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Sexual Behaviors and Human Papillomavirus Vaccination in a Heterosexually Active Adult Population at Increased Risk for HIV Infection

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Abstract

Human papillomavirus (HPV) is the most common sexually acquired infection in the US. Vaccination is effective against infection with high-risk HPV strains, yet HPV vaccine coverage is lower in the US than the national target. This study aimed to determine the relationship between sexual behaviors and HPV vaccination in a heterosexually active population at increased risk for HIV infection. Data from 380 participants aged 18–45 years obtained from the National HIV Behavioral Surveillance system increased risk heterosexuals cycle 5 (2019) in Houston, Texas, was analyzed. RDS-Analyst was used to generate population-based descriptive statistics. Modified Poisson regression models clustered on recruitment chain were conducted in SAS

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Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical Approval The data contained no personal identifying information, and the study protocol was reviewed and approved as exempt by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston.

Consent to Participate The current study is a secondary data analysis of the NHBS data. Participants in the NHBS verbally consented prior to participating in the NHBS.

9.4 to assess the relationship between sexual behaviors and HPV vaccination. Only 11.5% of participants had received at least one dose of the HPV vaccine. Regarding behaviors within the past 12 months, 44.8% reported having condomless casual sex, 51.3% reported having concurrent sexual partnerships while in their most recent relationship, 14.5% reported exchanging sex, and participants had an average of 4–5 sex partners. Further, those who exchanged sex had a significantly lower prevalence of HPV vaccine uptake when compared to those who did not exchange sex (adjusted prevalence ratio 0.23; confidence interval 0.10–0.52), while all other measures of sexual behavior were not significantly associated with HPV vaccination. More research is needed to understand the relationship between exchange sex and low prevalence of vaccination, specifically in women who bear the highest burden of poor HPV-related morbidity and mortality.

Keywords

Human papillomavirus vaccine; Sexual behaviors; HPV; Exchange sex; Transactional sex

Introduction

Human papillomavirus (HPV) is the most common sexually acquired infection in the United States (US) and is spread through skin-to-skin contact, primarily during sexual activity (Brianti et al., 2017; CDC, 2021; Hirth, 2019; WHO, 2021). Most people naturally clear the virus, however, persistent infection with high-risk HPV types can lead to certain cancers and other sequelae (Brianti et al., 2017; CDC, 2021). Preventive measures, such as vaccination against HPV, are the best defense against infection with high-risk types of HPV (CDC, 2020b). Vaccination is currently recommended for adolescents and young adults aged 9–26 years (Meites et al., 2019; NCI, 2019), while shared patient-provider decision-making for vaccination of adults aged 27–45 years is advised (Meites et al., 2019; NCI, 2019). Despite being highly effective, vaccine coverage is much lower in the US than the national target of 80% (ODPHP, 2021). Currently, an estimated 58.6% of adolescents and 21.5% of young adults have received the recommended number of HPV vaccine doses (Boersma & Black, 2020; Pingali et al., 2021). Vaccine uptake is particularly low in urban, low-income racial/ethnic minority adult populations (Amboree et al., 2022b).

Uptake of HPV preventive care, including vaccination, is highly complex and has been shown to be influenced by many factors including sociodemographic characteristics and healthcare access (Amboree & Darkoh, 2021). Vaccine uptake is also impacted by vaccine hesitancy, defined as “a delay in acceptance or refusal of vaccines despite availability of vaccination services” (Bedford et al., 2018; Grandahl & Neveus, 2021; Sonawane et al., 2021b). Vaccine hesitancy is multi-causal and has been linked to safety concerns, distrust of medical providers, historical abuses of power (Amboree & Darkoh, 2021; Sonawane et al., 2021a), and low self-perceived risk of infection in deciding to receive other vaccines (Du et al., 2021).

HPV vaccination among adults may also be affected by uncertainty regarding indications for vaccination. Though catch-up vaccination for adults aged 27–45 years may not be

beneficial for everyone, some individuals may be at heightened risk of new HPV infections and, thus, may benefit from vaccination (Meites et al., 2019). One of the individual factors that contributes to this increased risk is an increase in sexual behaviors, as new infections can occur with new sexual partners (Meites et al., 2019). Sexual behaviors that may contribute to an increased risk for HPV acquisition include a higher number of sexual partners, condomless sex, and concurrent sexual relationships (Bowyer et al., 2014). However, the populations that are highest risk may have the lowest vaccine coverage. Our prior research suggests that heterosexually active populations at heightened risk of human immunodeficiency virus (HIV) infection (due to living in a census track with higher HIV infection rates and socioeconomic deprivation, and mostly being from racial/ethnic minority groups) may have almost four times lower vaccine coverage compared to the general US population (Amboree et al., 2022b). However, it is unknown whether sexual behaviors differ among vaccinated and unvaccinated heterosexually active adults at heightened risk for HIV infection (Bowyer et al., 2014). Thus, the purpose of this study was to determine the relationship between sexual behaviors and HPV vaccination status, as well as examine the association between self-perceived risk of HPV infection and vaccination status in a heterosexually active population at increased risk of HIV infection.

Method

Data for this study were obtained from the Center for Disease Control and Prevention's National HIV Behavioral Surveillance (NHBS) system in Houston, Texas. NHBS is conducted in 23 US cities with high HIV prevalence and collects data every year in populations at increased risk for HIV infection; specifically, men who have sex with men, people who inject drugs, and heterosexually active adults at increased risk for HIV infection (HET). NHBS uses a standardized, interviewer-administered survey instrument to gather information on participant demographics, sexual behaviors, alcohol and drug use history, HIV and other sexually transmitted infection (STI) testing and use of prevention services, and health conditions as well as site-specific questions of interest. Data from the 2019 HET cycle in the Houston-The Woodlands-Sugar Land metropolitan statistical area (thereafter referred to as Houston MSA), were used for these analyses (CDC, 2020a).

Participants

The data were collected between July and December 2019 using respondent driven sampling (RDS), a social network-based sampling method. NHBS recruitment methods are described in detail elsewhere (Denson et al., 2017; Paz-Bailey et al., 2014; Richards et al., 2008; Sionean et al., 2014). Briefly, recruitment began with initial recruits or "seeds" who were identified before the start of data collection. After the seeds completed the study activities, they were asked to recruit up to 5 other people they know or associate with. These recruited persons then completed the study activities and recruited others, and so on. Participants received incentives for their participation in study activities, specifically monetary compensation for time spent completing the survey and providing specimens for HIV and other STI testing (CDC, 2020a). The target final sample size was 500 non-seed eligible respondents. The target population was comprised of individuals aged 18–60 years who lived in the Houston MSA, identified as male or female, reported having vaginal or

anal sex with someone of the opposite sex in the past 12 months, and were able to complete the interview in English or Spanish. NHBS also defines heterosexually active adults at increased risk for HIV as having low household income—defined as at or below 150% of the poverty guidelines adjusted for geographic differences in the cost of living. However, for the purposes of this paper, we did not exclude those who did not meet the low-income definition due to all participants living in areas with high socioeconomic deprivation and increased HIV prevalence. Further, those who reported non-prescription drug injection in the past 12 months were excluded, as well as males who reported having male sex partners in the past 12 months, as those populations are captured in other cycles of data collection (CDC, 2020a).

For the current analyses, NHBS participants were included if they were aged 18–45 years at the time of their interview and completed the NHBS interview between July and December of 2019. A total of 380 out of the 591 NHBS-HET participants met these criteria. The data analyzed contained no personal identifying information, and the study protocol was reviewed and approved as exempt by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston.

Measures

Uptake of the HPV vaccine was assessed through the item: “Have you ever received a shot that protects against HPV, for example Gardasil?”, and was categorized as yes and no. The number of opposite sex sexual partners was assessed by asking participants “In the past 12 months, that is, since (autofill date) of last year, with how many different people have you had oral, vaginal, or anal sex?” Participants were then asked to categorize those partners as “main” or “casual” partners. Concurrent sexual partnerships were assessed by asking “During the time you were having a sexual relationship with (your most recent sex partner), did you have sex with other people?”

In the analyses, the number of opposite sex sexual partners in the past 12 months was treated continuously and ranged from 0 to 100, casual condomless vaginal/anal sex with a partner of the opposite sex in the past 12 months was categorized as yes and no, concurrent sexual partners while having a sexual relationship with most recent sex partner in the past 12 months was categorized as yes and no, and exchanging sex for money or drugs with most recent sex partner was categorized as yes and no. Perceived risk of HPV was assessed by asking “Compared to other people your age, what do you think the chances are that you will get HPV infection? Do you think you have more chance than other people like you, about the same as other people like you, or less chance than other people like you?” In the analyses, perceived risk of HPV infection was categorized into more risk than others like me, same risk as others like me, and less risk than others like me. Poverty was determined by assessing the participant’s self-reported annual household income and the number of dependents that relied on that income and comparing it to the federal poverty guidelines. In the analyses, poverty level was categorized as above the poverty level and below the poverty level. Participant sociodemographic variables included age in years (continuous and ranged 18–45 years), sex (dichotomized as female and male), and self-reported race/ethnicity (categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic

other). The non-Hispanic other category refers to those participants who reported being Asian, Alaskan Native, or Pacific Islander. Further sociodemographic variables included education (categorized as less than high school diploma, high school diploma or equivalent, and at least some college education), health insurance type (categorized as no health insurance, private health insurance, public health insurance, and some other insurance coverage), incarceration (categorized as never incarcerated, incarcerated but not within the past 12 months, and incarcerated within the past 12 months), having a usual source of healthcare (categorized as no usual source of healthcare, clinic or healthcare center, and doctor's office or HMO), and the time to last healthcare encounter (categorized as within the past 12 months, 1–2 years ago, 2–5 years ago, and more than 5 years ago).

Statistical Analysis

Data were cleaned, prepared, and formatted in SAS 9.4 (SAS Institute Cary, NC, USA). Data were then exported as a comma separated value file and converted into an RDS object for analysis in RDS-Analyst, which accounts for sources of bias inherent to RDS methodology (Gile & Handcock, 2010) and allows for calculation of population-based estimates. Giles' sequential sampling was utilized in RDS-Analyst to account for the RDS methodology of this sample and to create population weights (Gile & Handcock, 2010; Shi et al., 2016). There are currently no standard methods for estimating HET population sizes; therefore this was estimated by pooling available data (NCHS, 2017; USCB, 2019). In short, the population of the Houston MSA was estimated as 7,066,140 in 2019 (USCB, 2019). Of those, 43% were aged 20–49 years old (USCB, 2019). An estimated 12.9% of the Houston MSA lives in poverty and a national estimate of 9.5% of people reported at least 1 sexual risk behavior in the last 12 months (NCHS, 2017; USCB, 2019). Each of these data was used to calculate the population size estimate (calculations shown below).

3,038,440 aged 20–49 years old (inclusion criteria)

3,038,440 × 12.9% = 391,958 living in poverty (HET criteria)

391,958 × 9.5% = 37,236 reporting at least 1 sexual risk behavior (HET criteria)

RDS-Analyst was utilized to generate population prevalence estimates along with 95% confidence intervals and standard errors. Further, population cross-tabulations were conducted in RDS-Analyst. Univariable and multivariable regression analyses were conducted in SAS 9.4 using the modified Poisson regression approach with log link function and robust variance estimation clustered on recruitment chain (Zou, 2004). Estimates from regression analyses were RDS-adjusted using Gile's sequential sampling weights with estimated population size of 37,236. The unweighted multivariable estimates are also included. The PROC GENMOD statement was used to generate unadjusted and adjusted prevalence ratios and 95% confidence intervals that assess the association between HPV vaccine uptake and sexual behaviors. Adjusted models assessing condomless casual sex partners in the past 12 months, exchange sex in past 12 months, and the number of sex partners in the past 12 months were controlled for sociodemographic variables such as age, sex, race/ethnicity, education, health insurance, poverty, incarceration, usual source of healthcare, and last visit to healthcare provider, while the adjusted model assessing

concurrent sexual partnerships while in their most recent relationship within the past 12 months was controlled for age, sex, education, health insurance, poverty, incarceration, usual source of healthcare, and last visit to healthcare provider. Race/ethnicity was not controlled for in the concurrency model due to a lack of heterogeneity in the race/ethnicity variable resulting in data sparsity ($n < 10$) in multiple data cells. All tests performed were two-tailed, with a probability value of 0.05 used as the threshold for declaring statistical significance.

Results

Table 1 summarizes the weighted characteristics of this study population. The 380 respondents had an average age of 31 years, 62% were female, 74% were non-Hispanic Black, 52% had a high school diploma or equivalent, 58% reported having no health insurance, 83% had a household income below the federal poverty level, 63% had a history of incarceration, 52% had no usual source of healthcare, and 68% reported visiting a healthcare provider in the past year. Regarding sexual behaviors, participants reported an average of 4–5 sex partners of the opposite sex in the past 12 months. Almost two-thirds reported having sex with one or more casual partners in the past 12 months (data not shown in tables) and 45% reported having condomless sex with a causal sex partner of the opposite sex in the past 12 months. Over half of respondents reported having concurrent sexual partnerships while in their most recent relationship within the past 12 months, and almost 15% reported receiving money or drugs to have sex in the past 12 months. Regarding the HPV vaccine, 11.5% of participants reported that they had received at least one dose of the vaccine.

Table 2 shows sexual behaviors and perceived risk of HPV infection stratified by HPV vaccination. The only sexual behavior associated with vaccination status in the stratified analyses was exchange sex in the past 12 months. Specifically, unvaccinated individuals had significantly higher prevalence of engaging in exchange sex for money or drugs compared to vaccinated individuals (15.78% vs. 3.94%, $p = .04$) (data not shown in tables). Perceptions of HPV infection risk did not vary significantly among vaccinated and unvaccinated participants.

Table 3 shows the weighted unadjusted prevalence ratios, and the final weighted and unweighted multivariable modified Poisson regression models assessing the relationship between sexual behaviors and HPV vaccination status. There were 10 recruitment chains with minimum cluster size of 1 and maximum cluster size of 317. Exchange sex in the past 12 months was the only sexual behavior that showed a statistically significant association with HPV vaccination status. Those who received money or drugs to have sex in the past 12 months had 0.23 (95% CI 0.10–0.52) times the prevalence of being vaccinated compared to those who had not exchanged sex in the past 12 months after adjusting for sociodemographic characteristics. We further stratified exchange sex by biological sex and found that, of those who reported exchanging sex for money or drugs in the past 12 months, 91% were female ($p < .001$) (data not shown in tables).

Discussion

The findings from this study suggest that sexual behaviors, including the number of opposite-sex sexual partners, concurrent sexual relationships, and condomless casual sex, were not significantly associated with HPV vaccine coverage. This aligns with existing literature stating that there is no relationship between sexual activity and HPV vaccination in college-aged men and women, and young girls (Brouwer et al., 2019; Donken et al., 2018; Jena et al., 2015; Liddon et al., 2012). These findings have been consistent among cross-sectional studies, thus longitudinal study designs are likely needed to assess the effect, if any, of HPV vaccination on sexual behaviors (Donken et al., 2018). Being that some vaccine-hesitant parents report not vaccinating their children due to concerns of increased sexual promiscuity, the finding that HPV vaccination is not associated with an increase in sexual activity is important to respond to this ideology.

Further, our study found that those with recent experience in exchanging sex for money or drugs had significantly lower prevalence of vaccination compared to those who did not exchange sex. The reason for this has not been assessed, however, exchange sex can be viewed as a marker of social vulnerability (Stoebenau et al., 2011). The prevalence of exchange sex in the study population was almost 15%. The extremely high prevalence of exchange sex in this community shows the high vulnerability of the study population. Not only is this population vulnerable due to socioeconomic deprivation, but heightened vulnerability can be due to factors like lack of regular healthcare access and preventive care services, thus, the risks that the study population experiences are multidimensional.

Exchange sex, more appropriately termed “transactional sex”, is a complex subject, but social determinants of health factors may primarily contribute to a person’s decision to engage in transactional sex (Ranganathan et al., 2016). Research has shown that severely impoverished women are more likely to engage in transactional sex to meet basic needs (Stoebenau et al., 2011). In our study, women accounted for 91% of those who engaged in transactional sex. Engaging in transactional sex has been linked to poor health outcomes in women such as increased HIV risk (Ranganathan et al., 2016). These women are also at increased risk for poor health outcomes due to partnership dynamics, lack of empowerment in their sexual relationships, and inability to negotiate effective condom use in these relationships (Ranganathan et al., 2016). Additionally, transactional sex is different from commercial sex work (Ranganathan et al., 2016; Stoebenau et al., 2011), thus, women who engage in transactional sex are much less likely to identify themselves as sex workers or prostitutes, which means that the increased risk of poor health outcomes in this important group may be overlooked (Ranganathan et al., 2016).

While adults at increased risk may benefit from the HPV vaccine, the prevalence of vaccination in this population was extremely low (Amboree et al., 2022b). Additionally, those with the highest level of sexual risk had the lowest prevalence of vaccination. In a population that has extremely low preventive healthcare utilization, especially in terms of HPV vaccine coverage, this further exacerbates the existing intersectional disparities and risk, specifically in the women, for poor outcomes such as infection with high-risk

HPV genotypes, namely HPV-16/−18, which have higher likelihood of leading to cervical malignancies or anal cancer.

Limitations

The findings from our study should be interpreted with some important limitations in mind. Although RDS is generally considered to provide valid population-based estimates of hard-to-reach populations, the inherent biases that come with RDS data (Gile & Handcock, 2010) also apply to our study. Our analyses were robust and account for the RDS sampling methodology, thus, we believe our results to be accurate estimates of the target population. Additionally, the cross-sectional nature of the data limits the conclusions that can be drawn as there is no ability to assess risk or causation (Levin, 2006). Further, the use of interview data increases the risk of information biases such as response bias and recall bias (Cataldo et al., 2019), as participants may not be aware if/when they received the HPV vaccination, especially in childhood or adolescence. However, the NHBS uses a standardized NHBS questionnaire which decreases the risk of bias and increases the internal validity of this study. Notably, self-reported vaccination status has been shown to be racially biased with Black, Hispanic, and Asian populations being less likely to self-report vaccine initiation (Spencer et al., 2019; Vu et al., 2019). Therefore, there may be some inherent bias with the use of self-reported vaccination as an indicator of preventive healthcare utilization (Spencer et al., 2019; Vu et al., 2019). Lastly, the indicator used to estimate HPV vaccine uptake in this study focuses on having received one or more doses of the vaccine rather than vaccine completion. We do not expect this to have adversely impacted our results as literature suggests that the odds of completing the vaccine series may follow the same patterns as that of vaccine initiation in young adults (Adjei Boakye et al., 2018). Additionally, the National Cancer Institute recently found that most women were protected from high-risk HPV types after only receiving one dose of the HPV vaccine (NCI, 2020); thus, there may be no significant limitation in using vaccine initiation as an indicator other than potentially overestimating vaccine coverage in this population, as literature suggests that only a little over half of those who initiate the vaccine complete the vaccine series (Chan et al., 2021).

Conclusions

The results presented suggest that sexual behaviors in general are not significantly associated with HPV vaccine uptake or self-perceived risk of infection. However, there is a statistically significant relationship between exchange sex and HPV vaccine uptake. The mechanism behind this is not currently understood, thus, more research is needed in this area, especially in highly vulnerable, hard-to-reach populations, and specifically in women who bear the highest burden of HPV-related morbidity and mortality. Additionally, our findings highlight the need to increase preventive healthcare in low-income, hard-to-reach populations. Ideally, healthcare providers should focus more intently on having in-depth conversations with members of high-risk groups, especially those involved in transactional sex, who have aged out of the targeted vaccination group (i.e., older than 26 years) to assess their need for catch-up vaccination or other preventive health services such as HPV-related cancer screenings. However, recent research has shown that this population does not encounter the healthcare system due to a significant lack in preventive healthcare access and utilization (Amboree et al., 2022a) making these clinical decision-

making conversations much more difficult to achieve. Future targeted interventions are necessary to increase preventive healthcare access and utilization for low-income vulnerable populations, especially those who engage in transactional sex, so that important patient-provider conversations can take place and necessary preventive care can be provided.

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Table 1

Weighted demographic characteristics of the study population

Characteristic	N	Weighted % (95% CI[a])	SE[b]
Age, continuous (mean, SD[c])	380	–	30.9, 8.1
Sex			
Male	160	38.2 (29.6–46.8)	4.4
Female	220	61.8 (53.2–70.4)	4.4
Race/ethnicity			
Non-Hispanic White	22	4.8 (1.3–8.4)	1.8
Non-Hispanic Black	288	73.7 (65.6–81.9)	4.2
Hispanic	61	19.7 (12.5–26.5)	3.6
Non-Hispanic other	7	1.9 (− 0.2 to 4.0)	1.1
Education			
Less than HS diploma	96	24.4 (17.5–31.3)	3.5
HS diploma or equivalent	181	51.7 (43.6–59.7)	4.1
Some college or above	103	24.0 (17.5–30.4)	3.3
Health insurance type			
No health insurance	226	57.6 (49.5–65.6)	4.1
Private plan	27	7.5 (4.0–11.0)	1.8
Public plan	118	32.9 (25.1–40.7)	4.0
Other	6	2.1 (− 0.2 to 4.4)	1.2
Poverty			
Above poverty level	72	16.6 (10.9–22.3)	2.9
Below poverty level	308	83.4 (77.7–89.1)	2.9
Incarcerated			
Never incarcerated	126	36.7 (28.5–44.9)	4.2
Incarcerated, but not within past 12 months	166	44.6 (35.8–53.4)	4.5
Incarcerated within past 12 months	88	18.7 (13.3–24.0)	2.7
Usual source of healthcare			
No usual source of healthcare	196	52.0 (43.4–60.4)	4.3
Clinic or health care center	124	32.4 (24.6–40.1)	3.9

Characteristic	N	Weighted % (95% CI[a])	SE[b]
Doctor's office or HMO	54	15.7 (10.3–21.3)	2.8
Last visit to healthcare provider			
Within past year	246	67.8 (60.4–75.1)	3.7
1–2 years ago	74	16.1 (11.1–21.3)	2.6
2–5 years ago	50	13.9 (8.7–19.0)	2.6
5+ years ago	10	2.2 (0.3–4.0)	0.9
HPV vaccine uptake			
No	334	88.5 (84.2–93.0)	2.3
Yes	46	11.5 (7.0–15.8)	2.3
Condomless casual sex partners in the past 12 months			
No	174	55.2 (47.5–62.9)	3.9
Yes	204	44.8 (37.1–52.5)	3.9
Concurrent sexual partnerships while in most recent relationship within the past 12 months			
No	151	48.7 (39.6–57.9)	4.7
Yes	214	51.3 (42.1–60.5)	4.7
Exchange sex in past 12 months			
No	336	85.5 (76.5–94.2)	4.5
Yes	44	14.5 (5.8–23.6)	4.5
# of sex partners in past 12 months (mean, SD[c])	375	–	4.4, 7.8
Perceived risk			
More	43	15.0 (7.7–22.4)	3.8
Same	135	43.6 (34.3–52.4)	4.6
Less	134	41.5 (32.4–50.9)	4.7

[a] CI = confidence interval

[b] SE = standard error

[c] SD = standard deviation

Table 2

Sexual behaviors by HPV vaccination among the study population

Sexual behavior	HPV Vaccine Uptake	
	Population column %	*p*-value
Condomless casual sex partners in the past 12 months		.73
No	51.6	
Yes	48.4	
Concurrent sexual partnerships while in most recent relationship within the past 12 months		.11
No	36.9	
Yes	63.1	
Exchange sex in past 12 months		.04 *
No	90.0	
Yes	10.0	
Perceived Risk of HPV infection		.68
More	10.2	
Same	62.1	
Less	27.8	
Number of sex partners in past 12 months (mean, SD)	3.31, 5.63	.68

* $p < .05$

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Table 3

Unadjusted and adjusted weighted and unweighted prevalence ratios from modified Poisson regression models assessing the association between HPV vaccine coverage and sexual behaviors among the study population

Sexual Behavior	Unadjusted Weighted PR[a] (95% CI[b])	*p*-value	HPV Vaccine uptake			
			Adjusted weighted PR[a] (95% CI[b])[c]	Adjusted weighted *p*-value	Adjusted unweighted PR[a] (95% CI[b])[d]	Adjusted unweighted *p*-value
Condomless casual sex partners in the past 12 months[e]	0.88 (0.34–2.29)	.79	1.62 (0.61–4.27)	.33	1.02 (0.43–2.46)	.95
Concurrent sexual partnerships while in most recent relationship within the past 12 months[f]	1.83 (0.36–9.23)	.47	1.94 (0.58–6.45)	.28	1.41 (0.51–3.88)	.51
Exchange sex in past 12 months[e]	0.24 (0.08–0.74)	.01 *	0.23 (0.10–0.52)	< .001 ***	0.30 (0.17–0.52)	< .001 ***
Number of sex partners in past 12 months[e]	0.97 (0.90–1.04)	.40	1.00 (0.94–1.06)	.98	1.01 (0.97–1.05)	.74
Perceived risk of HPV infection						
More	2.15 (0.47–9.80)	.32	–	–	–	–
Same	0.98 (0.04–24.44)	.99	–	–	–	–
Less	0.97 (0.90–1.04)	.40	–	–	–	–

[a] PR = Prevalence ratio

[b] CI = Confidence interval

[c] Model adjusted with RDS-weights

[d] Model not adjusted with RDS-weights

[e] Multivariable model adjusted for age, sex, race/ethnicity, education, insurance type, poverty, incarceration, usual place of healthcare, and last healthcare visit

[f] Multivariable model adjusted for age, sex, education, insurance type, poverty, incarceration, usual place of healthcare, and last healthcare visit

* $p < .05$,

*** $p < .001$