RESEARCH PAPER

Identification of potential missed opportunities for human papillomavirus (HPV) vaccination in women referred to an academic colposcopy clinic for evaluation of abnormal cervical cytology

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ABSTRACT

Objective: To identify possible predictors of missed opportunities for human papillomavirus (HPV) counseling and vaccination prior to presentation at an academic colposcopy clinic. **Materials and Methods:** We examined the characteristics of 638 vaccinated and 1,024 unvaccinated age-eligible patients using data from a patient registry of women presenting for colposcopic evaluation between 2/26/2007 and 3/10/2014 who were aged 26 or less at presentation. Demographics, smoking history, pregnancy history, sexually transmitted infections (STIs), sexual history, contraception use, immunosuppression, and medical problems were compared between HPV vaccinated and unvaccinated women. Multivariable logistic regression models included age, race, language, marital status, insurance type, lifetime number of sexual partners, other medical illnesses, number of pregnancies, contraception use, history of STIs, and smoking history to determine predictors of HPV vaccination. **Results:** In multivariable analysis, race, marital status, and language were not significantly associated with HPV vaccination. Women with fewer pregnancies were more likely to be vaccinated (p -trend < 0.0001). Vaccinated women were more likely to have other medical illnesses (OR=1.44, 95% CI=1.13–1.83) and be aware of their HPV status (OR=1.75, 95% CI= 1.40–2.18). **Conclusions:** In this study, greater number of pregnancies was associated with lower vaccination rates as compared to women who had never been pregnant. Reproductive health visits, such as postpartum and family planning visits, represent an ideal opportunity to educate women about HPV and the importance of vaccination, and should be an area of focus to improve current HPV vaccination rates.

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Introduction

In 2015, an estimated 12,900 new cases of cervical cancer will be diagnosed and 4,100 deaths will occur in the United States per the American Cancer Society.¹ Sexually transmitted infections with human papillomavirus (HPV) 16 and 18 are associated with approximately 70% of cervical cancer cases.² There are currently 3 FDA approved vaccines targeted against infection with HPV viruses: Gardasil (FDA approved 2006) which protects against HPV 16 and 18 which cause approximately 70% of cases of cervical cancer, in addition to HPV 6 and 11 which cause genital warts, Cevaxix (FDA approved 2009) which protects against HPV 16/18 and Gardasil 9 (FDA approved 2014) which covers 5 additional high risk HPV types in addition to those covered by the quadrivalent Gardasil vaccine. If administered prior to exposure, HPV vaccines prevent infection with oncogenic HPV leading to reduced development of precancerous cervical lesions.^{3–5} The American Cancer Society recommends HPV vaccination for all girls between the ages of 9 and 18 and discussing it with women aged 19–26.⁶ The American Congress of Obstetricians and Gynecologists (ACOG) and the United States Advisory Committee on Immunization Practices (ACIP) recommend the 3 dose series between ages 9–26.^{7,8} Despite this, US vaccination rates are suboptimal when compared to other industrialized

nations.^{9,10} The Centers for Disease Control and Prevention noted that in 2013 only 37.6% girls aged 13–17 received the complete 3 dose HPV vaccine series and in 2013, 36.9% of women aged 19–26 y reported receipt of greater than or equal to 1 dose of HPV vaccine.^{11,12}

The President's Cancer Panel published a call for action in 2014 to increase HPV vaccination rates and emphasized reducing missed clinical opportunities by improving physician counseling strategies.¹³ Missed opportunities may be due to provider reluctance to offer vaccines, lack of provider knowledge about the HPV virus and vaccine, personal attitudes or beliefs, lack of incentives to counsel and offer the vaccines, and lack of systems to remind providers when to offer the vaccines.^{13,14}

Known positive predictors of HPV vaccine administration includes; increasing age from 13 to 17 y old, private insurance, prior vaccination, parental and patient knowledge, and physician counseling and recommendation.^{10,15,16} One significant negative predictor is older age between 18–26 where completion of the 3 dose HPV vaccine declines significantly from 21.6% at ages 18–20 to 9.5% at ages 21–26.¹⁷ The objective of this study is to identify characteristics of patients referred to an academic colposcopy clinic who may have had missed

opportunities for HPV counseling and vaccination prior to presenting with abnormal cytology or HPV screening tests.

Results

A total of 1,662 women accounting for 3,512 visits were included in the analysis based on the criteria listed above (see Table 1). 1,024 (61.6%) women reported being unvaccinated and 638 (38.4%) reported receiving at least one dose of the HPV vaccine. The majority of women who reported receiving the HPV vaccine received all 3 doses (64.7%) (Table 1). The average age of the study cohort was 22.6 y old, and this did not differ between the 2 groups.

The multivariable logistic regression analysis is presented in Table 2. Race, marital status, and language were all strongly associated with vaccination in the crude analysis, but were no longer significant in the multivariable model. An analysis model was created to determine which variable (or variables) caused the change in the association between these demographic factors and HPV vaccination and the results showed that number of pregnancies was the main factor. When race, marital status, language, and vaccination status were adjusted for the number of pregnancies, they were not independently associated with the likelihood of vaccination. Results were similar when number of live births and abortions were modeled instead of total number of pregnancies; therefore these groups were not separated. In an analysis of number of pregnancies (Table 3), we found that Caucasian and Asian women had a significantly lower median number of pregnancies than African American, Hispanic and women of other races ($p < 0.0001$).

Women with 3 or more pregnancies were 61% less likely to report HPV vaccination than women who had never been pregnant (OR = 0.39, 95% CI 0.24–0.63). In adjusted models, women with other medical illnesses were significantly more likely to report receiving the HPV vaccine (OR 1.41, 95% CI 1.11–1.80). Women who reported only barrier or no birth control use were 39% (OR = 0.61, 95% CI = 0.46–0.80) and 47% (OR = 0.53, 95% CI = 0.34–0.83) less likely to report vaccination than women who used hormonal contraception, respectively. Current smokers were 40% less likely (OR = 0.60, 95% CI = 0.41, 0.87) to report prior vaccination. Compared to women with private insurance, women with no insurance were 54% (OR = 0.46, 95% CI = 0.23–0.91) less likely to be vaccinated. The likelihood of vaccination among women with government or other insurance did not significantly differ from those with private insurance. Women with HIV were 77% less likely to receive the HPV vaccine than HIV negative women, although this result did not reach statistical significance (OR = 0.23, 95% CI = 0.05–1.06), likely because of the small sample size of HIV infected women ($n = 16$).

Women in this study were also asked about whether they had ever been infected with HPV during each visit and 362 (35.4%) of unvaccinated and 334 (52.4%) of vaccinated women answered yes to having been infected with HPV ($p < 0.0001$). Given that all patients in the registry had been referred with abnormal cytology, this question was intended to find out if the patient was aware of the association between abnormal cytology and HPV. The question was not intended to discern if actual HPV testing had been performed, as this was addressed

separately by requesting all HPV test results. In multivariable analysis, women who answered “yes” to HPV infection were more likely to have received the HPV vaccine (OR = 1.75, 95% CI = 1.40–2.18).

Discussion

In this study we determined that reproductive history, specifically number of pregnancies, might play a greater role at predicting lower HPV vaccination rates than other factors previously described in the literature such as race, language, and education. We found that the strong association between race and likelihood of prior vaccination became null when adjusted for number of pregnancies. In addition, we determined that vaccinated women were more likely to have other medical illnesses and use hormonal contraception.

It is known that physician counseling and recommendation to receive the HPV vaccine improve vaccination rates.^{10,15} Opportunities to counsel women about the HPV vaccine can occur at healthcare visits including primary care visits, reproductive health visits for contraception or visits surrounding pregnancy, annual exams with gynecologists, and family planning visits. Ironically, women in our study who likely had more reproductive visits, including women with a higher number of pregnancies (abortions and live births) were less likely to report HPV vaccination.

Visits surrounding pregnancies and reproductive health (whether intrapartum, postpartum, family planning visits for termination, follow up visits after a miscarriage) should be used to counsel women about HPV and the importance of the vaccine. Although contraindicated in pregnancy, vaccine administration postpartum in breastfeeding women is acceptable according to ACOG committee opinion 641, which states that the HPV vaccine series is safe for both the newborn and mother.¹⁸ OB/GYN clinics should be encouraged to develop implementation systems for administering the HPV vaccine to postpartum women.

Provider counseling regarding HPV as the cause of abnormal cervical cytology prior to patients arrival to the Center for Lower Genital Tract Disease clinic was suboptimal. Only (35.4%) of unvaccinated and 334 (52.4%) of vaccinated women answered yes to having been infected with HPV, suggesting many women did not understand their underlying disease process. In multivariable analysis, women who answered “yes” to HPV infection were 75% more likely to have received the HPV vaccine (OR = 1.75, 95% CI = 1.40–2.18), suggesting the importance of education and counseling. We hypothesize that vaccinated women are better informed and therefore have a better understanding of their HPV status than unvaccinated women due to vaccine education and less so due to their actual HPV status, since we know that essentially all women presenting to our clinic for evaluation were infected with HPV. To improve patient understanding in our clinic, women receive extensive counseling from a senior nurse and gynecology resident as well as written handouts regarding HPV as the causative agent of abnormal cervical cytology and cervical cancer, colposcopy, potential need for further excisional procedures, and HPV vaccines. A clinic nurse then offers age eligible women the vaccine.

Table 1. Comparison of patient characteristics by HPV vaccination status.

	Unvaccinated N = 1, 024*	Vaccinated N = 638 *	p-value†
Age, mean (Standard Deviation)	22.7 (2.3)	22.6 (2.2)	0.27
Race/ethnicity, N (%)			
Caucasian	423 (42.9%)	359 (58.6%)	<0.0001
Hispanic	278 (28.2%)	116 (18.9%)	
African American	223 (22.6%)	96 (15.7%)	
Asian	23 (2.3%)	17 (2.8%)	
Other	39 (4.0%)	25 (4.1%)	
Marital status, N (%)			
Single	906 (89.5%)	598 (93.9%)	0.02
Married	68 (6.7%)	24 (3.8%)	
Divorced/separated	12 (1.2%)	4 (0.6%)	
Other	26 (2.6%)	11 (1.7%)	
Language, N (%)			
English	845 (84.8%)	570 (91.5%)	0.0004
Spanish	111 (11.1%)	38 (6.1%)	
Other	40 (4.0%)	15 (2.4%)	
Insurance, N (%)			
Private	482 (48.0%)	426 (67.7%)	<0.0001
Government	466 (46.4%)	179 (28.5%)	
None	43 (4.3%)	13 (2.1%)	
Other	14 (1.4%)	11 (1.8%)	
Lifetime number of sexual partners, N (%)			
1–3	344 (35.8%)	213 (34.4%)	0.03
3–5	327 (34.1%)	179 (28.9%)	
7–10	203 (21.2%)	155 (25.0%)	
10+	86 (9.0%)	73 (11.8%)	
Other medical illness, N (%)			
No	772 (75.9%)	440 (69.3%)	0.003
Yes	245 (24.1%)	195 (30.7%)	
Pregnancies, N (%)			
0	473 (46.6%)	438 (69.5%)	<0.0001
1	238 (23.5%)	105 (16.7%)	
2	126 (12.4%)	49 (7.8%)	
>2	177 (17.5%)	38 (6.0%)	
Currently pregnant, N (%)			
No	858 (84.7%)	605 (95.6%)	<0.0001
Yes	155 (15.3%)	28 (4.4%)	
Parity, N (%)			
0	652 (64.9%)	509 (82.5%)	<0.0001
1	214 (21.3%)	72 (11.7%)	
>1	139 (13.8%)	36 (5.8%)	
Abortions/miscarriages, N (%)			
0	552 (64.3%)	444 (79.7%)	<0.0001
1	198 (23.1%)	83 (14.9%)	
>1	108 (12.6%)	30 (5.4%)	
Birth control, N (%)			
Hormonal contraception	462 (51.0%)	414 (66.8%)	<0.0001
Barrier	239 (26.4%)	120 (19.4%)	
Long acting reversible contraception	96 (10.6%)	48 (7.7%)	
Tubal ligation	7 (0.8%)	2 (0.3%)	
None	97 (10.7%)	34 (5.5%)	
Other	5 (0.6%)	2 (0.3%)	
Sexually transmitted infections, N (%)			
Herpes	48 (4.7%)	33 (5.2%)	0.65
Gardnerella	4 (0.4%)	3 (0.5%)	0.99
Warts	51 (5.0%)	27 (4.2%)	0.48
Syphilis	1 (0.1%)	2 (0.3%)	0.56
Trichomonas	35 (3.4%)	18 (2.8%)	0.50
Chlamydia	210 (20.5%)	96 (15.0%)	0.005
Gonorrhea	38 (3.7%)	20 (3.1%)	0.53
HPV	362 (35.4%)	334 (52.4%)	<0.0001
HIV	14 (1.4%)	2 (0.3%)	0.03
Smoking history, N (%)			
Never	623 (61.0%)	431 (67.9%)	0.0008
Former	245 (24.0%)	147 (23.2%)	
Current	153 (15.0%)	57 (9.0%)	
Vaccine doses, N (%)			
1	–	126 (19.8%)	–
2	–	99 (15.5%)	–
3	–	413 (64.7%)	–

* Some patients have missing values, therefore not each characteristic totals 1,662. Total missing for each variable: pregnancies, N = 18; parity, N = 40; abortions/miscarriages, N = 247; race, N = 63; marital status, N = 13; language, N = 43; insurance type, N = 28; lifetime number of sexual partners, N = 82; other medical illnesses, N = 10; currently pregnant, N = 16; birth control, N = 136; smoking, N = 6.

† p-values from tests comparing vaccinated and unvaccinated patients were calculated from chi-square tests for categorical variables and t-test for age.

Table 2. Crude and adjusted odds ratios (95% confidence intervals) for HPV vaccination by patient characteristics.

	CrudeOR (95% CI)	Adjusted*OR (95% CI)	Adjusted* p-value
Age (years)			
Continuous	0.98 (0.94, 1.02)	0.94 (0.89, 0.98)	0.001
Race/ethnicity			
White	1.00	1.00	
Hispanic	0.49 (0.38, 0.64)	1.15 (0.79, 1.67)	0.47
African American	0.51 (0.38, 0.67)	0.98 (0.69, 1.40)	0.92
Asian	0.87 (0.46, 1.66)	1.10 (0.56, 2.18)	0.78
Other	0.76 (0.45, 1.27)	1.45 (0.79, 2.65)	0.23
Marital status			
Single	1.00	1.00	
Married	0.54 (0.33, 0.86)	0.96 (0.57, 1.62)	0.87
Divorced/separated	0.50 (0.16, 1.57)	0.70 (0.21, 2.39)	0.57
Other	0.64 (0.31, 1.31)	0.89 (0.41, 1.92)	0.76
Language			
English	1.00	1.00	
Spanish	0.51 (0.35, 0.64)	0.94 (0.57, 1.54)	0.79
Other	0.56 (0.30, 1.02)	0.80 (0.41, 1.56)	0.51
Insurance			
Private	1.00	1.00	
Government	0.44 (0.35, 0.54)	0.80 (0.59, 1.08)	0.14
None	0.34 (0.18, 0.64)	0.46 (0.23, 0.91)	0.03
Other	0.89 (0.40, 1.98)	0.88 (0.36, 2.11)	0.77
Lifetime number of sexual partners			
1–3	1.00	1.00	
3–5	0.88 (0.69, 1.14)	0.81 (0.62, 1.07)	0.14
7–10	1.23 (0.94, 1.62)	1.05 (0.77, 1.43)	0.75
10+	1.37 (0.96, 1.96)	1.25 (0.83, 1.88)	0.29
Other medical illness			
No	1.00	1.00	
Yes	1.40 (1.12, 1.75)	1.41 (1.11, 1.80)	0.006
Number of pregnancies			
0	1.00	1.00	
1	0.48 (0.37, 0.62)	0.64 (0.46, 0.88)	0.007
2	0.42 (0.30, 0.60)	0.66 (0.43, 1.03)	0.06
3+	0.23 (0.16, 0.34)	0.39 (0.24, 0.63)	0.0001
p-trend			<0.0001
Birth control			
Hormonal contraception	1.00	1.00	
Barrier	0.56 (0.43, 0.72)	0.61 (0.46, 0.80)	0.0004
Long acting reversible contraception	0.56 (0.38, 0.81)	0.81 (0.54, 1.21)	0.30
Tubal ligation	0.32 (0.07, 1.54)	0.78 (0.15, 34.2)	0.78
Other	0.45 (0.09, 2.31)	0.43 (0.08, 2.28)	0.32
None	0.39 (0.26, 0.59)	0.53 (0.34, 0.83)	0.006
History of STIs			
Chlamydia	0.69 (0.53, 0.90)	1.00 (0.73, 1.36)	0.99
HPV	2.01 (1.64, 2.46)	1.75 (1.40, 2.18)	<0.0001
HIV	0.23 (0.05, 1.00)	0.23 (0.05, 1.06)	0.06
Smoking history			
Never	1.00	1.00	
Former	0.87 (0.68, 1.10)	0.82 (0.63, 1.07)	0.14
Current	0.54 (0.39, 0.75)	0.60 (0.41, 0.87)	0.007

Note: Odds ratios > 1 indicate greater likelihood of vaccination.

*Adjusted for all variables in table.

Although not significant, women with HIV in this study were less likely to receive the HPV vaccine. This finding is supported by data in the literature surrounding hepatitis B vaccine uptake, which shows lower clinical uptake rates of 17% to 49% in HIV infected women.¹⁹ Encouragingly, in multivariable analysis, women with other medical illnesses such as asthma, anemia, etc were more likely to get the HPV vaccine. This finding may suggest that primary care providers are administering the HPV vaccination at other healthcare visits aside from reproductive health visits, and could be another area to target to increase the HPV vaccination rate. Additionally, a positive parental attitude for the vaccine is a predictor of HPV vaccine initiation.²⁰ It is possible that women who accept the HPV

vaccine during reproductive health visits, might be more likely to vaccinate their own children in the future, which could improve HPV vaccination rates in the US.

An argument could be made that women who have already engaged in sexual intercourse with abnormal cervical cytology might not benefit from receiving the HPV vaccine. However, in our cohort, the majority of women presented with low-grade squamous intraepithelial lesions or less. Prior data suggest that low grade lesions are typically not caused by HPV 16 and 18 but rather other subtypes, suggesting that many women in our cohort and other clinical settings may still have some protective benefit from the HPV vaccination and should still be offered the vaccine after appropriate counseling.²¹

Table 3. Median (interquartile range) pregnancies, live births, and abortions by race.

Race	N	Median (interquartile range)	Kruskal Wallis p-value
Caucasian	776	0 (0–0)	<0.0001
Hispanic	388	2 (1–3)	
African American	315	1 (0–2)	
Asian	39	0 (0–0)	
Other	64	1 (0–2)	
Marital status			<0.0001
Single	1487	0 (0–1)	
Married	92	1 (0–3)	
Divorced/separated/other	53	2 (1–3)	
Language			<0.0001
English	1398	0 (0–1)	
Spanish	149	2 (1–3)	
Other	55	1 (0–2)	

A strength of this study is that the Center for Lower Genital Tract Disease database was created the same year that the quadrivalent HPV vaccine was first available in clinical practice in 2006 and demographic information and characteristics of HPV vaccination was obtained for all women seen in our center. The detailed data collected for each patient encounter allows for identification of predictors of HPV vaccination. This study population is relatively diverse, both with respect to the patient population and the types of providers caring for these women prior to presenting to our center because the Center for Lower Genital Tract Disease at Brigham and Women's Hospital is a main regional referral center for New England.

Limitations of this study include the fact that some of the vaccination and medical information was collected by self-report and could not be verified by medical records, which may have lead to some misclassification of exposures and inexact dates of vaccination. However, we do not feel that the study is flawed by recall bias because although exact dates of vaccination and number of doses received may be subject to recall error, it is unlikely that patients would misremember whether or not they received the vaccine in a systematically biased way. In addition, the specific vaccine type (bivalent vs. quadrivalent) was not specified. Clinical information is entered into the database by many clinicians, not a specific data entry person, which may result in entry error, although this also would not be expected to bias the data in any particular direction. However, because the information is used for clinical care, there is incentive to ensure that the entered data are accurate, and attending physicians attest to the data before finalizing the record. There may be other unmeasured factors such as education, income, and cultural values that may be associated with both pregnancy and non-vaccination and it is a limitation of our study that we do not have this data. Another limitation of our study is that patients were not asked whether they had been offered the HPV vaccine in the past, they were only asked if they received the HPV vaccine in the past. We also had missing values for many of the variables studied as noted in Table 1. However, because the sample size was large, including over 1,600 women, most of the variables studied were missing for $\leq 5\%$ of the sample, with the exception of numbers of miscarriages/abortions (missing for 15%) and birth control (missing for 8%).

In summary, this study suggests that among women referred for evaluation of abnormal cervical cytology, those who have

had more pregnancies (including live births, terminations and miscarriages) are less likely to have been vaccinated, despite more reproductive health visits. We believe that these reproductive health visits represent missed opportunities that could be utilized to improve HPV education and vaccination rates in the United States. The importance of provider recommendation cannot be understated given the strong correlation with higher HPV vaccination acceptance rates.^{10,20} This is further supported by our data, which showed that women who were educated and understood their HPV status were more likely to have received the HPV vaccine. One way to address this is to provide standardized educational materials about HPV, which will allow providers to have a more productive conversation about HPV and the benefits of the HPV vaccine while affording an opportunity to recommend the HPV vaccine. This is particularly important in light of the recently approved the 9-valent HPV vaccine which provides coverage for HPV types 16, 18, 31, 33, 45, 52 and 58, as well as types 6 and 11 and has the potential to increase the protection against cervical cancer from 70% to 90%.²² Further research is needed to address the most effective ways to optimize educating patients about the HPV vaccine and how to translate this into greater acceptance rate.

Materials and methods

This study was approved by the Partners Healthcare Institutional Review Board at Brigham and Women's Hospital (Boston, MA, USA). We analyzed patients from the Center for Lower Genital Tract Disease at 2 institutions in Boston, Massachusetts. In 2006 an electronic patient registry was created to collect demographic, clinical, and outcome information from women with abnormal cervical cytology or HPV tests referred to the center for colposcopy. The methods for this registry have been described elsewhere.²³ Briefly, women with abnormal cervical cytology or HPV tests are referred to this clinic for evaluation or management. Each patient completes a standardized paper form containing demographics, HPV vaccine status, comorbidities, reproductive history, and lifestyle factors during every visit. The forms are then reviewed by a physician or a nurse and entered into the database prospectively. Counseling opportunities and content on related topics such as: cervical cytology, HPV, colposcopy, treatment options, smoking cessation and the HPV vaccine (if age eligible) are entered into the

database. Patients who were unvaccinated for HPV were offered the vaccination. Patients then undergo a standard colposcopic exam by a resident and a dedicated attending physician colposcopy expert or the by expert alone, and directed biopsies and endocervical curettage (ECC) are obtained if indicated. A dedicated team of gynecologic pathologists review cervical cytology and pathology specimens and a physician or a nurse enters all patient data into the Center for Lower Genital Tract Disease electronic database prospectively.

Patients are then managed by either the 2006 or by modified 2012 American Society for Colposcopy and Cervical Pathology (ASCCP) guidelines, depending on when they presented for evaluation.^{24–26} All entered data are saved for research purposes but are also automatically merged into the clinical record and the attending physician attests to its validity prior to signing the note.

Women who were evaluated between 2/26/2007 and 3/10/2014 and were age 26 or less at their first appointment were included in the current analysis so as to include all women in the Food and Drug Administration (FDA) approved age range for the quadrivalent vaccine approved in 2006. The youngest patient in our cohort was age 9. Patient characteristics from the first visit were reviewed to identify women who had prior contact with healthcare providers during a reproductive visit and to uncover counseling opportunities in those settings that may have been missed chances to offer the HPV vaccine. They were then analyzed in 2 groups by HPV vaccination status. Contraception methods were grouped into mutually exclusive categories including hormonal contraception (birth control pills, patches, Depo provera, and vaginal rings), barrier, long acting reversible contraception (intrauterine devices, Nexplanon or Implanon), tubal ligation, none, and other. Women who utilized both hormonal contraception and barrier methods were grouped into the appropriate hormonal category. The patient form included an open-ended question for any other medical illnesses not already captured on the form and we dichotomized this variable to any or no report of a medical illness.

Differences between vaccinated and unvaccinated women were first assessed by chi-square tests for categorical variables and t-tests for normally distributed continuous variables. Kruskal Wallis tests were also used to compare number of pregnancies by demographic factors. P-values <0.05 were considered statistically significant.

We built an unconditional multivariable logistic regression model and calculated odds ratios (OR) and 95% confidence intervals (CI). Because variables in univariable analyses may become significant after adjustment and because factors that do not quite reach the level of significance may still be important confounders, we included all variables with p-values of at least 0.10 in the multivariable model. This model included age, race, marital status, language, insurance type, lifetime number of sexual partners, other medical illnesses, number of pregnancies, birth control, history of STIs, and smoking history. To prevent records with missing values from being dropped from analyses, a category for missing values was created for each variable with missing data and an indicator for this category was included in the models.²⁷ Statistical analysis was performed using SAS (version 9.2, SAS Institute, Cary, NC).

Abbreviations

HPV	Human Papillomavirus
STIs	sexually transmitted infections
ACOG	American Congress of Obstetricians and Gynecologists
ACIP	United States Advisory Committee on Immunization Practices
ASCCP	American Society for Colposcopy and Cervical Pathology
FDA	Food and Drug Administration

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

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