Title

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Partner-level and sexual networking factors are associated with vaccine-type and non-vaccine-type human papillomavirus infection after vaccine introduction in young women

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Abstract

Background.—The aim of this study was to determine individual, partner-level and sexual networking factors associated with vaccine- and non-vaccine-type human papillomavirus (HPV) in young women, by vaccination status.

Methods.—Sexually experienced women 13-26 years (N=784) completed a survey and were tested for 36 HPV genotypes. We determined factors associated with 4-valent vaccine-type HPV (HPV6, 11, 16, 18) and non-vaccine-type HPV among vaccinated and unvaccinated women, using univariable and multivariable logistic regression models.

Results.—Participants' mean age was 19.2 years, 77.7% had received ≥1 vaccine dose, and 7.7% were positive for vaccine-type (HPV6, 11, 16, and/or 18). Factors associated with vaccine-type HPV in vaccinated women included gonorrhea history (adjusted odds ratio [AOR]=2.71), new female sex partner(s) (AOR=4.79), age at vaccination (≥15 vs. <15 years: AOR=2.47), and age discordance with most recent partner (don't know vs. discordant: AOR=9.17). Factors associated with non-vaccine-type HPV in vaccinated women included history of sexually transmitted infection (AOR=2.69), male most recent partner (AOR=2.85), age of first sex (AOR=1.15), and partner concurrency (don't know vs. 1 other partner, AOR=2.03). Factors associated with vaccine-type HPV in unvaccinated women included new female sex partner(s) (AOR=7.45) and partner concurrency (don't know vs. no, AOR=2.95). Factors associated with non-vaccine-type HPV in unvaccinated women included race (White vs. multiracial, AOR=4.10) and partner concurrency (don't know vs. 0, AOR=4.65).

Conclusions.—Novel findings of this study, including associations between female sex partners and HPV, and between not knowing about partner concurrency and HPV, have implications for sexual education, clinical counseling, and public health interventions.

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Short Summary

Factors associated with HPV infection in young women include partner-level and sexual networking variables, differ depending upon HPV type and vaccination status, and may be different in the post-HPV-vaccination era.

Keywords

papillomavirus infections; vaccines; sexual behavior; sex partners

INTRODUCTION

Human papillomavirus (HPV) is a common sexually transmitted infection (STI) that may cause anogenital warts as well as oropharyngeal and anogenital cancers in men and women.[1] Safe and effective vaccines that prevent HPV were licensed in the U.S. for young women in 2006 and young men in 2011,[2] but vaccination coverage remains suboptimal,[3] leaving many women and men at risk for HPV and its sequelae. For example, in surveillance studies we conducted during the 11 years after HPV vaccine introduction among sexually experienced young women 13 to 26 years of age recruited from clinical settings, we demonstrated that although vaccine introduction led to a greater than 80% decline in vaccine-type HPV detection among vaccinated women, the decline in vaccine-type HPV detection among unvaccinated women was only 40%.[4] In addition, non-vaccine-type HPV prevalence did not decline overall and increased among unvaccinated women.[5] These findings are consistent with those of published meta-analyses examining trends in vaccine-type[6] and non-vaccine-type HPV[7] globally after vaccine introduction.

Identifying risk factors for HPV in the post-HPV-vaccination era will provide essential information for office, school, and community-based educational initiatives, public health interventions, and vaccination strategies to prevent HPV-associated cancers. Individual-level risk factors for HPV among women have been well-described and include first sexual intercourse at an early age, number of sex partners, and frequency of sexual intercourse.[8 9] Vaccination after sexual initiation may also be a risk for HPV among vaccinated individuals, given that the vaccines are preventive. However, little is known about partner-level or sexual networking risk factors for HPV. These include discordance, defined as differences between sex partners in age, race, ethnicity, or number of partners, and concurrency, defined as having more than one sexual partnership at the same time. Discordance may be a marker for engaging in riskier sexual behaviors; e.g., if it leads to a limited ability to negotiate condom use, and concurrency increases risk for STI transmission. Discordance and concurrency have been shown to be associated with bacterial STIs and HIV,[10–12] but few studies have explored associations with HPV, and those studies were largely conducted in adult populations.[13–17] Furthermore, data are needed regarding whether risk factors for HPV are different after HPV vaccines were introduced, whether factors associated with HPV differ for vaccine-type and non-vaccine-type HPV, and whether any associations vary by vaccination status.

The aim of this study was to determine individual, partner-level, and sexual networking factors associated with vaccine-type and non-vaccine-type HPV in vaccinated and

unvaccinated young women. Based on the results of a recent study we conducted among adolescent and young adult men,[16] we hypothesized that partner-level and sexual networking factors would be associated with both vaccine-type and non-vaccine-type HPV in vaccinated and unvaccinated young women.

MATERIALS AND METHODS

Participants, setting, and design

The study population for these analyses was comprised of adolescent and young adult women (N=784) who were recruited for two cross-surveillance studies (2013-2014 and 2016-2017). Participants were recruited sequentially from the Teen Health Center at Cincinnati Children's Hospital Medical Center and the Cincinnati Health Department. Young women 13 to 26 years of age who reported previous sexual contact – defined as genital-oral or genital-genital contact with male or female partners – were eligible to participate, and those who had participated in any previous surveillance study were ineligible to participate again, to ensure that study samples were independent. Participants completed a self-administered survey instrument in English or Spanish assessing vaccination status, sociodemographic characteristics, HPV vaccination history, reproductive health history, substance use, and sexual behaviors. Previous surveillance studies were conducted in 2007-2008 and 2010-2011, but starting with the 2013-2014 surveillance study, partner-level and sexual networking items were added to the survey instrument; therefore, only data from participants enrolled in the 2013-2014 and 2016-2017 surveillance studies were analyzed in this study. Participants also provided a cervicovaginal swab, collected by the participant or clinician using a standard procedure.[8] Participants provided written informed consent to participate in the study as described, and the Institutional Review Boards of the hospital and the health department approved each study.

Measures

Self-reported vaccination status was verified via electronic medical records and a statewide vaccine registry.[18] Vaccinated participants were defined as having received at least one dose of the 4-valent or 9-valent HPV vaccine. Anogenital samples were analyzed for HPV genotypes using the Roche Linear Array Assay, a polymerase chain reaction amplification technique that uses an L1 consensus primer system and reverse-line blot detection strip to identify 36 different genotypes.[19]

The two primary outcome or dependent variables were 1) prevalence of ≥1 4-valent vaccine-type HPV (HPV6, 11, 16 and/or 18) and 2) prevalence of a non-4-valent vaccine-type HPV. Independent variables included individual, partner-level and sexual networking measures. Individual measures included participant demographic characteristics, age at HPV vaccination, whether HPV vaccination was received before or after sexual initiation, sexual behaviors, and substance use. Partner-level measures included the most recent partners' demographic characteristics and sexual behaviors, including discordance (defined as differences between sex partners in age, race, ethnicity, or number of partners) and concurrency (defined as having more than one sexual partnership at the same time).[20] Sexual networking measures were assessed for the three most recent sex partners in the last 12

months, and included discordance and concurrency. Participant and partner discordance was assessed as follows: 1) partner-level: discordance considering only the most recent sex partner in three categories (concordant, discordant, and don't know) and 2) sexual networking: discordance considering the three most recent partners in three categories (100% concordant, discordant for any partner, and do not know for any partner). Race or ethnicity discordance was defined as a reported difference in race or ethnicity between the participant and partner, age discordance was defined as a greater than 3-year difference in age between the participant and partner as in previous studies,[21] and discordance in number of sex partners was defined as any difference in the number of reported sex partners (categorized as 0, 1, and 2 or more) between the participant and partners in the past three months and the past twelve months. Similarly, participant and partner concurrency (had sex with any other person between the first and last time they had sex with the partner and participant, respectively) was assessed as follows: 1) partner-level: concurrency considering only the most recent sex partner in three categories (concurrency, no concurrency, and do not know, as well as number of sex partners other than the participant in the past 12 months) and 2) sexual networking: concurrency considering the three most recent partners in three categories (100% no concurrency, concurrency with any partner, and do not know for any partner). Participant lifetime concurrency (had practiced concurrency with any partner in their lifetime) was categorized as no, yes, and don't remember.

Statistical analyses

Associations between each of the independent variables and each of the two outcomes were assessed using univariable logistic regression models. Independent variables associated with outcome variables at $p \leq .10$ in univariable analysis were eligible for inclusion in the multivariable logistic regression models. These independent variables were evaluated for collinearity, and if found one variable was selected, taking into account the degree of statistical significance of the variables and consistency in the variables chosen between multivariable models. Stepwise variable selection was used for multivariable modeling. Only variables associated with the outcome at $p \leq .05$ were retained in the final models. All analyses were stratified by participant vaccination status and run separately for each of the two outcomes. Almost all variables had minimal missing data; complete case analysis was used in univariable and multivariable analysis. All analyses were conducted in SAS v9.4 (SAS Institute, Cary, NC).

Because the primary aims of the surveillance studies were to determine long-term trends in vaccine-type and non-vaccine type HPV to assess vaccine effectiveness and herd protection, the study was not statistically powered for the analysis presented in this manuscript. Given the small sample size and the large number of independent variables analyzed, we combined multiple study waves to increase sample size, and used a step-wise approach for dimension reduction and multivariable regression. Strategies used in the step-wise approach were as follows: independent variables were grouped into individual-level, partner-level, and network-level variables, only independent variables associated with outcomes at $p \leq 0.1$ were considered in multivariable modeling, independent variables considered for multivariable modeling were examined for multicollinearity (conceptually and statistically), and multivariable regression models were built using candidate independent variables at

the individual-level first, followed by adding partner-level variables, then network-level variables.

RESULTS

Individual, partner-level and sexual networking characteristics, proportion vaccinated, and HPV prevalence

The median age of participants was 19 years (Table 1). Most (67.5%) of participants self-reported their race as Black, 7.8% as Multiracial or other, 24.7% as White, and 6.1% of Hispanic ethnicity. Most participants (68.9%) reported they held public health insurance and 10.8% held private insurance. Approximately half of participants reported a lifetime history of an STI (only 2 reported HIV infection), 19.4% reported lifetime cigarette smoking, and 52.9% lifetime marijuana use. Median age of first sexual intercourse was 15 years, median number of lifetime male sex partners was 3, 80.7% reported more than one lifetime male sex partner, 16.1% reported at least one lifetime female sex partner, and 54.7% reported no condom use during the last sexual encounter with their main partner. Discordance by age with one of the three most recent sex partners was reported by 24.7% while 6.4% did not know, 16.3% reported discordance in the number of sexual partnerships while 51.2% did not know, and 16.2% reported that at least one of the three most recent partners practiced concurrency while 40.7% did not know.

Among all participants, 77.7% had received one or more HPV vaccine doses: 6.8% had received 1 dose, 8.1% had received 2 doses, and 62.8% had received 3 doses. Most had received the 4-valent HPV vaccine (87.8%), but 12.2% had received the 9-valent HPV vaccine as it was introduced toward the end of the recruitment period. Seventy-one percent had received the first vaccine dose before 15 years of age and 67.2% initiated sex after vaccination. Among all participants, 63.4% were infected with at least one HPV type, 45.5% with at least one high-risk (cancer-associated) type, 7.7% with at least one 4-valent vaccine type (HPV 6, 11, 16 and/or 18), 6.3% with HPV16 and/or 18, and 61.7% with at least one non-vaccine-type HPV. Infection rates were higher in unvaccinated vs. vaccinated women for each of these variables (Figure 1). Multivariable results are as follows, and effect sizes and 95% confidence intervals including any overlap are shown in Figures 2, 3, 4, and 5.

Variables associated with vaccine-type HPV infection in vaccinated women

The following variables were associated with higher odds of vaccine-type HPV infection in vaccinated women in a multivariable logistic regression model (Figure 2): history of gonorrhea (adjusted odds ratio [AOR] = 2.71; 95% confidence interval [CI] = 1.25-5.89), new female partners in the past 3 months (AOR = 4.79; 95% CI = 1.42-16.15), and age at vaccination (≥15 years vs. <15 years: AOR = 2.47; 95% CI = 1.17-5.20), and age discordance with most recent sex partner (don’t know vs. discordant: AOR = 9.17; 95% CI = 1.58-52.63).

Variables associated with non-vaccine-type HPV infection in vaccinated women

The following variables were associated with higher odds of non-vaccine-type HPV infection in vaccinated women in a multivariable logistic regression model (Figure 3):

lifetime history of sexually transmitted infection other than genital warts (AOR = 2.69; 95% CI = 1.88-3.84), most recent sex partner is male (AOR = 2.85; 95% CI = 1.06-7.64), partner concurrency (most recent sex partner's number of sex partners other than participant, past 12 months: don't know vs. 0 partners, AOR = 2.34; 95% CI = 1.52-3.59; don't know vs. 1 partner, AOR = 2.03; 95% CI = 1.17-3.54), and older age of first sex (age defined continuously) with most recent partner (AOR = 1.15; 95% CI = 1.05-1.25).

Variables associated with vaccine-type HPV infection in unvaccinated women

The following variables were associated with higher odds of vaccine-type HPV infection in unvaccinated women in a multivariable logistic regression model (Figure 4): having a new female sex partner in the past 12 months (AOR = 7.45; 95% CI = 1.47-37.78) and concurrency of most recent partner (don't know vs. no concurrency, AOR = 2.95; 95% CI = 1.21-7.21).

Variables associated with non-vaccine-type HPV infection in unvaccinated women

The following variables were associated with higher odds of non-vaccine-type HPV infection in unvaccinated women in a multivariable logistic regression model (Figure 5): race (White vs. multiracial, AOR = 4.10; 95% CI = 1.21-13.95) and concurrency (most recent partner's number of sex partners other than participant, past 12 months: don't know vs. 0, AOR = 4.65; 95% CI = 1.96-11.03; ≥2 vs. 0, AOR = 2.60; 95% CI = 1.02-6.66).

DISCUSSION

This is the first study, to our knowledge, to determine individual, partner-level and sexual networking variables associated with vaccine-type and non-vaccine-type HPV in young women after vaccine introduction, and whether associations were different according to vaccination status. In this study sample, we identified several individual factors associated with HPV including White race, history of STI, later age of first sexual intercourse, and older age at vaccination. The finding that older age at vaccination was independently associated with vaccine-type HPV in vaccinated women underscores the importance of vaccinating both boys and girls at the recommended age of 11-12 years, prior to sexual initiation, given that HPV vaccines are preventative.

In contrast to individual-level factors, which differed across models, partner-level and sexual networking variables were more consistently associated with HPV outcomes across models. As hypothesized, we found that these variables were associated with both vaccine-type and non-vaccine type HPV and in both vaccinated and unvaccinated young women. We noted two patterns in the multivariable models. The first was gender of recent sex partners: among both vaccinated and unvaccinated women, having a new female sex partner was associated with a higher risk of vaccine-type HPV. Conversely, among vaccinated women, male gender of the most recent sex partner was associated with a higher risk of non-vaccine-type HPV. The few studies that have examined HPV infection among sexual minority women have demonstrated disparities by sexual orientation. Solazzo and colleagues found that women reporting that they were heterosexual but had same-sex partners, were mostly heterosexual, or were bisexual had higher odds of HPV infection compared with completely

heterosexual women, while lesbian women had lower odds of HPV infection.[22] Reiter et al. similarly reported that bisexual women and women who reported partners of both sexes had higher odds of HPV infection in univariable analyses, while lesbian women and women who reported only same-sex partners had lower odds of HPV infection in multivariable analyses.[23] Our finding that having a new female sex partner was associated with a higher risk of vaccine-type HPV in both vaccinated and unvaccinated women raises concern about the risk for HPV-associated cancers among sexual minority women. Compared to heterosexual women, sexual minority women may be less aware of their risk for HPV, less likely to practice safer sexual behaviors, less likely to discuss safer sex practices with partners, and less likely to obtain a Pap test.[22 24] Additional research is needed to determine what drives these differences, though previous work suggests they may be influenced by misconceptions regarding STI transmission in female same-sex partnerships and sexual orientation disparities in sex education and in medical care.[25] Taken together, these findings suggest that clinicians should routinely assess sexual orientation and sexual practices among women, and should educate sexual minority women about practices and behaviors to prevent STIs, encourage HPV vaccination, and advocate for patients to participate in cervical cancer screening.

The second pattern we noted was that partner-level and sexual networking variables were consistently associated with a higher risk of HPV. Age discordance with the most recent partner was associated with vaccine-type HPV in vaccinated women, and partner's practice of concurrency was associated with both vaccine-type HPV in unvaccinated women and with non-vaccine-type HPV among vaccinated and unvaccinated women. Our findings are consistent with a small number of previous studies that have examined associations between concurrency and HPV, primarily conducted in adults. In a study of unvaccinated adult women in the United Kingdom, partner concurrency was associated with high-risk HPV infection.[13] In a sample of unvaccinated adult women in the U.S., those who reported a concurrent partnership had an increased risk for a high-risk HPV infection.[14] In a study of adult Taiwanese men who have sex with men, concurrency was associated with penile HPV detection.[15] Finally, in a study of 13-26 year-old young men in the U.S., partner concurrency was associated with HPV16/18 detection in unvaccinated and vaccinated men.[16] Our findings imply that young women whose partners practice concurrency are at elevated risk for HPV in the post-HPV-vaccination era and should be targeted for education about cervical cancer prevention through safer sexual behaviors, vaccination (if unvaccinated), and cervical cancer screening when indicated. However, partner-level and sexual networking behaviors are not routinely assessed in the sexual history, and should be considered by clinicians as a component of routine care given their consistent association with HPV and other STIs. Finally, investigators designing interventions to reduce HPV and other STIs should consider addressing concurrency behaviors as a component of the intervention. Wingood et al. reported that an intervention to reduce HIV infection that aimed to decrease concurrent partnerships also decreased HPV infection.[26]

An unexpected finding was that in all multivariable models – predicting vaccine-type and non-vaccine-type HPV among both vaccinated and unvaccinated women – the "don't know" category for sexual networking variables was associated with a higher risk of HPV. Not knowing one's partner's age (even in comparison to report of age discordance) and

whether one's partner was practicing concurrency (even in comparison to report of one's partner having a sex partner in addition to the participant) were associated with HPV infection. Drumright et al. similarly demonstrated in a sample of young adults that lack of awareness of a partner's concurrency was associated with STI risk.[27] They note that individuals who are unaware of their partner's concurrency may practice less safe sexual behaviors because they assume the partner is monogamous, whereas those who are aware of a partner's concurrency practice safer behaviors because they perceive higher risk for STI acquisition from the partner. In addition, lack of knowledge may be a proxy for poor communication with one's sex partners. Communication with sex partners has been linked to safer sexual behaviors,[28] and safer-sex communication skills training has been shown to improve communication and behaviors such as condom use which reduce the risk of STIs.[29] Lack of knowledge regarding age discordance or concurrency of one's sex partner may also be reflective of a greater proportion of casual or short-term sexual partnerships. The finding that a lack of knowledge about one's partner's age or sexual practices is associated with higher risk for HPV warrants further research and has implications for counseling in clinical care settings and sexual education initiatives. Clinicians should consider assessing knowledge about a patient's partner and providing targeted counseling to those who lack knowledge about their partners. Sexual education and public health interventions should both incorporate messaging centering on the importance of communicating about risks for STIs with potential sex partners and address communication barriers.

This study has several limitations. First, data were cross-sectional, so causal inferences cannot be assumed. Second, behaviors were self-reported, and socially-desirable responses (including responses of "don't know" if participants did not want to admit to a partner's concurrency) or recall bias may have limited the validity of these data. Similarly, partner-level and sexual networking variables were assessed based on participants' responses, so were not validated based on partner responses. In addition, we did not ask participants about their partners' vaccination status. Study participants in our study were recruited from clinical sites providing care to a patients who were predominantly racial minorities and low-income, limiting generalizability. Finally, although we used a reliable and accurate method of HPV DNA testing, there are limitations to all HPV tests in terms of accuracy.[30]

In conclusion, the results of this study demonstrate that those factors associated with HPV infection in young women may be different in the post-HPV-vaccination era, and differ by HPV type (vaccine-type and non-vaccine-type) and vaccination status. These findings have implications for sexual education initiatives, office-based clinical counseling, and public health interventions.

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Conflicts of Interest and Source of Funding.

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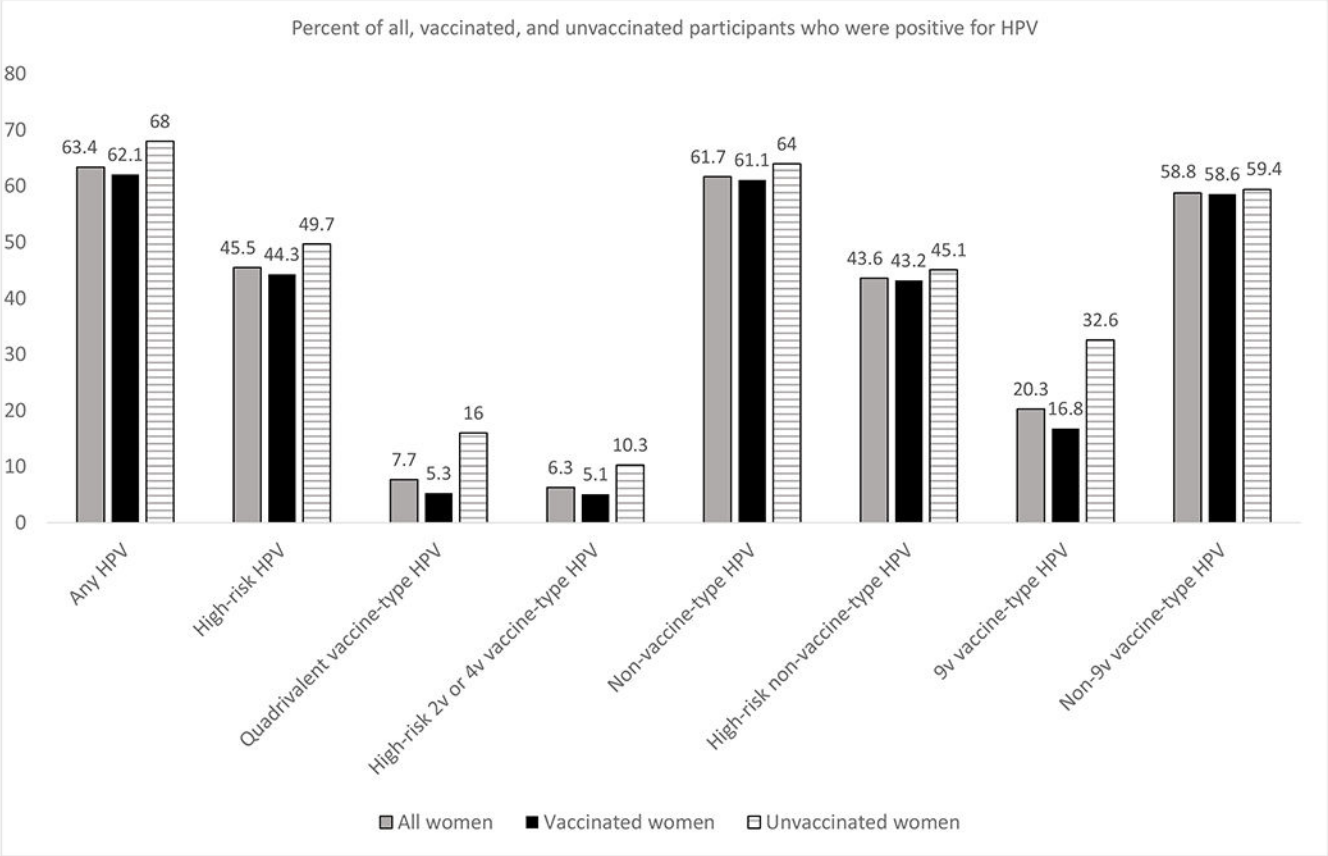

Figure 1.

HPV prevalence (% positive for HPV) among all participants (N=784), unvaccinated participants (N=175), and vaccinated participants (N=609)

High-risk HPV: HPV16, 18, 26, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 67, 68, 70, 73, and/or 82

Quadrivalent vaccine-type HPV: HPV6, 11, 16, and/or 18

High-risk 2v or 4v vaccine-type HPV: HPV16 and/or 18

Non-vaccine-type HPV: HPV26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55 (now considered a subtype of 44), 56, 58, 59, 61, 62, 64 (now considered a subtype of 34), 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, and/or 89

High-risk non-vaccine-type HPV: HPV26, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 67, 68, 70, 73, and/or 82

9v vaccine-type HPV: HPV6, 11, 16, 18, 31, 33, 45, 52, and/or 58

Non-9v vaccine-type HPV: HPV26, 35, 39, 40, 42, 51, 53, 54, 55 (now considered a subtype of 44), 56, 59, 61, 62, 64 (now considered a subtype of 34), 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, and/or 89

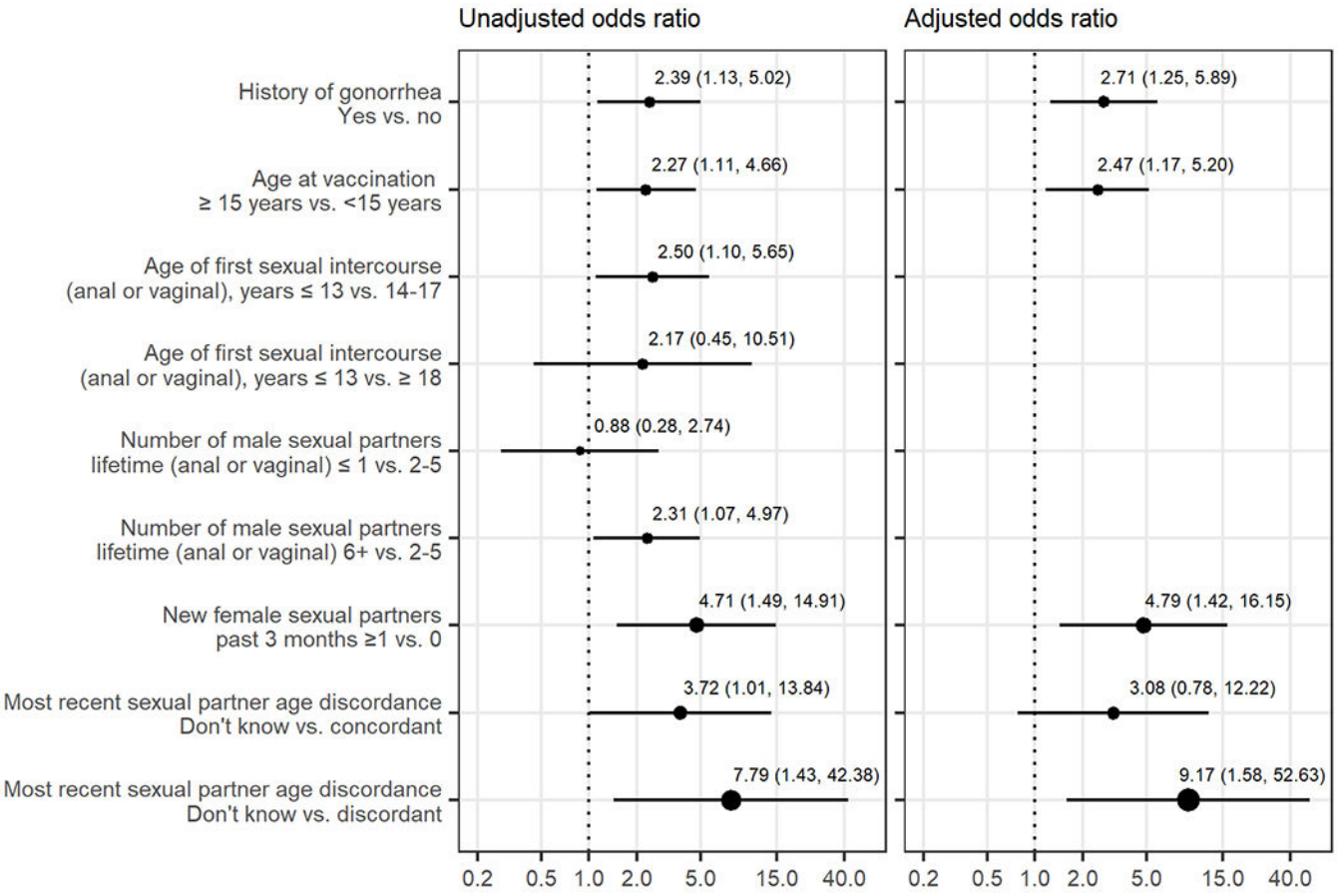

Figure 2.

Independent variables associated with HPV6, 11, 16 and/or HPV18 infection in vaccinated women: results of unadjusted and adjusted logistic regression models (n=609). Unadjusted and adjusted odds ratios (dots, size proportional to the odds ratio) and 95% confidence intervals (horizontal error bars) are graphed on a base 10 logarithmic scale and indicated numerically. The vertical dotted line indicates no effect. Names of variables are shown on the left.

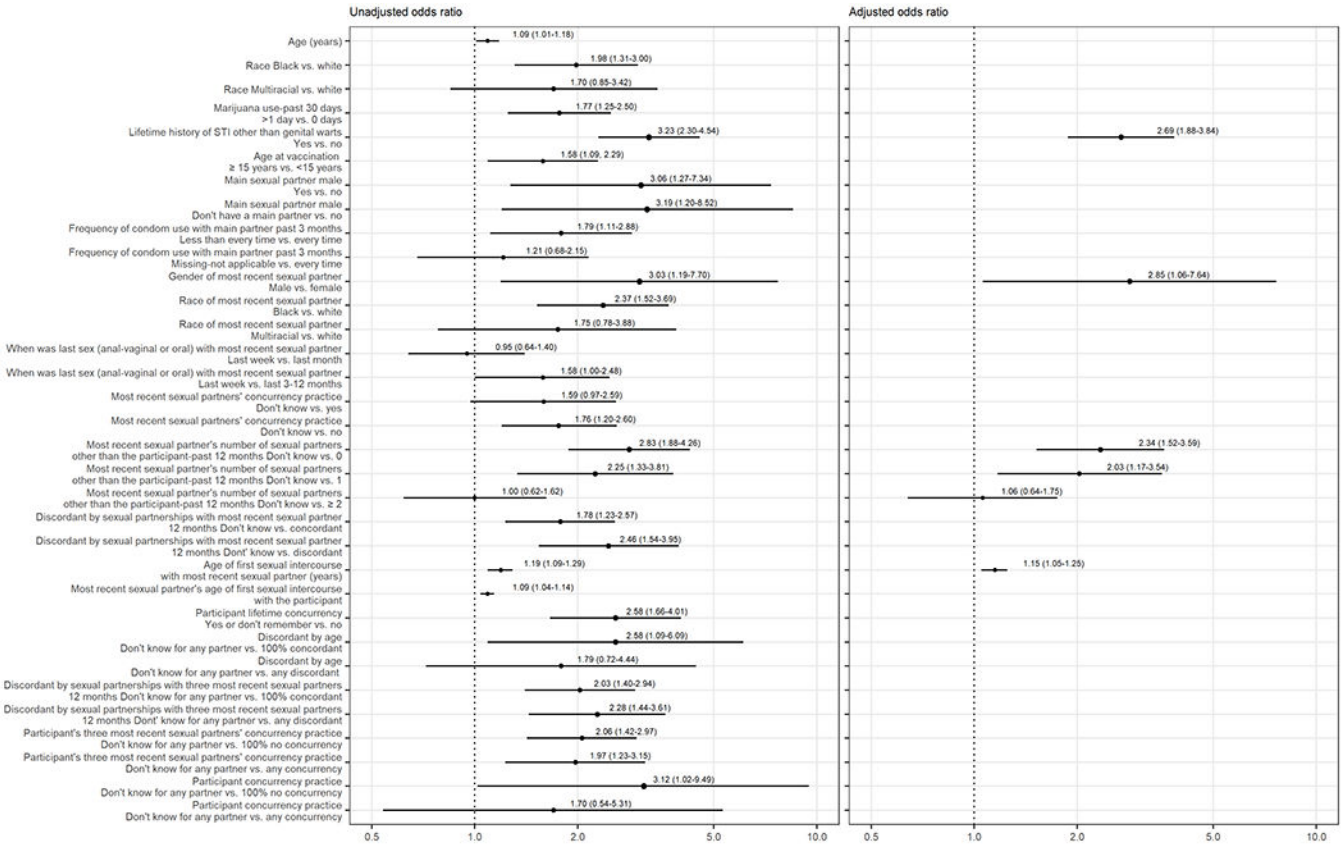

Figure 3.

Independent variables associated with non-vaccine-type HPV infection in vaccinated women: results of unadjusted and adjusted logistic regression models (n=604). Unadjusted and adjusted odds ratios (dots, size proportional to the odds ratio) and 95% confidence intervals (horizontal error bars) are graphed on a base 10 logarithmic scale and indicated numerically. The vertical dotted line indicates no effect. Names of variables are shown on the left.

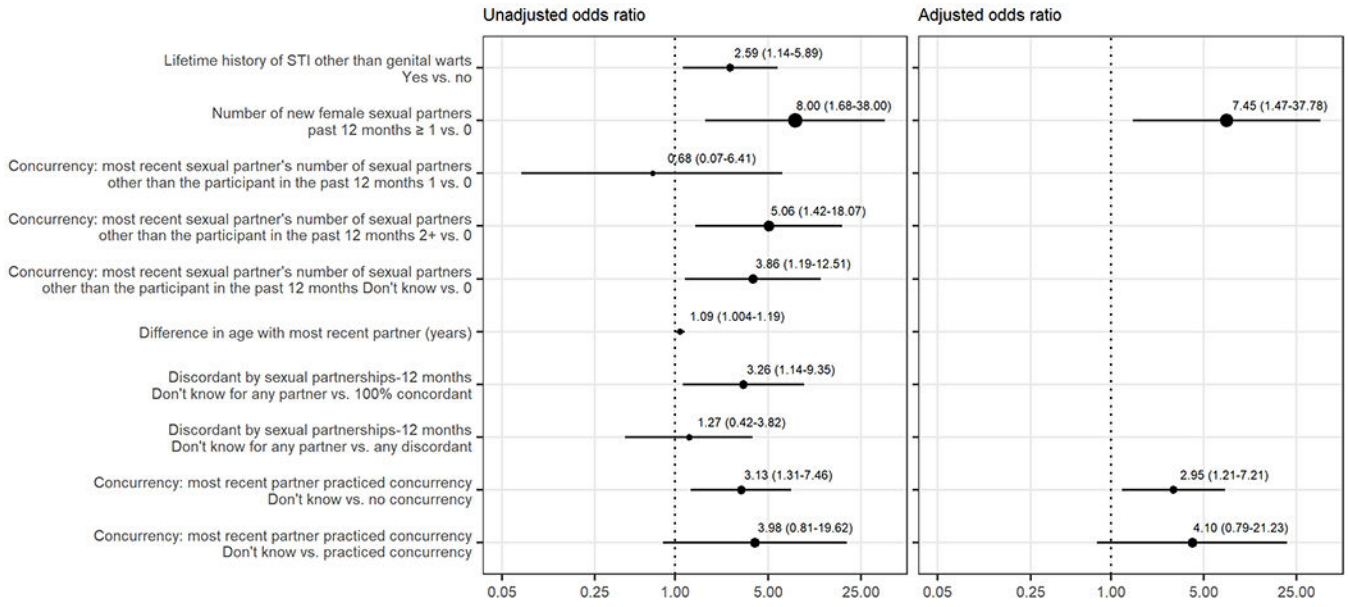

Figure 4.

Independent variables associated with vaccine-type HPV infection in unvaccinated women: results of unadjusted and adjusted logistic regression models (n=175). Unadjusted and adjusted odds ratios (dots, size proportional to the odds ratio) and 95% confidence intervals (horizontal error bars) are graphed on a base 10 logarithmic scale and indicated numerically. The vertical dotted line indicates no effect. Names of variables are shown on the left.

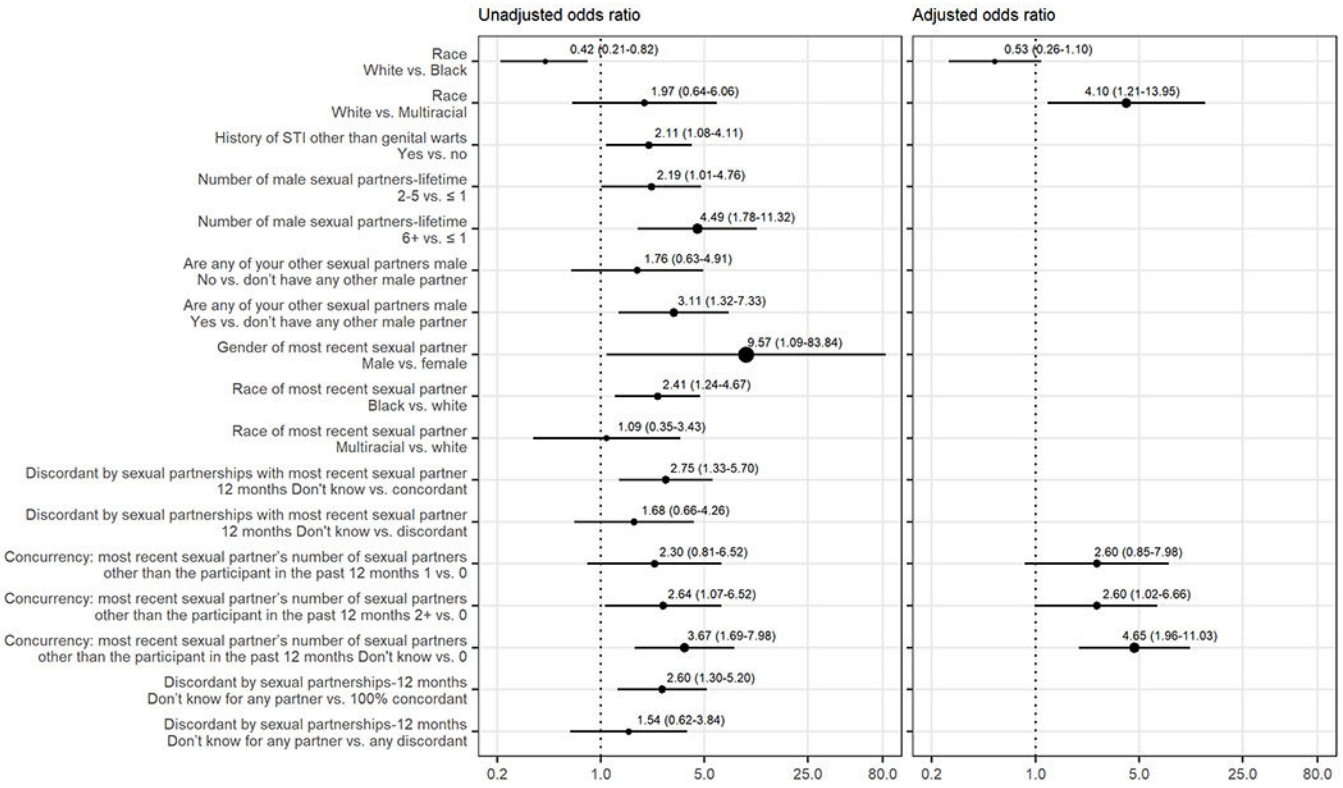

Figure 5.

Independent variables associated with non-vaccine-type HPV infection in unvaccinated women: results of unadjusted and adjusted logistic regression models (n=175). Unadjusted and adjusted odds ratios (dots, size proportional to the odds ratio) and 95% confidence intervals (horizontal error bars) are graphed on a base 10 logarithmic scale and indicated numerically. The vertical dotted line indicates no effect. Names of variables are shown on the left.

Table 1.

Participant characteristics (N=784)[1]

Characteristic	N (%)	Median (range)
HPV vaccination status		
Received ≥1 HPV vaccine dose	609 (77.7)	
Number of HPV vaccine doses received		
0	175 (22.4)	
1	53 (6.8)	
2	63 (8.1)	
3+	491 (62.8)	
Vaccine type received		
≥1 dose of the 4-valent vaccine	289 (87.8)	
≥1 dose of the 9-valent vaccine	40 (12.2)	
Age at vaccination		
< 15 years	429 (71.0)	
≥ 15 years	175 (29.0)	
Sexual initiation status at vaccination		
Initiated sex after vaccination	406 (67.2)	
Initiated sex before vaccination	198 (32.8)	
Recruitment site		
Teen Health Clinic	543 (69.3)	
Health Department	241 (30.7)	
Sociodemographic characteristics		
Age (years)		19 (13, 26)
13-17	222 (28.3)	
18-21	437 (55.7)	
≥22	125 (15.9)	
Race		
White, Asian, or Pacific Islander	194 (24.7)	
Black	529 (67.5)	
Multiracial, other	61 (7.8)	
Ethnicity		
Non-Hispanic White	158 (20.2)	
Non-Hispanic Black	528 (67.4)	
Others	98 (12.5)	
Appalachian descent	15 (1.9)	
Hispanic ethnicity	48 (6.1)	
Marital status		
Never Married	765 97.6)	

Characteristic	N (%)	Median (range)
Ever Married	19 (2.4)	
Insurance Plan		
Private health insurance	85 (10.8)	
Public health insurance (Medicaid, Medicaid managed care)	540 (68.9)	
Unsure or missing	159 (20.3)	
Sexual health		
History of STI other than warts	413 (52.7)	
History of chlamydia	327 (41.7)	
History of gonorrhea	155 (19.8)	
History of trichomonas	196 (25.0)	
History of herpes	44 (5.6)	
History of pregnancy	278 (35.5)	
Substance use		
Lifetime smoking	152 (19.4)	
Frequency of smoking, past 30 days		
0 days	611 (77.9)	
>1 day	173 (22.1)	
Lifetime marijuana use	415 (52.9)	
Marijuana use, past 30 days		
0 days	504 (64.6)	
>1 day	276 (35.4)	
Sexual behaviors		
Age of first sexual intercourse (anal or vaginal), years		15 (5, 26)
≤13	104 (13.3)	
14-17	599 (76.4)	
≥18	81 (10.3)	
Number of male sexual partners, lifetime (anal or vaginal)		3 (0, 200)
≤1	151 (19.3)	
2-5	409 (52.4)	
6+	221 (28.3)	
Number of male sexual partners, past 3 months (anal or vaginal)		1 (0, 10)
0	74 (9.4)	
1	565 (72.1)	
2+	145 (18.5)	
Number of new male sexual partners, past 3 months (anal or vaginal)		0 (0, 9)
0	537 (68.5)	
1+	247 (31.5)	
Number of male sexual partners, past 12 months (anal or vaginal)		1 (0, 70)
≤1	462 (58.9)	

Characteristic	N (%)	Median (range)
2+	322 (41.1)	
Number of new male partners, past 12 months (anal or vaginal)		1 (0, 40)
≤1	651 (83.0)	
2+	133 (17.0)	
Number of female sexual partners, lifetime		0 (0, 50)
0	658 (83.9)	
1+	126 (16.1)	
Number of female sexual partners, past 3 months		0 (0, 6)
0	734 (93.6)	
1+	50 (6.4)	
Number of female sexual partners, past 12 months		1 (0, 9)
0	760 (96.9)	
1+	24 (3.1)	
Number of new female sexual partners, past 3 months		0 (0, 6)
0	712 (90.8)	
1+	72 (9.2)	
Number of new female sexual partners, past 12 months		0 (0, 7)
0	737 (94.0)	
1+	47 (6.0)	
History of anal sex	164 (20.9)	
Number of anal sex partners, past 3 months		0 (0, 10)
0	704 (89.8)	
1+	80 (10.2)	
Number of anal sex partners, past 12 months		1 (0, 12)
0	674 (86.0)	
1+	110 (14.0)	
History of receiving oral sex, past 3 months		
No	280 (35.7)	
Yes	504 (64.3)	
History of giving oral sex, past 3 months		
No	377 (48.2)	
Yes	406 (51.9)	
Frequency of oral sex (given or received) with any partner		2 (0, 201)
0	234 (29.9)	
1-5	362 (46.3)	
6+	186 (23.8)	
Is your main sexual partner male?		
No	27 (3.4)	
Yes	671 (85.6)	
Don’t have a main partner	86 (11.0)	
Frequency of condom use with main partner past 3 months		
Less than every time	550 (70.2)	

Characteristic	N (%)	Median (range)
Every time	105 (13.4)	
Missing, not applicable	129 (16.5)	
Condom use, last sexual encounter with main partner		
No	429 (54.7)	
Yes	242 (30.9)	
Missing, not applicable	113 (14.4)	
Are any of your other sexual partners male?		
No	65 (8.3)	
Yes	289 (36.9)	
Don’t have any other male partner	429 (54.8)	
Frequency of condom use with non-main partners, past 3 months		
Less than every time	150 (19.1)	
Every time	75 (9.6)	
Missing or not applicable	559 (71.3)	
Condom use, last sexual encounter with non-main partner		
No	101 (12.9)	
Yes	188 (24.0)	
Missing or not applicable	495 (63.1)	
Sexual orientation		
Attracted to opposite sex	652 (83.2)	
Attracted to same sex or undecided	132 (16.8)	
Discordance and concurrency		
Discordant by race		
100% concordant	614 (78.3)	
Any discordant	157 (20.0)	
Do not know for ≥1 of the 3 most recent partners	13 (1.7)	
Discordant by ethnicity		
100% concordant	741 (94.5)	
Any discordant	30 (3.8)	
Do not know for ≥1 of the 3 most recent partners	13 (1.7)	
Discordant by age		
100% concordant	540 (68.9)	
Any discordant	194 (24.7)	
Do not know for ≥1 of the 3 most recent partners	50 (6.4)	
Discordant by sexual partnerships, 3 months		
100% concordant	268 (34.2)	
Any discordant	126 (16.1)	
Do not know for ≥1 of the 3 most recent partners	390 (49.7)	
Discordant by sexual partnerships, 12 months		
100% concordant	255 (32.5)	
Any discordant	128 (16.3)	

Characteristic	N (%)	Median (range)
Do not know for ≥1 of the 3 most recent partners	401 (51.2)	
Participant's three most recent partners' concurrency practice		
100% no concurrency	338 (43.1)	
Any concurrency	127 (16.2)	
Do not know for ≥1 of the 3 most recent partners	319 (40.7)	
Participant concurrency practice with the 3 most recent partners		
100% no concurrency	551 (70.3)	
Any concurrency	208 (26.5)	
Do not know for ≥1 of the 3 most recent partners	25 (3.2)	
Participant lifetime concurrency		
No	618 (78.8)	
Yes or don't remember	166 (21.2)	

[1] There were few missing data so missing data are not reported separately in the table: 5 variables had 1 missing value, 3 had 2 missing values, 1 had 3 missing values, and 1 had 4 missing values.