.

RESULTS

Table 1 shows the descriptive characteristics and weighted proportions of US women aged 30–64 years in BRFSS 2016 to 2020 overall and by race/ethnicity. Our weighted sample was 60.8% NHW, 12.2% NHB, 18.7% Hispanic, 0.9 % AI/AN, 5.7 % NH Asian, and 1.8% identified as other race. The majority was 40 years or older. Hispanic women had the highest proportion of women with low education, unemployment, low income, and no personal doctor. In addition, a larger proportion of NH Asian women reported having higher educational attainments compared to other racial/ethnic subgroups.

Table 2 depicts the temporal trends in weighted proportions of women with up-to-date CCS and by specific screening methods, from 2016 to 2020 overall and by race/ethnicity. There was minimal change in CCS rates over the 5-year study period. Overall, up-to-date CCS rates remained unchanged from 2016 to 2018 (84.2% vs. 84.6%), though rates showed a little downtick from 2018 to 2020 (84.6% vs. 83.3%). While Pap testing declined over time (82.7% vs. 80.6%) from 2016 to 2020, HPV-based testing increased substantially from 2016 to 2020 overall (43.4% vs. 52.7%), and across subgroups, despite a little dip in 2020. Also, we found disparities in up-to-date CCS and by screening methods among NH Asian women (up-to-date CCS 74.4%, Pap testing 73.0%, and HPV testing 44.1%) compared to NHW women (up-to-date CCS 83.2%, Pap testing 80.8%, HPV testing 51.8%) in 2020.

Crude odds ratios (Table 3) suggested that across all racial/ethnic groups, household income, health insurance, having a personal physician, and routine check-up were associated with having up-to-date CCS. Whereas the relationships between up-to-date CCS and age, marital status, education, employment, and general health varied across groups. In the multivariable analysis including all racial/ethnic groups, we found evidence for interaction between race/ethnicity and SES variables (income, $p<0.001$; education, $p<0.001$; and employment, $p=0.044$). In the adjusted multivariable logistic regression models (Table 4), age and attending routine health check were consistent predictors of up-to-date CCS regardless of race/ethnicity. In addition, having a personal physician was linked to CCS completion for most subgroups except among NHO women. Other important findings from our data include, across all race/ethnic group, older women were less likely to have up-to-date CCS. On the contrary, women who attended wellness checks within the past year had approximately three to fourteen times the odds of following CCS guidelines.

Furthermore, previous mammogram use was associated with greater odds of up-to-date CCS in NHW (aOR = 2.97, 95% CI: 2.72, 3.25), NHB (aOR = 2.75, 95% CI: 2.18, 3.47), Hispanic (aOR = 2.74, 95% CI: 2.22, 3.37), and NH Asian women (aOR = 3.78, 95% CI 2.62, 5.45) (all $p<0.001$). In contrast, there were variations in the link between socioeconomic status variables and up-to-date CCS across groups. In addition, predictors of HPV-based testing are available in the Tables 5 and 6. Likewise, correlates of receiving HPV-based testing varied but routine health examinations and age were consistent predictors for all racial/ethnic subgroups. We tested for collinearity among our predictor variables and the mean variance inflation factor (VIF) for collinearity test was less than 2.

DISCUSSION

We examined recent trends in cervical cancer screening and predictors by race/ethnicity among a nationally representative sample of US women aged 30–64 years, who had not undergone a hysterectomy, from 2016 to 2020. Overall, up-to-date CCS rates were stable from 2016 to 2018, with a slight, but significant decline from 84.6% in 2018 to 83.3% in 2020. Though Pap test rates dwindled overall and across racial/ethnic subgroups, there was an upsurge in HPV-based testing over time. These findings are consistent with previous studies.[23–26]

An analysis of county-level data reported a similar decline in Pap test uptake.[23] Additionally, population-based studies using the National Health Interview Survey (NHIS) reported declines in Pap testing.[25,27] Silver and colleagues examined yearly data on HPV and Pap tests participation in an academic medical center and observed a significant increase in HPV/Pap co-testing uptake. Another analysis using healthcare claims data reported a decline in overall cervical cancer screening rates but an upsurge in HPV/Pap co-testing rates.[26] The shift towards HPV-based screening may be due to evolving scientific knowledge on the higher accuracy of the method compared to Pap testing,[28] in detecting high-risk HPV in cervical cells identified as a major causal factor in cervical cancer.[29,30]

Our analyses showed racial/ethnic differences in rates and predictors of up-to-date CCS and HPV-based testing. Studies have documented disparities in cancer screening participation, including CCS among racially minoritized populations.[11,31] Furthermore, across all racial/ethnic subgroups, older women were less likely to receive timely screening. Past studies have documented low CCS participation among older women.[14,18,21,32] Unlike older women, younger women are more likely to have contact with health care providers for reproductive health reasons including pregnancy care, family planning services, and thus may receive CCS.[33,34] In addition, older women's perceived susceptibility to cervical cancer and need for screening may be low.[35] Yet older women are at higher risk of cervical cancer,[14,21] and poor screening behavior may reduce the opportunity to detect easily treatable cervical cancer. In our study, we found that women who engaged with healthcare services, particularly routine general examinations were more likely to be up to date with CCS. Understanding and addressing barriers to preventive services may help mitigate delayed or no participation in CCS and increase the opportunity to achieve the WHO global cervical cancer elimination goals[6]

In the present study, SES variables, and general health were not consistent predictors of up-to-date CCS and HPV testing for all subgroups. For example, NHW, NH AI/AN, and NH Asian women with higher incomes were more likely to receive timely CCS, while greater income was not a determinant for NHB, Hispanic and NHO women. Notwithstanding, higher income was linked to HPV testing among NHB, Hispanic, and NH Asian women. In addition, the association between up-to-date CCS or HPV testing and income was stronger among NH Asian women compared to other race/ethnicity. Many studies in diverse settings, including in the United States, United Kingdom, Italy, Spain, and Sweden,[21,32,36–39] have suggested a link between higher education attainment and CCS. However, in our study, this was not true among Hispanic and NH AI/AN women. Our results suggest a need to

understand both implicit and explicit barriers to timely CCS participation, including cultural, religious, and psychosocial factors across socioeconomic classes.

Our study has several limitations. First, all variables used in the analysis were measured with self-reported surveys and could not be verified by medical record review. Thus, it could be subject to recall bias and social desirability. Second, the BRFSS uses a cross-sectional survey, and we cannot determine clear temporality or make causal inferences from our findings. Third, we cannot rule out the possibility that HPV testing was under-reported. Many participants reported being unsure of receiving the test and were excluded from the HPV testing analysis. Providers could inform and educate their clients about specific CCS tests and potential advantages of the tests being administered. Fourth, many national surveys, including BRFSS, have reported lower participation rates in recent years.[40] Non-response bias is a potential limitation in the current study; however, we used weighted data in our analyses to minimize potential biases. Fifth, the time frame of our data from 2016 to 2020 may not reflect changes based on the most recently updated guidelines,[7,8] future studies could investigate changes before and after these updates. Lastly, the 2020 data were collected during the COVID-19 pandemic, and due to the lockdown, people might have delayed or canceled preventive care utilization. Moreover, recent studies have suggested a substantial decline in cancer prevention services utilization during the COVID-19 pandemic, particularly during the 2020 lockdown order.[41,42] Despite these limitations, BRFSS is a large sample and has been shown to be reliable and valid.[20] and outcomes of interest were measured for multiple years.

In conclusion, this population-based study provides essential updates on recent cervical cancer screening utilization. The slight decrease in CCS rates in 2020 may be attributable to disruptions in preventive healthcare delivery during the COVID-19 pandemic lockdown order. The increase in HPV testing overall and across all racial/ethnic subgroups may reflect evolving scientific evidence for HPV as a preferred screening method. There is persisting disparity in CCS participation by age and race/ethnicity. It is of serious concern that older women at the greatest risk of being diagnosed with cervical cancer are less likely to be screened. There is a need for more exploratory research to understand CCS participation barriers that may be peculiar to these groups of women and their mechanisms of influence. In addition, though the link between CCS and socioeconomic factors varied by race/ethnicity, having regular healthcare providers and preventive services utilization were consistent predictors of up-to-date CCS. Policies funding inclusive and culturally relevant interventions and optimizing access to routine health checks could increase CCS participation across all groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

Funding:

This work was funded by a research training award from the Cancer Prevention & Research Institute of Texas (CPRIT) for the Systems Epidemiology of Cancer Training (SECT) Program (RP210037; I. Sokale, PI: A. Thrift).

This research was also supported by a grant from the National Institute on Minority Health and Health Disparities (NIMHD, R01MD01375, PI: J Montealegre). This study was also supported by the facilities and resources of the Dan L Duncan Comprehensive Cancer Center P30 CA125123 (PI: Heslop). The funders had no role in the design of the study, the collection, analyses or interpretation of the data, the writing of the manuscript or the decision to publish the results.

REFERENCES

1. Burton-Jeangros C, Cullati S, Manor O, Courvoisier DS, Bouchardy C, Guessous I. Cervical cancer screening in Switzerland: cross-sectional trends (1992–2012) in social inequalities. Eur J Public Health. 2017;27(1):167–173. [PubMed: 28177486]
2. Patel K, Gishe J, Liu J, Heaston A, Manis E, Moharreri B, et al. Factors Influencing Recommended Cancer Screening in Low-Income African American Women in Tennessee. J Racial Ethn Health Disparities. 2020;7(1):129–136. [PubMed: 31664677]
3. Cuzick J, Clavel C, Petry KU, Meijer CJ, Hoyer H, Ratnam S, et al. Overview of the European and North American studies on HPV testing in primary cervical cancer screening. Int J Cancer. 2006;119(5):1095–1101. [PubMed: 16586444]
4. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209–249. [PubMed: 33538338]
5. National Cancer Institute. Surveillance, Epidemiology, and End Results Program. Cancer Statistics Facts: Cervical Cancer [cited 2022 Jan 10]. Available from: https://seer.cancer.gov/statfacts/html/cervix.html
6. World Health Organization. Cervical Cancer Elimination Initiative. World Health Organization; 2022. Accessed October 18, 2022. Available from: https://www.who.int/initiatives/cervical-cancer-elimination-initiative#cms
7. US Preventive Services Task Force, Curry SJ, Krist AH, et al. Screening for Cervical Cancer: US Preventive Services Task Force Recommendation Statement. JAMA. 2018;320(7):674–686. [PubMed: 30140884]
8. American Cancer Society. The American Cancer Society Guidelines for the Prevention and Early Detection of Cervical Cancer Updated April 22, 2022 [cited 2022 Jan 10]. Available from: https://www.cancer.org/cancer/cervical-cancer/detection-diagnosis-staging/cervical-cancer-screening-guidelines.html
9. National Cancer Institute. Cancer Trends Progress Report: Cervical cancer screening. [cited 2022 Sep 1]. Available from: https://progressreport.cancer.gov/detection/cervical_cancer.
10. Quinn M, Babb P, Jones J, Allen E. Effect of screening on incidence of and mortality from cancer of cervix in England: evaluation based on routinely collected statistics. BMJ. 1999;318(7188):904–908. [PubMed: 10102852]
11. Suk R, Hong YR, Rajan SS, Xie Z, Zhu Y, Spencer JC. Assessment of US Preventive Services Task Force Guideline-Concordant Cervical Cancer Screening Rates and Reasons for Underscreening by Age, Race and Ethnicity, Sexual Orientation, Rurality, and Insurance, 2005 to 2019. JAMA Netw Open. 2022;5(1):e2143582. Published 2022 Jan 4. [PubMed: 35040970]
12. Yu L, Sabatino SA, White MC. Rural-Urban and Racial/Ethnic Disparities in Invasive Cervical Cancer Incidence in the United States, 2010–2014. Prev Chronic Dis. 2019;16:E70. [PubMed: 31172917]
13. Kobetz E, Seay J, Amofah A, Pierre L, Bispo JB, Trevil D, et al. Mailed HPV self-sampling for cervical cancer screening among underserved minority women: study protocol for a randomized controlled trial. Trials. 2017;18(1):19. [PubMed: 28086983]
14. Cadet TJ, Burke SL, Stewart K, Howard T, Schonberg M. Cultural and emotional determinants of cervical cancer screening among older Hispanic women. Health Care Women Int. 2017;38(12):1289–1312. [PubMed: 28825525]
15. Baezconde-Garbanati L, Murphy ST, Moran MB, Cortessis VK. Reducing the Excess Burden of Cervical Cancer Among Latinas: Translating Science into Health Promotion Initiatives. Calif J Health Promot. 2013;11(1):45–57. [PubMed: 24587769]

16. Yoo GJ, Le MN, Vong S, Lagman R, Lam AG. Cervical cancer screening: attitudes and behaviors of young Asian American women. J Cancer Educ. 2011;26(4):740–746. [PubMed: 21553330]
17. Coughlin SS, King J, Richards TB, Ekwueme DU. Cervical cancer screening among women in metropolitan areas of the United States by individual-level and area-based measures of socioeconomic status, 2000 to 2002. Cancer Epidemiol Biomarkers Prev. 2006;15(11):2154–2159. [PubMed: 17119040]
18. Luque JS, Tarasenko YN, Chen C. Correlates of Cervical Cancer Screening Adherence Among Women in the US: Findings from HINTS 2013–2014. J Prim Prev. 2018;39(4):329–344. [PubMed: 29876723]
19. Centers for Disease Control and Prevention (CDC). Behavioral risk factor surveillance system survey data. Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention, [2019]. Updated September 30, 2021 [Cited 2022 Mar 31]. Available from: https://www.cdc.gov/brfss/data_documentation/index.htm
20. Nelson DE, Holtzman D, Bolen J, Stanwyck CA, Mack KA. Reliability and validity of measures from the Behavioral Risk Factor Surveillance System (BRFSS). Soz Praventivmed. 2001;46 Suppl 1:S3–S42. [PubMed: 11851091]
21. Harper DM, Plegue M, Harmes KM, Jimbo M, SheinfeldGorin S. Three large scale surveys highlight the complexity of cervical cancer under-screening among women 45–65years of age in the United States. Prev Med. 2020;130:105880. [PubMed: 31678587]
22. Heintzman J, Hatch B, Coronado G, Ezekiel D, Cowburn S, Escamilla-Sanchez O, et al. Role of Race/Ethnicity, Language, and Insurance in Use of Cervical Cancer Prevention Services Among Low-Income Hispanic Women, 2009–2013. Prev Chronic Dis. 2018 Feb 22;15:E25. [PubMed: 29470167]
23. MacLaughlin KL, Jacobson RM, Radecki Breitkopf C, Wilson PM, Jacobson DJ, Fan C, et al. Trends Over Time in Pap and Pap-HPV Cotesting for Cervical Cancer Screening. J Womens Health (Larchmt). 2019;28(2):244–249. [PubMed: 30614380]
24. Silver MI, Rositch AF, Phelan-Emrick DF, Gravitt PE. Uptake of HPV testing and extended cervical cancer screening intervals following cytology alone and Pap/HPV cotesting in women aged 30–65 years. Cancer Causes Control. 2018;29(1):43–50. [PubMed: 29124542]
25. Watson M, Benard V, King J, Crawford A, Saraiya M. National assessment of HPV and Pap tests: Changes in cervical cancer screening, National Health Interview Survey. Prev Med. 2017;100:243–247. [PubMed: 28502575]
26. Watson M, Benard V, Flagg EW. Assessment of trends in cervical cancer screening rates using healthcare claims data: United States, 2003–2014. Prev Med Rep. 2018;9:124–130. [PubMed: 29527465]
27. Hall IJ, Tangka FKL, Sabatino SA, Thompson TD, Graubard BI, Breen N. Patterns and Trends in Cancer Screening in the United States. Prev Chronic Dis. 2018;15:E97. [PubMed: 30048233]
28. Murphy J, Kennedy EB, Dunn S, McLachlin CM, Kee Fung MF, Gzik D, et al. HPV testing in primary cervical screening: a systematic review and meta-analysis. J Obstet Gynaecol Can. 2012;34(5):443–452. [PubMed: 22555137]
29. Hu Z, Ma D. The precision prevention and therapy of HPV-related cervical cancer: new concepts and clinical implications. Cancer Med. 2018 Oct;7(10):5217–5236. [PubMed: 30589505]
30. Winer RL, Hughes JP, Feng Q, Xi LF, Cherne S, O'Reilly S, et al. Early natural history of incident, type-specific human papillomavirus infections in newly sexually active young women. Cancer Epidemiol Biomarkers Prev. 2011 Apr;20(4):699–707. [PubMed: 21173170]
31. Stanley SL, Thomas CC, King JB, Richardson LC. Predictors of never being screened for cervical cancer by metropolitan area. J Community Health. 2014;39(2):400–408. [PubMed: 24162857]
32. Marlow L, McBride E, Varnes L, Waller J. Barriers to cervical screening among older women from hard-to-reach groups: a qualitative study in England. BMC Womens Health. 2019;19(1):38. [PubMed: 30808349]
33. Asamu OO, & Danawi H (2021). Childbirth educators' role regarding pregnant women and cervical cancer prevention. Journal of Excellence in Nursing and Healthcare Practice, 2021;3(1), 23–31.

34. Kuczborska K, Kacperczyk-Bartnik J, Wolska M, Pluta M, Bartnik P, Dobrowolska-Redo A, et al. Secondary cervical cancer prevention in routine prenatal care - coverage, results and lessons for the future. Ginekol Pol. 2019;90(7):396–402. [PubMed: 31392709]

35. Montgomery K, Bloch JR, Bhattacharya A, Montgomery O. Human papillomavirus and cervical cancer knowledge, health beliefs, and preventative practices in older women. J Obstet Gynecol Neonatal Nurs. 2010;39(3):238–249.

36. Murfin J, Irvine F, Meechan-Rogers R, Swift A. Education, income and occupation and their influence on the uptake of cervical cancer prevention strategies: A systematic review. J Clin Nurs. 2020;29(3–4):393–415. [PubMed: 31713934]

37. Damiani G, Federico B, Basso D, Ronconi A, Bianchi CB, Anzellotti GM, et al. Socioeconomic disparities in the uptake of breast and cervical cancer screening in Italy: a cross sectional study. BMC Public Health. 2012;12:99. [PubMed: 22305108]

38. Martín-López R, Hernández-Barrera V, de Andres AL, Carrasco-Garrido P, de Miguel AG, Jimenez-Garcia R. Trend in cervical cancer screening in Spain (2003–2009) and predictors of adherence. Eur J Cancer Prev. 2012;21(1):82–88. [PubMed: 22129658]

39. Östensson E, Alder S, Elfström KM, Sundström K, Zethraeus N, Arbyn M, et al. Barriers to and facilitators of compliance with clinic-based cervical cancer screening: population-based cohort study of women aged 23–60 years [published correction appears in PLoS One. 2015;10(8):e0135534]. PLoS One. 2015;10(5):e0128270. [PubMed: 26011051]

40. Czajka JL, Beyler A. Background paper declining response rates in federal surveys: Trends and implications. Mathematica policy research. 2016 Jun 15;1:1–86.

41. DeGroff A, Miller J, Sharma K, Sun J, Helsel W, Kammerer W, et al. COVID-19 impact on screening test volume through the National Breast and Cervical Cancer early detection program, January-June 2020, in the United States. Prev Med. 2021;151:106559. [PubMed: 34217410]

42. Mayo M, Potugari B, Bzeih R, Scheidel C, Carrera C, Shellenberger RA. Cancer Screening During the COVID-19 Pandemic: A Systematic Review and Meta-analysis. Mayo Clin Proc Innov Qual Outcomes. 2021;5(6):1109–1117. [PubMed: 34693211]

Table 1.

Sample characteristics overall and according to race/ethnicity, Behavioral Risk Factors Surveillance System, 2016–2020 (n=235,713)

Characteristic	All (N=235,713)	Race/Ethnicity						*P*-value
		Non-Hispanic White (n=172,079)	Non-Hispanic Black (n=20,913)	Hispanic (n=24,848)	Non-Hispanic AI/AN (n=4,449)	Non-Hispanic Asian (n=7,165)	Non-Hispanic Other (n=6,259)	
	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	
Age								
30–39	58,194 (33.1)	37,727 (29.4)	5,955 (36.7)	8,936 (40.6)	1,214 (35.9)	2,336 (38.6)	2,026 (39.1)	<0.001
40–49	59,965 (27.5)	41,667 (26.0)	5,707 (28.9)	7,657 (30.1)	1,153 (27.5)	2,137 (31.2)	1,644 (27.6)	
50–59	74,700 (26.6)	57,786 (29.3)	6,157 (24.0)	5,860 (21.4)	1,402 (26.4)	1,796 (20.7)	1,699 (23.4)	
60–64	42,854 (12.8)	34,899 (15.3)	3,094 (10.4)	2,395 (7.9)	680 (10.2)	896 (9.5)	890 (9.9)	
Marital Status								
Married/cohabiting	150,025 (65.1)	117,351 (70.7)	7,189 (37.5)	15,015 (63.3)	2,055 (49.4)	5,038 (76.1)	3,377 (56.4)	<0.001
Not Married	85,688 (34.9)	54,728 (29.3)	13,724 (62.5)	9,833 (36.7)	2,394 (50.6)	2,127 (23.9)	2,882 (43.6)	
Education								
< High school	14,521 (11.9)	5,452 (5.3)	1,565 (10.1)	6,466 (37.6)	509 (15.4)	215 (3.4)	314 (7.6)	<0.001
High school	50,165 (21.6)	34,726 (21.3)	5,686 (24.6)	5,927 (23.2)	1,292 (28.8)	1,221 (13.1)	1,313 (20.3)	
> High School	171,027 (66.4)	131,901 (73.4)	13,662 (65.4)	12,455 (39.2)	2,648 (55.8)	5,729 (83.5)	4,632 (72.1)	
Employment Status								
Employed	158,306 (65.4)	118,995 (68.3)	13,416 (66.4)	14,250 (54.3)	2,511 (55.7)	5,129 (70.6)	4,005 (64.1)	<0.001
Unemployed	77,407 (34.6)	53,084 (31.7)	7,497 (33.6)	10,598 (45.7)	1,938 (44.3)	2,036 (29.4)	2,254 (35.9)	
Household Income								
<$15,000	19,238 (8.7)	9,733 (5.2)	3,079 (13.3)	4,384 (17.8)	892 (16.8)	439 (4.5)	711 (10.2)	<0.001
$15,000–49,000	70,882 (30.1)	45,169 (24.6)	8,826 (40.7)	10,865 (44.1)	1,921 (38.3)	1,968 (19.8)	2,133 (29.3)	
$50,000 or more	119,113 (49.1)	98,660 (59.3)	6,737 (35.4)	5,960 (22.6)	1,198 (33.4)	3,864 (59.2)	2,694 (47.9)	
Missing	26,480 (12.0)	18,517 (10.9)	2,271 (10.5)	3,639 (15.4)	438 (11.5)	894 (16.5)	721 (12.6)	
Health Insurance								

Characteristic	All (N=235,713)	Race/Ethnicity						*P*-value
		Non-Hispanic White (n=172,079)	Non-Hispanic Black (n=20,913)	Hispanic (n=24,848)	Non-Hispanic AI/AN (n=4,449)	Non-Hispanic Asian (n=7,165)	Non-Hispanic Other (n=6,259)	
	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	
Yes	213,149 (87.4)	160,033 (92.3)	18,598 (88.6)	18,266 (68.8)	4,059 (90.0)	6,512 (92.3)	5,681 (89.0)	<0.001
No	22,564 (12.6)	12,046 (7.7)	2,315 (11.4)	6,582 (31.2)	390 (11.0)	653 (7.7)	578 (11.0)	
General Health								
Good/Better	199,922 (84.2)	150,453 (87.7)	16,339 (80.2)	18,567 (73.8)	3,257 (75.3)	6,372 (84.3)	4,934 (79.2)	<0.001
Poor/Fair	35,791 (15.8)	21,626 (12.3)	4,574 (19.8)	6,281 (26.2)	1,192 (24.7)	793 (15.7)	1,325 (20.8)	
Had a Personal Physician								
Yes	200,528 (82.1)	149,866 (85.7)	18,136 (84.9)	18,099 (68.3)	3,222 (75.9)	5,998 (84.3)	5,207 (81.1)	<0.001
No	35,185 (17.9)	22,213 (14.3)	2,777 (15.1)	6,749 (31.7)	1,227 (24.1)	1,167 (15.7)	1,052 (18.9)	
Last Routine Check-up								
< 1 year	179, 544 (74.9)	129,904 (74.5)	17,844 (84.0)	18,295 (71.6)	3,417 (76.2)	5,435 (72.2)	4,649 (71.9)	<0.001
1 – < 5 years	43,872 (19.8)	32,512 (19.6)	2,630 (13.5)	5,274 (23.0)	795 (18.2)	1,427 (24.5)	1,234 (22.2)	
> 5 years/Never	12,297 (5.2)	9,663 (5.9)	439 (0.24)	1,279 (5.4)	237 (5.6)	303 (3.3)	376 (5.9)	
Had a Mammogram								
Yes	172,256 (66.9)	129,035 (69.6)	15,328 (67.3)	15,944 (60.6)	3,144 (66.6)	4,641 (60.2)	4,164 (60.5)	<0.001
No	63,457 (33.1)	43,044 (30.4)	5,585 (32.7)	8,904 (39.4)	1,305 (33.4)	2,524 (39.8)	2,095 (39.5)	
Up-to-date CCS								
Yes	195,103 (84.0)	141,522 (83.5)	18,418 (88.5)	20,918 (84.6)	3,508 (80.7)	5,606 (79.7)	5,131 (81.3)	<0.001
No	40,610 (16.0)	30,557 (16.5)	2,495 (11.5)	3,930 (15.4)	941 (19.3)	1,559 (20.3)	1,128 (18.7)	
Had Pap Test Within Past 3 Years[a]								<0.001
Yes	189,737 (81.9)	137,796 (81.6)	18,000 (87.0)	20,235 (81.9)	3,374 (78.7)	5,395 (76.3)	4,937 (77.7)	
No	44,650 (18.1)	33,370 (18.4)	2,773 (13.0)	4,465 (18.1)	1042 (21.3)	1,710 (23.7)	1,290 (22.3)	

Characteristic	All (N=235,713)	Race/Ethnicity						*P*-value
		Non-Hispanic White (n=172,079)	Non-Hispanic Black (n=20,913)	Hispanic (n=24,848)	Non-Hispanic AI/AN (n=4,449)	Non-Hispanic Asian (n=7,165)	Non-Hispanic Other (n=6,259)	
	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	Sample No (Weighted %)	
Had HPV Test Within Past 5 Years[a]								<0.001
Yes	79,107 (49.9)	53,882 (48.9)	9,010 (57.6)	9,895 (49.8)	1,777 (51.0)	2,065 (41.0)	2,236 (56.8)	
No	91,858 (50.1)	66,767 (51.1)	7752 (42.4)	9,831 (50.2)	1,713 (49.0)	3,559 (59.0)	2,478 (43.2)	
Survey Year								
2016	79,313 (31.7)	58,329 (31.9)	7,217 (31.6)	8,375 (32.0)	1,311 (29.3)	2,180 (29.3)	1,901 (31.0)	<0.001
2018	81,640 (35.8)	59,990 (36.4)	7,340 (35.5)	8,177 (34.3)	1,659 (36.2)	2,405 (36.6)	2,069 (32.9)	
2020	74,760 (32.5)	53,760 (31.8)	6,356 (32.9)	8,296 (33.7)	1,479 (34.5)	2,580 (34.1)	2,289 (36.0)	

[a]May not add up to total due to missing values, don't know or refused to answer responses.

Abbreviations: AI/AN, American Indian/Alaska Native; CCS, cervical cancer screening; HPV, human papillomavirus; Pap, Papanicolaou

p-value from chi-square tests comparing characteristics by racial/ethnic subgroups

Table 2.

Weighted proportions of women with up-to-date cervical cancer screening and by screening methods, BRFSS 2016–2020

Cervical Cancer Screening	Overall & Race/Ethnicity	Proportions of women by year (95% CI)[a]			Percent Change[b] 2016–2020	2020 vs. 2016[c]	
		2016	2018	2020		*t*	*p*-Value
Up-to-date cervical cancer screening (n=235,713)	Overall	84.2 (83.7, 84.7)	84.6 (84.1, 85.1)	83.3 (82.6, 83.9)	−1.07	−2.85	**0.004**
	NHW	84.4 (83.9, 84.9)	83.9 (83.4, 84.5)	83.2 (82.6, 83.8)	−1.42	−2.90	**0.004**
	NHB	86.1 (84.6, 87.5)	89.5 (88.2, 90.6)	88.5 (87.0, 89.9)	2.79	1.91	0.056
	Hispanic	84.6 (83.1, 85.9)	86.1 (84.6, 87.5)	82.8 (80.9, 84.6)	−2.13	−1.52	0.129
	NH AI/AN	84.1 (79.8, 87.6)	77.5 (69.7, 83.8)	81.4 (77.1, 85.0)	−3.21	−0.71	0.475
	NH Asian	78.4 (75.1, 81.4)	78.7 (75.2, 81.9)	74.4 (70.5, 77.9)	−5.10	−2.07	0.039
	NHO	82.7 (79.5, 85.4)	84.1 (81.3, 86.5)	79.1 (74.7, 82.8)	−4.35	−1.41	0.159
Pap testing (n=234,387)	Overall	82.7 (82.2, 83.2)	82.5 (81.9, 83.0)	80.6 (80.0, 81.3)	−2.54	−5.29	**<0.001**
	NHW	82.5 (81.9, 83.1)	81.7 (81.0, 82.3)	80.8 (80.2, 81.4)	−2.06	−4.77	**<0.001**
	NHB	85.1 (83.4, 86.6)	88.6 (87.2, 89.8)	87.3 (85.5, 88.8)	2.59	1.58	0.113
	Hispanic	83.1 (81.5, 84.5)	83.8 (82.0, 85.5)	78.8 (76.5, 81.0)	−5.17	−3.17	**0.001**
	NH AI/AN	80.5 (75.6, 84.7)	77.7 (72.4, 82.2)	78.1 (73.1, 82.4)	−7.08	−0.89	0.372
	NH Asian	80.0 (76.2, 83.3)	76.4 (72.2, 80.3)	73.0 (68.4, 77.2)	−8.75	−2.48	**0.013**
	NHO	80.4 (76.8, 83.6)	76.6 (72.6, 80.2)	76.3 (71.4, 80.7)	−5.10	−1.35	0.177
HPV testing (n=170,965)	Overall	43.4 (42.6, 44.2)	53.2 (52.4, 54.1)	52.7 (51.7, 53.7)	21.43	14.14	**<0.001**
	NHW	42.4 (41.5, 43.3)	52.4 (51.4, 53.3)	51.8 (50.8, 52.9)	22.17	13.51	**<0.001**
	NHB	50.1 (47.8, 52.5)	61.8 (59.5, 64.0)	60.1 (57.6, 62.5)	19.96	5.58	**<0.001**
	Hispanic	42.6 (40.5, 44.8)	53.5 (50.9, 56.1)	52.6 (49.6, 55.5)	23.47	4.96	**<0.001**
	NH AI/AN	44.7 (38.1, 51.5)	50.2 (43.7, 56.8)	57.0 (49.5, 64.1)	27.52	2.42	**0.016**
	NH Asian	37.3 (32.2, 42.7)	41.1 (36.2, 46.1)	44.1 (38.0, 50.3)	18.23	1.50	0.133
	NHO	54.9 (49.2, 60.4	60.5 (55.4, 65.4)	55.1 (49.6, 60.4)	0.36	0.41	0.680

[a] Weighted proportions

[b] Percentage change was calculated by dividing the difference in screening rates (2020 minus 2016) by the 2016 proportion and then multiplied by 100.

[c] P-value derived from test for trend using simple linear regression models and adjusting for age, education, income, and health insurance

Abbreviations: CI, confidence interval; NHW, non-Hispanic White; NHB, non-Hispanic Black; NH AI/AN, non-Hispanic American Indian/Alaskan Native; NH Asian, non-Hispanic Asian; NHO, non-Hispanic Other races.

Table 3.

Unadjusted bivariate analysis of up-to-date cervical cancer screening by race/ethnicity, Behavioral Risk Factors Surveillance System, 2016–2020 (n=235,713).

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age						
30–39	1.00	1.00	1.00	1.00	1.00	1.00
40–49	**0.77 (0.72, 0.83)** [a]	**0.77 (0.62, 0.95)** [c]	**0.82 (0.68, 0.99)** [c]	0.67 (0.42, 1.06)	1.22 (0.89, 1.68)	**0.66 (0.47, 0.93)** [c]
50–59	**0.61 (0.57, 0.65)** [a]	**0.56 (0.46, 0.69)** [a]	**0.76 (0.62, 0.93)** [b]	**0.45 (0.28, 0.71)** [b]	1.04 (0.73, 1.49)	**0.46 (0.31, 0.66)** [a]
60–64	**0.48 (0.45, 0.52)** [a]	**0.34 (0.26, 0.46)** [a]	**0.62 (0.47, 0.80)** [a]	**0.42 (0.25, 0.69)** [b]	0.93 (0.55, 1.60)	**0.40 (0.25, 0.63)** [a]
Marital Status						
Not Married	1.00	1.00	1.00	1.00	1.00	1.00
Married/Cohabiting	**1.61 (1.531.69)** [a]	**1.32 (1.10, 1.57)** [b]	**1.32 (1.13, 1.54)** [a]	1.26 (0.90, 1.77)	**1.88 (1.40, 2.52)** [a]	1.31 (0.98, 1.75)
Education						
< High school	1.00	1.00	1.00	1.00	1.00	1.00
High school	**1.54 (1.36, 1.73)** [a]	**1.59 (1.21, 2.09)** [b]	1.09 (0.89, 1.32)	1.34 (0.80, 2.23)	1.91 (0.92, 3.93)	1.50 (0.90, 2.48)
> High School	**2.97 (2.65, 3.32)** [a]	**3.27 (2.53, 4.23)** [a]	**1.73 (1.46, 2.06)** [a]	1.98 (1.27, 3.07)	**3.59 (1.88, 6.85)** [a]	**2.53 (1.67, 3.83)** [a]
Employment Status						
Unemployed	1.00	1.00	1.00	1.00	1.00	1.00
Employed	**1.65 (1.57, 1.74)** [a]	**1.99 (1.68, 2.36)** [a]	**1.26 (1.08, 1.47)** [a]	1.20 (0.86, 1.69)	1.05 (0.79, 1.40)	**1.79 (1.34, 2.39)** [a]
Household Income						
<$15,000	1.00	1.00	1.00	1.00	1.00	1.00
$15,000–49,000	**1.45 (1.32, 1.60)** [a]	**1.48 (1.19, 1.84)** [a]	**1.25 (1.01, 1.54)** [c]	1.49 (0.96, 2.31)	1.67 (0.89, 3.13)	1.47 (0.93, 2.33)
$50,000 or more	**3.36 (3.06, 3.69)** [a]	**2.78 (2.11, 3.65)** [a]	**2.07 (1.61, 2.65)** [a]	**2.88 (1.79, 4.62)** [a]	**4.49 (2.48, 8.14)** [a]	**2.40 (1.49, 3.87)** [a]
Missing	**1.86 (1.67, 2.07)** [a]	0.85 (0.65, 1.12)	1.05 (0.82, 1.33)	1.53 (0.87, 2.71)	**2.29 (1.20, 4.37)** [c]	1.38 (0.82, 2.33)

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Health Insurance						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**4.16 (3.85, 4.49)** [a]	**2.87 (2.36, 3.48)** [a]	**2.17 (1.85, 2.54)** [a]	**3.36 (2.13, 5.32)** [a]	**2.74 (1.80, 4.15)** [a]	**3.37 (2.33, 4.89)** [a]
General Health						
Poor/Fair	1.00	1.00	1.00	1.00	1.00	1.00
Good/Better	**2.12 (1.99, 2.26)** [a]	**1.84 (1.53, 2.21)** [a]	**1.32 (1.12, 1.56)** [b]	1.21 (0.84, 1.75)	0.95 (0.58, 1.54)	**1.41 (1.04, 1.91)** [c]
Had a Personal Physician						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**3.26 (3.07, 3.46)** [a]	**3.66 (3.02, 4.45)** [a]	**2.37 (2.03, 2.78)** [a]	**2.48 (1.75, 3.52)** [a]	**2.88 (2.11, 3.93)** [a]	**2.72 (1.99, 3.70)** [a]
Routine Check-up						
> 5 years/Never	1.00	1.00	1.00	1.00	1.00	1.00
< 1 year	**12.67 (11.59, 13.85)** [a]	**19.19 (12.91, 28.53)** [a]	**8.74 (6.79, 11.26)** [a]	**9.94 (5.71, 17.30)** [a]	**8.61 (4.90, 15.12)** [a]	**14.73 (8.70, 24.95)** [a]
1 – < 5 years	**5.69 (5.16, 6.26)** [a]	**7.01 (4.59, 10.69)** [a]	**3.89 (2.97, 5.09)** [a]	**5.41 (2.92, 10.03)** [a]	**3.82 (2.09, 6.98)** [a]	**6.60 (3.82, 11.41)** [a]
Had a Mammogram						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.55 (1.47, 1.63)** [a]	1.53 (1.29, 1.81)[a]	**1.77 (1.52, 2.07)** [a]	1.23 (0.88, 1.74)	**2.70 (2.06, 3.55)** [a]	1.31 (0.98, 1.75)

Boldface indicates statistical significance

[a] P < 0.001

[b] p <0.01

[c] p < 0.05

Abbreviations: OR, odds ratio; CI, confidence interval; AI/AN, American Indian/Alaska Native

Table 4.

Adjusted multivariable analysis of up-to-date cervical cancer screening by race/ethnicity, Behavioral Risk Factors Surveillance System, 2016–2020 (n=235,713).

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Age						
30–39	1.00	1.00	1.00	1.00	1.00	1.00
40–49	**0.36 (0.33, 0.40)** [a]	**0.41 (0.32, 0.53)** [a]	**0.48 (0.39, 0.60)** [a]	**0.53 (0.34, 0.83)** [b]	**0.63 (0.44, 0.91)** [c]	**0.56 (0.38, 0.83)** [b]
50–59	**0.21 (0.19, 0.24)** [a]	**0.25 (0.18, 0.33)** [a]	**0.31 (0.24, 0.40)** [a]	**0.34 (0.21, 0.54)** [a]	**0.40 (0.25, 0.63)** [a]	**0.36 (0.23, 0.54)** [a]
60–64	**0.15 (0.14, 0.17)** [a]	**0.16 (0.12, 0.23)** [a]	**0.22 (0.16, 0.31)** [a]	**0.29 (0.18, 0.49)** [a]	**0.38 (0.21, 0.69)** [b]	**0.31 (0.19, 0.49)** [a]
Marital Status						
Not Married	1.00	1.00	1.00		1.00	
Married/Cohabiting	**1.12 (1.05, 1.19)** [a]	1.06 (0.88, 1.28)	**1.30 (1.11, 1.53)** [b]	—	1.26 (0.91, 1.75)	—
Education						
< High school	1.00	1.00	1.00	1.00	1.00	1.00
High school	**1.17 (1.01, 1.34)** [c]	1.20 (0.88, 1.64)	0.89 (0.72, 1.09)	0.95 (0.55, 1.62)	1.80 (0.83, 3.88)	1.37 (0.76, 2.47)
> High School	**1.62 (1.41, 1.86)** [a]	**2.07 (1.51, 2.83)** [a]	1.07 (0.88, 1.31)	1.14 (0.70, 1.87)	**2.50 (1.24, 5.04)** [c]	**1.88 (1.15, 3.06)** [c]
Employment Status						
Unemployed	1.00	1.00	1.00			1.00
Employed	**1.18 (1.10, 1.25)** [a]	**1.34 (1.10, 1.64)** [a]	1.14 (0.96, 1.36)	—	—	1.37 (0.99, 1.91)
Household Income						
<$15,000	1.00	1.00	1.00	1.00	1.00	1.00
$15,000–49,000	**1.16 (1.03, 1.31)** [c]	1.03 (0.80, 1.32)	1.09 (0.86, 1.39)	1.48 (0.94, 2.34)	1.37 (0.77, 2.43)	1.16 (0.67, 2.00)
$50,000 or more	**1.71 (1.50, 1.95)** [a]	1.22 (0.87, 1.70)	1.25 (0.94, 1.66)	**2.61 (1.58, 4.34)** [a]	**2.75 (1.56, 4.86)** [a]	1.20 (0.69, 2.07)
Missing	**1.36 (1.19, 1.55)** [a]	**0.66 (0.49,0.89)** [b]	0.96 (0.74, 1.25)	1.49 (0.80, 2.77)	1.46 (0.78, 2.73)	1.19 (0.65, 2.18)

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Health Insurance						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.80 (1.64, 1.98)** [a]	**1.42 (1.14, 1.78)** [b]	**1.28 (1.06, 1.55)** [c]	**1.96 (1.24, 3.10)** [b]	1.25 (0.81, 1.92)	**1.96 (1.27, 3.03)** [a]
General Health						
Poor/Fair	1.00	1.00	1.00			1.00
Good/Better	**1.61 (1.48, 1.74)** [a]	**1.33 (1.08, 1.65)** [b]	1.15 (0.96, 1.38)	—	—	1.38 (0.69, 1.51)
Had a Personal Physician						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.55 (1.43, 1.67)** [a]	**2.13 (1.69, 2.69)** [a]	**1.35 (1.10, 1.65)** [b]	**1.45 (1.00, 2.10)** [c]	**1.65 (1.17, 2.32)** [b]	1.36 (0.94, 1.95)
Routine Check-up						
> 5 years/Never	1.00	1.00	1.00	1.00	1.00	1.00
< 1 year	**9.25 (8.33, 10.26)** [a]	**11.95 (7.68, 18.59)** [a]	**6.44 (4.89, 8.47)** [a]	**7.71 (4.18,**	**4.93 (2.79, 8.72)** [a]	**13.57 (7.34, 25.07)** [a]
1 – < 5 years	**4.35 (3.91, 4.84)** [a]	**4.97 (3.17, 7.79)** [a]	**3.28 (2.52, 4.27)** [a]	**14.23)** [a] **4.15 (2.18, 7.90)** [a]	**2.65 (1.46, 4.79)** [b]	**6.04 (3.23, 11.28)** [a]
Had a Mammogram						
No	1.00	1.00	1.00		1.00	
Yes	**2.97 (2.72, 3.25)** [a]	**2.75 (2.18, 3.47)** [a]	**2.74 (2.22, 3.37)** [a]	—	**3.78 (2.62, 5.45)** [a]	—

Boldface indicates statistical significance

[a] $P < 0.001$

[b] $p < 0.01$

[c] $p < 0.05$

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; AI/AN, American Indian/Alaska Native

Models were adjusted for survey year

Table 5.

Unadjusted bivariate analysis of HPV testing in past 5 years by race/ethnicity, BRFSS 2016–2020 (n=170,965)

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age						
30–39	1.00	1.00	1.00	1.00	1.00	1.00
40–49	**0.66 (0.62, 0.70)** [a]	**0.75 (0.65, 0.87)** [a]	0.94 (0.81, 1.08)	0.84 (0.55, 1.28)	0.97 (0.72, 1.30)	**0.72 (0.52, 0.99)** [c]
50–59	**0.41 (0.39, 0.44)** [a]	**0.43 (0.37, 0.50)** [a]	**0.67 (0.57, 0.80)** [a]	**0.44 (0.30, 0.66)** [a]	**0.52 (0.36, 0.77)** [b]	**0.44 (0.31, 0.61)** [a]
60–64	**0.27 (0.25, 0.29)** [a]	**0.27 (0.23, 0.33)** [a]	**0.41 (0.32, 0.51)** [a]	0.59 (0.30, 1.16)	0.57 (0.32, 1.03)	**0.35 (0.22, 0.55)** [a]
Marital Status						
Not Married	1.00	1.00	1.00	1.00	1.00	1.00
Married/Cohabiting	**0.93 (0.88, 0.97)** [b]	**0.85 (0.75, 0.95)** [b]	1.05 (0.93, 1.18)	0.95 (0.69, 1.33)	0.97 (0.73, 1.29)	0.87 (0.68, 1.12)
Education						
< High school	1.00	1.00	1.00	1.00	1.00	1.00
High school	**1.17 (1.01, 1.35)** [c]	**1.37 (1.10, 1.72)** [b]	**1.36 (1.15, 1.60)** [a]	0.87 (0.52, 1.47)	0.90 (0.34, 2.34)	0.98 (0.58, 1.64)
> High School	**1.72 (1.50, 1.98)** [a]	**2.08 (1.68, 2.57)** [a]	**2.34 (2.03, 2.70)** [a]	1.38 (0.87, 2.20)	1.73 (0.72, 4.15)	1.49 (0.95, 2.34)
Employment Status						
Unemployed	1.00	1.00	1.00	1.00	1.00	1.00
Employed	**1.35 (1.28, 1.41)** [a]	**1.52 (1.35, 1.71)** [a]	**1.28 (1.13, 1.44)** [a]	0.94 (0.68, 1.31)	1.18 (0.88, 1.59)	**1.37 (1.05, 1.78)** [c]
Household Income						
<$15,000	1.00	1.00	1.00	1.00	1.00	1.00
$15,000–49,000	**1.11 (1.00, 1.23)** [c]	**1.38 (1.16, 1.63)** [a]	**1.50 (1.27, 1.77)** [a]	1.41 (0.94, 2.12)	1.88 (1.00, 3.52)	1.16 (0.77, 1.75)
$50,000 or more	**1.38 (1.25, 1.52)** [a]	**1.73 (1.44, 2.06)** [a]	**2.40 (1.98, 1.89)** [a]	1.56 (0.97, 2.51)	**3.51 (1.97, 6.25)** [a]	1.34 (0.89, 2.03)
Missing	0.92 (0.82, 1.03)	0.99 (0.79, 1.26)	1.05 (0.85, 1.29)	1.56 (0.82, 2.99)	**2.41 (1.25, 4.66)** [b]	1.03 (0.62, 1.72)
Health Insurance						

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic AI/AN	Non-Hispanic Asian	Non-Hispanic Other
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.69 (1.55, 1.85)** [a]	**1.42 (1.19, 1.70)** [a]	**1.76 (1.54, 2.01)** [a]	**2.63 (1.58, 4.38)** [a]	**1.63 (1.07, 2.49)** [c]	**1.68 (1.13, 2.50)** [c]
General Health						
Poor/Fair	1.00	1.00	1.00	1.00	1.00	1.00
Good/Better	**1.32 (1.24, 1.41)** [a]	**1.46 (1.27, 1.68)** [a]	**1.47 (1.27, 1.69)** [a]	1.10 (0.77, 1.57)	0.72 (0.46, 1.14)	**1.17 (0.86, 1.58)**
Had a Personal Physician						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.39 (1.30, 1.48)** [a]	**1.78 (1.53, 2.08)** [a]	**1.75 (1.53, 2.01)** [a]	**1.66 (1.18, 2.34)** [b]	1.23 (0.88, 1.72)	1.21 (0.89, 1.65)
Routine Check-up						
> 5 years/Never	1.00	1.00	1.00	1.00	1.00	1.00
< 1 year	**3.37 (3.01, 3.77)** [a]	**5.10 (3.33, 7.80)** [a]	**4.82 (3.60, 6.45)** [a]	**3.83 (1.92, 7.62)** [a]	**3.07 (1.63, 5.80)** [b]	**4.33 (2.19, 8.57)** [a]
1 – < 5 years	**2.83 (2.50, 3.19)** [a]	**3.55 (2.26, 5.56)** [a]	**3.16 (2.32, 4.31)** [a]	**2.23 (1.06, 4.71)** [c]	**2.58 (1.29, 5.15)** [b]	**3.73 (1.82, 7.61)** [a]
Had a Mammogram						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**0.74 (0.71, 0.78)** [a]	**0.88 (0.78, 0.99)** [c]	**1.20 (1.07, 1.36)** [b]	0.91 (0.66, 1.26)	1.25 (0.96, 1.63)	0.79 (0.61, 1.01)

Boldface indicates statistical significance

[a] P < 0.001

[b] p <0.01

[c] p < 0.05

Abbreviations: OR, odds ratio; CI, confidence interval; AI/AN, American Indian/Alaska Native

Table 6.

Adjusted multivariable analysis of HPV testing in past 5 years, by race/ethnicity, Behavioral Risk Factors Surveillance System, 2016–2020 (n=170,965)

	Non-Hispanic White	Non-Hispanic Black	Hispanic[d]	Non-Hispanic AI/AN[d]	Non-Hispanic Asian[d]	Non-Hispanic Other[d]
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Age						
30–39	1.00	1.00	1.00	1.00	1.00	1.00
40–49	**0.50 (0.47, 0.54)** [a]	**0.60 (0.52, 0.71)** [a]	**0.74 (0.63, 0.86)** [a]	0.74 (0.50, 1.12)	0.95 (0.71, 1.29)	**0.70 (0.50, 0.98)** [c]
50–59	**0.30 (0.27, 0.32)** [a]	**0.33 (0.28, 0.40)** [a]	**0.45 (0.40, 0.55)** [a]	**0.39 (0.26, 0.58)** [a]	**0.52 (0.36, 0.76)** [b]	**0.42 (0.30, 0.59)** [a]
60–64	**0.19 (0.17, 0.20)** [a]	**0.21 (0.17, 0.27)** [a]	**0.26 (0.20, 0.34)** [a]	**0.50 (0.27, 0.94)** [c]	0.62 (0.34, 1.13)	**0.33 (0.21, 0.52)** [a]
Marital Status						
Not Married	1.00	1.00				
Married/Cohabiting	**0.80 (0.75, 0.84)** [a]	**0.74 (0.65, 0.84)** [a]	—	—	—	—
Education						
< High school	1.00	1.00	1.00			
High school	**1.21 (1.03, 1.43)** [c]	1.12 (0.88, 1.41)	1.15 (0.96, 1.37)			
> High School	**1.51 (1.28, 1.77)** [a]	**1.46 (1.16, 1.84)** [b]	**1.66 (1.41, 1.97)** [a]	—	—	—
Employment Status						
Unemployed	1.00	1.00	1.00			1.00
Employed	**1.08 (1.02, 1.15)** [b]	1.11 (0.96, 1.28)	0.94 (0.83, 1.07)	—	—	1.19 (0.90, 1.58)
Household Income						
<$15,000	1.00	1.00	1.00		1.00	
$15,000–49,000	1.02 (0.91, 1.15)	1.15 (0.95, 1.39)	**1.33 (1.11, 1.60)** [b]		1.67 (0.89, 3.14)	
$50,000 or more	1.11 (0.99, 1.25)	**1.31 (1.05, 1.65)** [c]	**1.48 (1.18, 1.84)** [b]		**2.86 (1.60, 5.14)** [b]	
Missing	0.90 (0.79, 1.02)	0.96 (0.75, 1.23)	0.99 (0.79, 1.23)	—	**2.07 (1.07, 4.00)** [c]	—
Health Insurance						

	Non-Hispanic White	Non-Hispanic Black	Hispanic[d]	Non-Hispanic AI/AN[d]	Non-Hispanic Asian[d]	Non-Hispanic Other[d]
	aOR (95% CI)	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	**1.32 (1.19, 1.45)** [a]	1.04 (0.86, 1.27)	**1.18 (1.00, 1.38)** [c]	1.88 (1.07, 3.29)	**1.65 (1.02, 2.66)** [c]	1.34 (0.88, 2.03)
General Health						
Poor/Fair	1.00	1.00	1.00			
Good/Better	**1.10 (1.01, 1.18)** [c]	1.14 (0.98, 1.33)	1.11 (0.96, 1.29)	—	—	—
Had a Personal Physician						
No	1.00	1.00	1.00	1.00		
Yes	**1.20 (1.12, 1.30)** [a]	**1.66 (1.39, 1.99)** [a]	**1.26 (1.08, 1.48)** [b]	1.23 (0.83, 1.81)	—	—
Routine Check-up						
> 5 years/Never	1.00	1.00	1.00	1.00	1.00	1.00
< 1 year	**2.95 (2.60, 3.34)** [a]	**3.60 (2.34, 5.54)** [a]	**3.40 (2.49, 4.65)** [a]	**3.21 (1.55, 6.65)** [b]	**2.61 (1.44, 4.73)** [b]	**4.51 (2.26, 8.99)** [a]
1 – < 5 years	**2.39 (2.11, 2.72)** [a]	**2.59 (1.66, 4.06)** [a]	**2.45 (1.78, 3.38)** [a]	1.99 (0.89, 4.44)	**2.27 (1.20, 4.30)** [c]	**3.69 (1.80, 7.58)** [a]
Had a Mammogram						
No	1.00	1.00	1.00			
Yes	**1.47 (1.37, 1.57)** [a]	**1.44 (1.24, 1.67)** [a]	**1.62 (1.39, 1.88)** [a]	—	—	—

Boldface indicates statistical significance

[a] P < 0.001

[b] p <0.01

[c] p < 0.05

[d] Empty cells: Variables not included in the multivariable model since p > 0.05 in the bivariate model

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; AI/AN, American Indian/Alaska Native

Models adjusted for survey year