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Persistent Disparities in Cervical Cancer Screening Uptake: Knowledge and Sociodemographic Determinants of Papanicolaou and Human Papillomavirus Testing Among Women in the United States

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Abstract

Objectives: Cervical cancer is the second-most common type of cancer among women aged 15-44, and racial, ethnic, and economic disparities exist in survival rates despite widely available screening tests and early treatment options. The objective of this study was to describe the association among knowledge, sociodemographic characteristics, and cervical cancer screening, with the goal of developing interventions to prevent cervical cancer in populations at risk of the disease.

Methods: In 2017, we conducted a nationwide survey of women in the United States aged ≥18 who had ever received a Papanicolaou (Pap) test (N = 630). We conducted *t* tests and one-way analysis of variance to determine sociodemographic differences (age, education, race, ethnicity, income, type of health insurance) in knowledge about cervical cancer screening (Pap test and human papillomavirus [HPV] test). We used logistic regressions to define significant determinants of cervical cancer screening behaviors in the previous 5 years.

Results: Of 629 respondents, 407 (64.7%) had an annual household income <$30 000, and 322 of 536 (60.1%) respondents had government-provided health insurance. Of 630 women who had ever had a Pap test, 425 (67.5%) had an HPV test. Hispanic and non-Hispanic white women were more likely than Hispanic and non-Hispanic black women (odds ratio [OR] = 2.49; 95% CI, 1.12-4.54; *P* = .02) and women with government-provided health insurance (OR = 1.91; 95% CI, 1.08-3.37; *P* = .03) were more likely than women with private health insurance to have received a Pap test in the previous 5 years. Knowledge of HPV was a significant predictor of having received an HPV test in the previous 5 years (OR = 1.37; 95% CI, 1.22-1.54; *P* < .001).

Conclusion: Disparities in cervical cancer screening among sociodemographic groups of women suggest the need for targeted interventions to improve knowledge about Pap and HPV tests.

Keywords

cervical cancer screening, Pap test knowledge, human papillomavirus (HPV), HPV knowledge, high-risk populations

Worldwide, cervical cancer is the second-most common type of cancer among women aged 15-44.[1] More than 11 000 diagnoses of cervical cancer occur annually in the United States despite the availability of a vaccine for oncogenic types of human papillomavirus (HPV) and 2 cervical cancer screening tests, the Papanicolaou (Pap) test for detecting precancerous lesions and a molecular HPV test for detecting high-risk HPV infections (ie, HPV infections that can cause cancer).[1] Advancements in HPV testing and clinical

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protocols during the past decade have resulted in several changes in gynecological practice. Currently, cervical cancer screening guidelines recommend a Pap test every 3 years for average-risk women aged 21-65. Women aged 30-65 are advised to receive a Pap test alone every 3 years, a high-risk HPV test alone every 5 years, or co-testing (a high-risk HPV test and a Pap test) every 5 years.[2-4] Despite the longstanding history of both tests, women in all sociodemographic groups have poor knowledge about them,[5-8] and the barriers to cervical cancer screening are numerous.[9] The *Healthy People 2020* target for cervical cancer screening among women aged 21-65 is 93%.[10] No group of women in the United States has achieved this goal.[11] The most recent national data, from 2015, showed that 84.4% of non-Hispanic black women, 82.7% of non-Hispanic white women,[12] 81.4% of women aged 21-44, and 80.6% of women aged 45-65 had received cervical cancer screening in the previous 3 years.[13]

The incidence of cervical cancer among Hispanic women (9.3 per 100 000 persons) and non-Hispanic black women (8.1 per 100 000 persons) is disproportionately high compared with the incidence of cervical cancer among non-Hispanic white women (7.2 per 100 000 persons).[14] This disparity has been attributed to lack of screening, and lack of screening has been attributed to unequal access to health care.[15] In addition, although data on cervical cancer screening disparities are limited, cervical cancer mortality is high among women who have a low income and low educational attainment, and women without health insurance are less likely than women with health insurance to undergo cervical cancer screening.[16] These social determinants of health are important factors to consider because they influence preventive behaviors.[17] One way to address persistent disparities is through communicative processes. Communicative processes can be used to build knowledge, a well-established predictor of behavior.

In this study, we explored the knowledge and sociodemographic determinants of cervical cancer screening behaviors among women in the United States to identify groups for targeted preventive interventions. Despite the success of cervical cancer screening in detecting precancerous lesions and high-risk HPV infections, not every woman has equal access to these preventive services. Research can help to overcome difficult-to-budge barriers (low income and low levels of education) and misunderstanding about changing guidelines so that all women have equal access to preventive services. Consistent with the Theory of Reasoned Action,[18,19] our research model examined knowledge of Pap testing and HPV as representative of behavioral beliefs. These beliefs about the outcomes and value of a behavior, along with beliefs about norms concerning the behavior, are posited by the Theory of Reasoned Action to predict intentions and health behaviors. Contemporary applications of the Theory of Reasoned Action usually focus on the relationship between intention and behavior.[20] Thus, we expected to find a racial disparity in knowledge about Pap tests and HPV and that women with greater knowledge about Pap tests and HPV would engage in cervical cancer screening behavior more regularly than women with less knowledge.

The primary objective of this study was to provide findings on cervical cancer screening knowledge and behavior that correspond with the incorporation of HPV screening in addition to Pap screening in national guidelines.[16,21] Our investigation was novel in its inclusion of Pap test *and* HPV knowledge measures as determinants of the 2 cervical cancer screening behaviors and its use of sampling strategies that ensured representation of women with sociodemographic characteristics (eg, race, ethnicity, income) associated with a high risk of cervical cancer and low rates of cervical cancer screening.[8,9,15,21]

Methods

Data

The data for this study came from a larger survey project in which data were collected in June 2017 through a Qualtrics online survey assessing cervical cancer screening knowledge, behaviors, experiences, and preferences for communication in a national sample of women in the United States who had a Pap test at least once in their lifetime. The study team worked directly with Survey Sampling International to determine the methods and goals for recruitment and data collection. Survey Sampling International sent email invitations to members of its US panel who met our study's target demographic group: women aged ≥18 and able to read English. The survey oversampled 3 groups to ensure representation of populations with high rates of cervical cancer: black women (20% of sample), Hispanic women (20% of sample), and women whose annual household income was ≤$30 000 (20% of sample). We excluded 27 women who identified as Asian (n = 3), American Indian/Alaska Native (n = 3), or "other" (n = 21) from the comparison and regression analyses because of their small numbers. Of 737 panelists who met the eligibility criteria and opened the survey, 60 opted out, 14 did not complete more than one-third of the survey, and 33 had never had a Pap test; 630 women who had ever had a Pap test completed the survey. The study was approved by the institutional review board of Indiana University–Purdue University Indianapolis.

Measures

To conduct the tests for association between cervical cancer screening knowledge and cervical cancer screening behavior, we defined cervical cancer screening behavior as having received a Pap or HPV test in the previous 5 years. To ensure women knew what they were being asked about, explanations of the purpose and procedure of each test accompanied

each behavior question. Women who did not remember if they had had either test in the previous 5 years were considered as not having engaged in cervical cancer screening behavior. We controlled for sociodemographic determinants and redefined the variables to achieve adequate cell frequencies, given the sample size (N = 630). We tested Hispanic ethnicity as a dichotomous variable. We transformed race into a dichotomous variable (Hispanic and non-Hispanic white and Hispanic and non-Hispanic black). Cross-tabulation between race and ethnicity showed that 8 of 130 black women and 82 of 472 white women identified as Hispanic, which would not allow for reliable comparison between groups defined by race and ethnicity together. We recoded the original 6 categories of education into 4 categories: ≤high school diploma, some college, 2-year college degree, and ≥4-year college degree. We recoded the original 12 categories of annual household income (in $10 000 intervals) into a dichotomous variable (<$30 000 and ≥$30 000) as an indicator of risk for cervical cancer occurrence.[15] We recoded the original 5 answers to the question on how often participants considered cost when making decisions about their health care into 3 categories: ≤half the time, most of the time, and always. For type of health insurance, we combined direct-purchase and employer-provided health insurance into 1 category (private health insurance), which yielded a dichotomous variable: government-provided health insurance and private health insurance. We tested age and knowledge scores as continuous variables.

We measured Pap test knowledge and HPV knowledge separately by using a 7-item sum scale adapted from similar scales.[21-24] For each topic, participants were asked to read statements about Pap tests (eg, "You only need a Pap test if you have symptoms," "It tests for pregnancy") and HPV (eg, "HPV is sexually transmitted," "HPV is relatively rare") and indicate whether they believed each statement was true or false or they did not know. To calculate the overall knowledge scores, we recoded the correct answer for each item as 1 and other responses as 0, and we summed the items on a scale ranging from 0 to 7. We then adjusted the scale to range from 1 to 8.

Statistical Analysis

First, we used descriptive statistics to understand the sociodemographic characteristics (ie, race, ethnicity, age, annual household income, education level, and type of health insurance) of the populations who had received a Pap test or an HPV test in the previous 5 years. Then, we conducted independent-samples *t* tests (comparing race, ethnicity, income level, and type of health insurance) and one-way analysis of variance (comparing levels of education and age groups) to compare knowledge scores for Pap test and HPV. We used the Tukey honest significant difference post hoc tests to determine conservative difference mean estimates between mean knowledge values across multiple groups based on education and age. Lastly, we conducted statistical analyses by using SPSS version 24.0 to estimate the odds of receiving cervical cancer screening in the previous 5 years based on sociodemographic characteristics and knowledge.[25] Significance was set at $P < .05$.

Results

Among 630 women who had ever had a Pap test, 483 (76.7%) women had had a Pap test in the previous 5 years and 425 (67.5%) had ever had an HPV test (Table 1). Of these 425 women, 197 (46.4%) had had an HPV test in the previous 5 years. The age range of survey participants who had ever had a Pap test (N = 630) was 25 to 66 (mean [SD] = 48.9 [10.5]); 407 of 629 (64.7%) women reported an annual household income <$30 000; 537 of 630 (85.2%) had health insurance. Of the 536 women who indicated type of health insurance, 322 (60.1%) had government-provided health insurance. By race (including both Hispanic and non-Hispanic), of 630 respondents, 472 (74.9%) were white and 131 (20.8%) were black; by ethnicity, of 628 respondents, 116 (18.5%) were Hispanic.

Sociodemographic Differences in Pap Test and HPV Knowledge

Pap test knowledge scores were significantly higher among Hispanic and non-Hispanic white women (mean score = 6.1) than among Hispanic and non-Hispanic black women (mean score = 5.7) ($t = 3.20$; $P = .002$) (Table 2). Although HPV knowledge scores were also higher among Hispanic and non-Hispanic white women (mean score = 5.7) than among Hispanic and non-Hispanic black women (mean score = 5.3), the difference was not significant. Both Pap test and HPV knowledge scores were higher among non-Hispanic women than among Hispanic women, but the differences were not significant. Women aged 55-64 had significantly higher Pap test knowledge scores (mean score = 6.2) than women aged 25-34 (mean score = 5.5) ($F = 4.44$; $P = .004$), yet the inverse was true for HPV knowledge scores. Women aged 25-34 had significantly higher HPV knowledge scores (mean score = 5.9) than women aged 55-64 (mean score = 5.2) ($F = 5.07$; $P = .002$). Pap test and HPV knowledge scores were significantly higher among women with an annual household income ≥$30 000 (mean score = 6.3) than among women with an annual household income <$30 000 (mean score = 5.8) ($t = -3.77$; $P < .001$). HPV knowledge was significantly higher among women who had an HPV test in the previous 5 years (mean score = 6.4) than among women who did not (mean score = 5.2) ($t = 6.34$; $P < .001$). Women who received a Pap test in the previous 5 years had higher Pap test knowledge scores than women who did not, but the difference was not significant.

Tukey honest significant difference post hoc tests showed that women who had ≥4-year college degree had significantly higher HPV knowledge scores (mean score = 6.2) than women who had some college (mean score = 5.5; $P = .001$) or ≤high

Table 1. Sociodemographic characteristics of a sample of women aged 18-66 who reported having a Pap test or an HPV test at least once (N = 630), United States, June 2017[a]

Characteristic	Ever Had a Pap Test (n = 630)		Ever Had an HPV Test (n = 425)	
	No. of Respondents to Survey Question[b]	Value[c]	No. of Respondents to Survey Question[b]	Value[c]
Knowledge score, mean (SD)[d]	613	6.0 (1.4)	420	5.7 (2.2)
Age, mean (SD), y	617	48.9 (10.5)	414	47 (10.4)
Annual household income, $				
<30 000	629	407 (64.7)	425	283 (66.6)
≥30 000		222 (35.3)		142 (33.4)
Race, including Hispanic and non-Hispanic				
White	630	472 (74.9)	425	308 (72.5)
Black		131 (20.8)		99 (23.3)
Other[e]		27 (4.3)		18 (4.2)
Ethnicity				
Hispanic	628	116 (18.5)	423	89 (21.0)
Non-Hispanic		512 (81.5)		334 (79.0)
Education				
≤High school diploma	629	206 (32.8)	424	128 (30.2)
Some college		168 (26.7)		119 (28.1)
2-year college degree		113 (18.0)		82 (19.3)
≥4-year college degree		142 (22.6)		95 (22.4)
Has health insurance				
Yes	630	537 (85.2)	425	371 (87.3)
No		93 (14.8)		54 (12.7)
Type of health insurance[f]				
Government-provided	536	322 (60.1)	370	226 (61.1)
Private		214 (39.9)		144 (38.9)
How often cost is considered when making health care decisions				
≤Half of the time	626	312 (49.8)	423	221 (52.2)
Most of the time		119 (19.0)		88 (20.8)
Always		195 (31.2)		114 (27.0)

Abbreviations: HPV, human papillomavirus; Pap, Papanicolaou; SD, standard deviation.
[a]Data source: A Qualtrics online survey assessing cervical cancer screening knowledge, behaviors, experiences, and preferences for communication in a national sample, conducted by the study team.
[b]Participants were not required to answer every item, and some women skipped questions.
[c]All values are number (percentage) unless otherwise indicated; percentages are based on the number of women who answered the question.
[d]Pap test knowledge and HPV knowledge were measured separately by using a 7-item sum scale adapted from similar scales.[21-23] For each topic, participants were asked to read statements about Pap tests and indicate whether they believed each statement was true or false or they did not know. The scale ranged from 1 to 8, with higher scores indicating greater knowledge.
[e]Three women identified as American Indian/Alaska Native, 3 as Asian, and 21 as "other" race. These women (n = 27) were excluded from subsequent analysis of knowledge by race and all regression analyses because of small numbers.
[f]One respondent who had health insurance did not indicate type.

school diploma (mean score = 5.3) ($F = 4.7$; $P = .003$), but we found no significant difference in Pap test knowledge based on education. We found no significant difference in knowledge of HPV or the Pap test based on type of health insurance.

Determinants of Pap Test Behavior

We found no significant association between Pap test knowledge and behavior overall (Table 3). By sociodemographic characteristics, we found significantly higher odds of receiving a Pap test in the previous 5 years among younger women (OR = 0.97; 95% CI, 0.94-0.99; $P = .01$) compared with older women, among white women (OR = 2.49; 95% CI, 1.12-4.54; $P = .02$) compared with black women, and among women with government-provided health insurance (OR = 1.91; 95% CI, 1.08-3.37; $P = .03$) compared with women with private health insurance. Women with ≤high school

Table 2. Differences in knowledge of Pap test and HPV test in a sample of women aged 18-66 who reported having a Pap test at least once (N = 630), United States, June 2017[a]

Characteristic	Pap Test Knowledge[b]		HPV Knowledge[b]	
	Mean Score (95% CI or SD)[c]	*t* or *F* (*P* Value)	Mean Score[c] (95% CI or SD)	*t* or *F* (*P* Value)
Age, y				
25-34	5.5 (5.2-5.8)[d]	*F* = 4.44 (.004)	5.9 (5.4-6.3)	*F* = 5.07 (.002)
35-44	6.0 (5.7-6.2)		6.1 (5.7-6.4)[d]	
45-54	6.0 (5.8-6.2)		5.7 (5.3-6.1)	
55-66	6.2 (6.0-6.4)[d]		5.2 (4.9-5.5)[d]	
Education				
≤High school diploma	6.0 (5.8-6.2)[d]	*F* = 1.30 (.28)	5.3 (4.9-5.6)	*F* = 4.70 (.003)
Some college	5.9 (5.6-6.1)[d]		5.5 (5.1-5.8)	
2-year college degree	6.1 (5.8-6.3)		5.6 (5.2-6.0)	
≥4-year college degree	6.2 (5.9-6.4)[d]		6.2 (5.8-6.5)	
Annual household income, $				
<30 000	5.8 (1.5)	*t* = –3.77 (<.001)	5.5 (2.2)	*t* = –2.02 (.04)
≥30 000	6.3 (1.3)		5.9 (2.2)	
Ethnicity				
Hispanic	5.8 (1.4)	*t* = –1.83 (.61)	5.4 (2.2)	*t* = –1.11 (.26)
Non-Hispanic	6.1 (1.4)		5.7 (2.3)	
Race[e]				
White	6.1 (1.4)	*t* = 3.20 (.002)	5.7 (2.2)	*t* = 1.92 (.06)
Black	5.7 (1.4)		5.3 (2.2)	
Type of health insurance				
Government-provided	6.1 (1.4)	*t* = 1.88 (.06)	5.6 (2.2)	*t* = 0.65 (.52)
Private	5.7 (1.5)		5.5 (2.5)	
Received a Pap test in previous 5 years				
Yes	6.1 (1.4)	*t* = 1.31 (.19)	—	
No	5.9 (1.6)			
Received an HPV test in previous 5 years				
Yes	—		6.4 (1.7)	*t* = 6.34 (<.001)
No			5.2 (2.4)	

Abbreviations: HPV, human papillomavirus; Pap, Papanicolaou; SD, standard deviation.
[a]Data source: A Qualtrics online survey assessing cervical cancer screening knowledge, behaviors, experiences, and preferences for communication in a national sample, conducted by the study team.
[b]Pap test knowledge and HPV knowledge were measured separately by using a 7-item sum scale adapted from similar scales.[21-23] For each topic, participants were asked to read statements about Pap tests and indicate whether they believed each statement was true or false or they did not know. The scale ranged from 1 to 8, with higher scores indicating greater knowledge.
[c]One-way analysis of variance was used to test the differences in knowledge based on age groups and level of education. Independent-samples *t* tests were used to test the difference in knowledge scores based on race, ethnicity, income, type of health insurance, and cervical cancer screening behavior. Significance was set at the $P < .05$ level.
[d]Knowledge scores were significantly different among these groups, according to Tukey honest significant difference post hoc tests.
[e]White and black race includes both Hispanic and non-Hispanic ethnicities. Three women identified as American Indian/Alaska Native, 3 as Asian, and 21 as "other" race. These women (n = 27) were excluded from the comparison analyses based on race because of small numbers.

diploma were significantly less likely than women with ≥4-year college degree to have had a Pap test in the previous 5 years (OR = 0.30; 95% CI, 0.14-0.66; $P = .002$).

Determinants of HPV Test Behavior

Knowledge about HPV was a significant predictor of receiving an HPV test in the previous 5 years (OR = 1.37; 95% CI, 1.22-1.54; $P < .001$). We found higher odds for receiving an HPV test in the previous 5 years among younger women (OR = 0.98; 95% CI, 0.96-1.00; $P = .047$) compared with older women and among women with an annual household income ≥$30 000 (OR = 0.53; 95% CI, 0.31-0.92; $P = .02$) compared with women with an annual household income <$30 000. Race, type of health insurance, and education were not significantly associated with HPV test behavior.

Table 3. Determinants of cervical cancer screening behavior in previous 5 years in a sample of women aged 18-66 who reported having a Pap test at least once (N = 630), United States, June 2017[a]

Predictor	Pap Test in Previous 5 Years[b,c] (n = 482)	HPV Test in Previous 5 Years[b,d] (n = 333)
Knowledge score	1.07 (0.90-1.27) [.45]	1.37 (1.22-1.54) [<.001]
Age	0.97 (0.94-0.99) [.01]	0.98 (0.96-1.00) [.047]
Annual household income, $		
<30 000	0.82 (0.47-1.42) [.47]	0.53 (0.31-0.92) [.02]
≥30 000	1.00 [Reference]	1.00 [Reference]
Ethnicity		
Non-Hispanic	0.80 (0.41-1.54) [.49]	0.97 (0.52-1.81) [.91]
Hispanic	1.00 [Reference]	1.00 [Reference]
Race (non-Hispanic and Hispanic)[e]		
White	2.49 (1.12-4.54) [.02]	1.56 (0.89-2.72) [.12]
Black	1.00 [Reference]	1.00 [Reference]
Education		
≤High school diploma	0.30 (0.14-0.66) [.002]	1.11 (0.57-2.17) [.75]
Some college	0.53 (0.23-1.22) [.13]	1.03 (0.53-2.04) [.92]
2-year college degree	0.46 (0.20-1.09) [.07]	0.94 (0.46-1.93) [.86]
≥4-year college degree	1.00 [Reference]	1.00 [Reference]
Health insurance		
Government-provided	1.91 (1.08-3.37) [.03]	1.38 (0.80-2.35) [.24]
Private	1.00 [Reference]	1.00 [Reference]
How often cost is considered when making health care decisions		
≤Half of the time	0.98 (0.55-1.72) [.93]	0.74 (0.41-1.33) [.31]
Most of the time	1.30 (0.60-2.82) [.50]	0.87 (0.43-1.78) [.70]
Always	1.00 [Reference]	1.00 [Reference]
Constant	24.00	0.51

Abbreviations: HPV, human papillomavirus; Pap, Papanicolaou.
[a]Data source: A Qualtrics online survey assessing cervical cancer screening knowledge, behaviors, experiences, and preferences for communication in a national sample, conducted by the study team.
[b]All values are odds ratio (95% CI) [*P* value]. $P < .05$ was considered significant.
[c]Pap test behavior model: $\chi^2_{11} = 33.2$; $P < .001$.
[d]HPV test behavior model: $\chi^2_{11} = 45.8$; $P < .001$.
[e]Three women identified as American Indian/Alaska Native, 3 as Asian, and 21 as "other" race. These women (n = 27) were excluded from these analyses because of small numbers.

Discussion

Our study explored the knowledge and socioeconomic determinants of women's Pap and HPV testing behaviors in the 5 years before June 2017. Despite the success of cervical cancer prevention through screening and vaccination, in 2019, more than 13 000 new cervical cancer cases and 4000 deaths were estimated in the United States, which exceed annual averages.[1] After several iterations, guidelines were finalized for co-testing in 2018, which create new communicative and education challenges for women who receive a positive test result for HPV and need follow-up care. Our findings indicate that (1) racial and socioeconomic disparities in Pap test and HPV knowledge exist, (2) knowledge is a significant variable in cervical cancer screening behavior, and (3) several demographic factors, including race, are strong determinants of cervical cancer screening behavior.

For Pap tests, knowledge and behavior were not related. However, HPV knowledge was a significant predictor of behavior; thus, women who knew more about HPV were more likely than women who knew less to have had an HPV test in the previous 5 years. Interestingly, though, the average HPV knowledge score among women who had ever had an HPV test was lower (average score, 5.7) than the average Pap test knowledge score among women who had ever had a Pap test (average score, 6.0). We also saw that HPV knowledge scores were lower among women who had not had an HPV test in the previous 5 years (average score, 5.2) than among women who had had an HPV test in the previous 5

years (average score, 6.4). This finding may indicate that new American College of Obstetricians and Gynecologists guidelines for education and revised protocols[2] are effective at improving knowledge and cervical cancer screening engagement, but the relative newness of the guidelines warrants more time to determine efficacy. Future research should continue to investigate the role of knowledge in predicting cervical cancer screening behavior, particularly as clinical recommendations and scientific developments change.

The lack of a significant association between Pap test knowledge and behavior may be best explained in terms of longevity of access to Pap tests. Pap tests have been routinely used in clinical practice for more than 60 years. Normative beliefs about Pap tests may be a stronger predictor of Pap test behavior than knowledge alone. Alternatively, HPV tests are a much newer approach to cervical cancer screening,[5] suggesting that increased knowledge about a previously little-known test is an important predictor of behavior. More research is needed on the role of knowledge in relation to subjective norms in predicting cervical cancer screening behaviors, especially because most Pap tests and HPV tests are now recommended to be given at the same time. Future work should continue to explore whether traditional health behavior models such as the Theory of Reasoned Action and the Theory of Planned Behavior, which privilege the role of knowledge and normative beliefs in predicting a single health behavior, are appropriate for understanding and predicting how various types of knowledge may predict related (and, often, simultaneous) health behaviors.

Cervical cancer screening behavior is less common among women without health insurance than among women with health insurance. Cervical cancer screening behavior also declines as age (and risk for cervical cancer occurrence) increases.[11] In our study, younger women were more likely than older women to have received a Pap test in the previous 5 years, but Pap test knowledge increased with age. This finding may highlight the emphasis on annual screening appointments among older women; although annual screening appointments are no longer recommended, less frequent Pap tests inherently yield less exposure to Pap test information. Younger women were also more likely to have gotten an HPV test than older women, which is consistent with the relationship between age and HPV knowledge, perhaps reflecting the effectiveness of several mass-media campaigns for the HPV vaccine.

Sociodemographically, women with an annual household income ≥$30 000 had 2 times higher odds than women with an annual household income <$30 000 of cervical cancer screening behavior and higher knowledge scores; women with ≥4-year college degree had 3.3 times higher odds than women with ≤high school diploma of cervical cancer screening behavior and higher knowledge scores, and women with government-provided health insurance had 1.4 times higher odds than women with private health insurance of cervical cancer screening behavior and higher knowledge scores. Previous research noted affordability and accessibility as the fundamental tenets of health care reform in the past decade, and an annual household income <$30 000 continues to be a barrier to cervical cancer screening.[26] We can assume an increase in government-provided health insurance coverage rates since the passage of the Affordable Care Act in 2010, which may have contributed to this counterintuitive finding on cervical cancer screening behavior. In addition, a 2018 report on cervical cancer screening trends among 42 million women in the United States with private health insurance during 2003-2014 showed a decline in cervical cancer screening rates; the report also demonstrated the prevalence of cervical cancer screening behavior based on medical insurance claims was lower than the prevalence based on self-reported data.[27] Future research should continue to examine the role of heath care coverage and socioeconomic status as determinants of cervical cancer screening behavior.

Race is a significant determinant in health disparities, and our findings demonstrate a large disparity between white and black women. White women in our sample had almost 2.5 times higher odds than black women of having had a Pap test in the previous 5 years. They also had higher Pap test and HPV knowledge scores. Future work must address this continuing disparity by designing interventions that ensure timely Pap and HPV education and testing behaviors among women with low levels of education, as well as low-income and black women. Previous research provided a mixed-methods approach to understanding normative beliefs in the black population, and continued efforts could shed light on persistent cultural barriers to cervical cancer screening.[28]

Limitations

Our study had several limitations. First, our cross-sectional, quantitative study design lacked nuance and depth in understanding the relationship between knowledge and behavior for cervical cancer screening. For example, instead of viewing knowledge as a determinant of screening behavior, the act of engaging in cervical cancer screening behavior and receiving Pap and HPV test results may have influenced women's knowledge about the tests themselves as well as HPV. Second, although the study design intended to represent women with characteristics that reflect populations at high risk for cervical cancer, the online format of the survey limited participation to women who had access to the necessary technology, which inherently eliminated a portion of the at-risk population from our study sample. In addition, because participants were on Survey Sampling International's national panel, the sample was not truly random. A larger, randomly selected sample is needed in the future to estimate the odds of cervical cancer screening behaviors more accurately. Third, self-report of cervical cancer screening behaviors may be unreliable and has been shown to be inflated compared with behaviors documented in health insurance claims records.[27] Future research

could include clinical or health insurance claims records to supplement self-reported data for more reliable results. Before the new cervical cancer screening guidelines, HPV tests were used only as follow-up tests to abnormal findings from a Pap test, so patients often lacked control over whether they received an HPV test, and the current HPV testing data may not represent a person's actual cervical cancer screening behavior decision. Lastly, because of a low response rate from Hispanic women, which inhibited a statistically robust comparison, we did not test ethnicity as a determinant of cervical cancer screening behavior. Future research should continue addressing the nuance of disparities in cervical cancer screening behavior.

Conclusions

This study provides critical data on cervical cancer screening rates among populations at risk of cervical cancer and offers an in-depth look at how various knowledge and sociodemographic variables may predict these screening behaviors. Interventions addressing cervical cancer screening disparities may benefit from this detailed look at sociodemographic determinants of screening uptake, particularly with the addition of HPV testing to guidelines. Racial and ethnic minority populations may differ in the way they use cancer screening services, and public health programs should aim to improve cervical cancer screening rates in these populations. To develop an appropriate intervention targeting women in populations at risk of cervical cancer, further research is needed to understand the cultural implications on preventive health care use.

Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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