Correlates of Human Papillomavirus Infection Among a National Sample of Sexual Minority Women

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Abstract

Background: Many sexual minority women are infected with human papillomavirus (HPV), yet little is known about correlates of HPV infection among this population.

Materials and Methods: We analyzed data from a national sample of sexual minority women (*i.e.*, women who either reported a history of female sexual partners or identified as nonheterosexual) aged 20–59 from the 2003 to 2012 National Health and Nutrition Examination Survey ($n=830$). Weighted logistic regression identified correlates of infection with any HPV type and infection with a high-risk HPV type.

Results: About 53% of women were infected with any HPV type, and about 37% were infected with a high-risk HPV type. Women who reported five or more sexual partners during their lifetime (adjusted odds ratio [aOR]=5.07, 95% confidence interval [CI]: 2.26–11.42) were more likely to be infected with a high-risk HPV type. Compared to women aged 20–29, women aged 40–49 (aOR=0.51, 95% CI: 0.32–0.81) or 50–59 (aOR=0.27, 95% CI: 0.14–0.53) were less likely to be infected with a high-risk HPV type, as were women who were married or living with a partner (aOR=0.62, 95% CI: 0.44–0.89). Mostly similar correlates were identified for infection with any HPV type, although infection with any HPV type was also less common among women who identified as lesbian compared to those who identified as heterosexual (aOR=0.38, 95% CI: 0.21–0.68).

Conclusions: Demographic and health-related characteristics were associated with HPV infection outcomes. Findings can inform HPV prevention efforts for sexual minority women by providing information about risk factors and subgroups at particular risk for infection.

Keywords: HPV, sexually transmitted infections, lesbian, bisexual, and transgender health, cancer

Introduction

AT LEAST FOUR MILLION sexual minority women (*i.e.*, women who either have a history of female sexual partners or identify as nonheterosexual) currently live in the United States (US),¹ and this population experiences many health-related disparities. For example, sexual minority women have higher rates of tobacco and alcohol use, physical inactivity, and poor dietary habits compared to other women.^{2,3} They are also less likely to receive several types of preventive care services, such as sexual and reproductive health services, and some cancer screening tests.^{4,5} Factors that contribute to these disparities are numerous and include lower access to healthcare, lack of health insurance, past experiences of discrimination in receiving healthcare, concerns about disclosure of sexual orientation to healthcare providers and resulting stigma, and lack of health promotion information and programs for sexual minority women.^{6,7}

Sexual minority women are at risk for and experience a substantial burden of both viral (*e.g.*, herpes simplex virus type 2) and bacterial (*e.g.*, chlamydia) sexually transmitted infections (STIs).^{8–11} Research suggests that this population is also greatly affected by infection with human papillomavirus (HPV). HPV is the most common STI in the US, with nearly 80 million Americans currently infected with at least one HPV type.¹² Although most HPV infections will resolve on their own without treatment, infections have the potential to cause several adverse health outcomes among women. High-risk (*i.e.*, oncogenic) HPV types are associated with numerous types of cancer among women, including cervical, oropharyngeal, vaginal, vulvar, and anal cancers,¹³ while nononcogenic HPV types cause almost all anogenital warts.¹⁴ It is estimated that HPV infections cause about 18,000 cases of cancer and 180,000 cases of genital warts annually among women in the US.¹⁵

Sexual minority women may acquire an HPV infection through several modes of transmission. HPV can be transmitted

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between female partners¹⁶ through different forms of contact, including genital-genital, anal-genital, oral-genital, digital-genital, and the sharing of sex toys.^{17,18} Furthermore, many sexual minority women have current or past male sexual partners,¹⁶ from whom they could have acquired an HPV infection.

Past studies suggest that up to about half of sexual minority women have a current genital HPV infection and about one-third are infected with a high-risk HPV type.^{19–23} However, little is known about the correlates of HPV infection among sexual minority women. It is important to determine correlates to identify risk factors for infection and subgroups of sexual minority women that may be at particular risk for HPV infection. This study analyzed data from a population-based sample of sexual minority women from the US to identify correlates of HPV infection.

Materials and Methods

Study design

We conducted secondary analyses of public-use data from the National Health and Nutrition Examination Survey (NHANES). Methodology for the NHANES has been described in detail elsewhere²⁴ and briefly below. The Centers for Disease Control and Prevention conducts the NHANES to assess the health and nutritional status of US residents. The NHANES uses a complex, stratified, multistage probability sample design with unequal probabilities of selection to obtain a nationally representative sample of the US noninstitutionalized civilian population. Data collection for the NHANES involves in-person questionnaires and physical examinations on consented individuals. Questionnaires are completed in participants' homes and use audio computer-assisted self-interviewing (ACASI) software to collect information on sensitive topics, such as sexual behavior and sexual identity. After questionnaires are completed, physical examinations are administered by trained personnel in mobile examination centers.

Beginning with the 2003–2004 survey cycle, the NHANES asked female participants ages 14–59 to provide self-collected cervicovaginal samples for HPV testing as part of their physical examination. Women self-collected samples in private using a swab (Catch-All Sample Collection Swab; Epicentre). To help with the collection process, women received instructions for collecting a sample.

We analyzed data from all five NHANES survey cycles that included data on genital HPV infection and had public-use data available at the time of our study: 2003–2004, 2005–2006, 2007–2008, 2009–2010, and 2011–2012. Although the NHANES is a series of independent cross-sectional surveys, data from multiple cycles can be combined and analyzed.²⁴ Response rates for women in the age range asked to provide cervicovaginal samples were over 70% for each of the NHANES survey cycles examined.²⁴

This analysis included data on 830 women from the 2003 to 2012 NHANES who were aged 20–59; provided cervicovaginal samples that were adequate for interpretation of HPV testing results; and either reported a history of female sexual partners or identified as nonheterosexual (*i.e.*, sexual minority women). We chose to use both sexual behavior and sexual identity in defining sexual minority women, as sexual orientation is a multidimensional construct and using information on only one dimension may have excluded some

sexual minority women. Additional information about how sexual behavior and sexual identity were assessed is provided below. We could not include female participants aged 14–19 who provided cervicovaginal samples in analyses because data on sexual behavior and/or sexual identity for these ages are not available in public-use datasets for all survey cycles. The National Center for Health Statistics Research Ethics Review Board approved data collection for the NHANES, and the Institutional Review Board at The Ohio State University indicated our secondary analyses did not meet the definition of human subject research.

HPV testing and outcomes

The Research Use Only Linear Array (LA) genotyping test (Roche Diagnostics) was used to detect HPV DNA on women's self-collected cervicovaginal samples.²⁵ This test included probes that could detect 37 HPV types (6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, XR(52), 53, 54, 55, 56, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, 89, and IS39). We examined two HPV infection outcomes (yes or no for each): (a) infection with any HPV type; and (b) infection with a high-risk HPV type (16, 18, 26, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 64, 66, 67, 68, 69, 70, 73, 82, or IS39). In classifying HPV types as high risk, we used a classification scheme that is consistent with past analyses of NHANES data.²⁵

Questionnaire data

Potential correlates. The NHANES questionnaire assessed various demographic and health-related characteristics that we examined as potential correlates of HPV infection outcomes (Table 1). Demographic characteristics included age, race/ethnicity, relationship/marital status, education level, and poverty level. Health-related characteristics included whether women had a healthcare visit in the last year, smoking status, age at first sexual intercourse (*i.e.*, vaginal, oral, or anal sex), and total number of sexual partners (male and female) during their lifetime. We dichotomized the total number of sexual partners (≤ 4 partners or 5+ partners) using a cutoff based on the median number of sexual partners reported by US women.²⁶

The NHANES assessed two dimension of sexual orientation: sexual identity and sexual behavior. Surveys assessed sexual identity with the item, "Do you think of yourself as....," and analytic categories included the following: (a) heterosexual or straight (hereafter, "heterosexual"); (b) bisexual; (c) homosexual or lesbian (hereafter, "lesbian"); or (d) other. For sexual behavior, the NHANES collected information on women's lifetime history of sex (vaginal, anal, or oral) with males and females separately. We used the resulting data to classify women as having: (a) male sexual partners only; (b) both male and female sexual partners; (c) female sexual partners only; or (d) no sex. We defined sexual minority women as women who either reported a history of female sexual partners or identified as nonheterosexual (*i.e.*, bisexual, lesbian, or other). This included women who identified as heterosexual, provided they reported a history of any female sexual partners. This also included women who reported a history of only male sexual partners or no sex partners, provided they identified as nonheterosexual.

TABLE 1. CHARACTERISTICS OF SEXUAL MINORITY WOMEN FROM THE 2003 TO 2012 NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY (N=830)

	n (weighted%)
NHANES survey cycle	
2003–2004	92 (13.2)
2005–2006	137 (20.4)
2007–2008	188 (22.6)
2009–2010	212 (20.3)
2011–2012	201 (23.5)
Demographic characteristics	
Age (years)	
20–29	296 (33.4)
30–39	191 (23.9)
40–49	186 (23.7)
50–59	157 (19.0)
Race/ethnicity	
Non-Hispanic white	362 (65.3)
Non-Hispanic black	202 (14.8)
Hispanic	193 (12.8)
Other	73 (7.1)
Relationship/marital status	
Not married	432 (49.4)
Married/living with a partner	398 (50.6)
Education	
Less than a high school degree	215 (18.4)
High school degree	165 (18.4)
More than a high school degree	449 (63.2)
Poverty level	
Below	232 (22.4)
At or above	551 (77.6)
Health characteristics	
Healthcare visit in the last year	
No	120 (13.2)
Yes	709 (86.8)
Smoking status	
Never smoker	376 (41.0)
Former smoker	150 (22.2)
Current smoker	304 (36.9)
Sexual health characteristics	
Age at first sexual intercourse	
15 or younger	347 (43.1)
16 or older	480 (56.9)
Total number of sexual partners during lifetime	
Four or fewer	199 (16.6)
Five or more	624 (83.4)
Sexual identity	
Heterosexual	297 (40.7)
Bisexual	243 (31.2)
Lesbian	87 (11.6)
Other	203 (16.5)
Sexual behavior	
Male partners only	159 (14.9)
Male and female partners	577 (77.8)
Female partners only	23 (2.4)
No sex	63 (4.9)
Sexual identity/behavior concordance	
Concordant	303 (39.1)
Discordant, identity only	222 (19.8)
Discordant, behavior only	297 (41.1)

Table reports raw frequencies and weighted percentages. Totals may not sum to stated sample size due to missing data. Percentages may not sum to 100% due to rounding. Sexual minority women were women who either reported a history of female sexual partners or identified as nonheterosexual.

NHANES, National Health and Nutrition Examination Survey.

Finally, since discordance between sexual identity and sexual behavior has been associated with riskier sexual practices among women,²⁷ which may increase the risk for HPV infection, we also examined concordance between these two dimensions. We classified women as: (a) concordant (*i.e.*, nonheterosexual identity and a history of female sexual partners); (b) discordant, sexual minority by identity only (*i.e.*, nonheterosexual identity, but no history of female sexual partners); or (c) discordant, sexual minority by behavior only (*i.e.*, heterosexual identity, but a history of female sexual partners).

Data analysis

We first estimated descriptive statistics and then used logistic regression to identify correlates of our two outcomes: infection with any HPV type and infection with a high-risk HPV type. For each outcome separately, we entered variables with $p < 0.20$ in bivariate models into a multivariable logistic regression model. The multivariable models controlled for NHANES survey cycle. The multivariable models produced adjusted odds ratios (aORs) and 95% confidence intervals (CIs). Analyses applied procedures for analyzing complex survey data in SAS Version 9.3 (Cary, NC). We report weighted percentages and effect estimates; frequencies are not weighted. Statistical tests were two tailed with a critical alpha of 0.05.

Results

Participant characteristics

Most women were younger than 50 years (81%), non-Hispanic white (65%), married or living with a partner (51%), had at least a high school degree (82%), and were at or above poverty level (78%) (Table 1). Over half (59%) of women were current or former smokers. Most women reported being at least 16 years old at first sexual intercourse (57%) and having at least five sexual partners during their lifetime (83%).

About 41% of women identified as heterosexual, 31% as bisexual, 12% as lesbian, and 17% as other. For sexual behavior, most women reported a history of both male and female sexual partners (78%), with fewer reporting only male partners (15%), only female partners (2%), or no sex partners (5%). There was substantial discordance between sexual identity and sexual behavior. Only about two out of five sexual minority women (39%) had concordance between sexual identity and sexual behavior. The other women in the sample had discordance between these dimensions of sexual orientation; 41% were categorized as a sexual minority based on a history of female sexual partners, but identified as heterosexual, while 20% of women identified as nonheterosexual, but did not report a history of female sexual partners.

Any HPV infection

The prevalence of any HPV type among sexual minority women, as measured by HPV DNA detection, was 53%. The most prevalent HPV types were types 53 (10%), 62 (10%), 84 (8%), 54 (7%), 16 (6%), 61 (6%), 51 (5%), and 89 (5%). Of these, types 53, 16, and 51 are classified as high-risk HPV types. All other HPV types had a prevalence of less than 5%.

In multivariable analyses (Table 2), infection with any type of HPV was less common among women who were aged 50–59 (aOR=0.48, 95% CI: 0.28–0.84; compared to women

TABLE 2. CORRELATES OF INFECTION WITH ANY HUMAN PAPILLOMAVIRUS TYPE AMONG SEXUAL MINORITY WOMEN (N=830)

	<i>No. of women infected with any HPV type/total No. of women in category (weighted%)</i>	<i>Bivariate OR (95% CI)</i>	<i>Multivariable OR (95% CI)</i>
Overall	450/830 (53.4)	—	—
Demographic characteristics			
Age (years)			
20–29	181/296 (62.0)	ref.	ref.
30–39	100/191 (50.1)	0.61 (0.36–1.05) ^a	0.57 (0.32–1.03) ^a
40–49	94/186 (51.6)	0.65 (0.43–1.00) ^b	0.65 (0.40–1.04) ^a
50–59	75/157 (44.4)	0.49 (0.29–0.82) ^c	0.48 (0.28–0.84) ^c
Race/ethnicity			
Non-Hispanic white	197/362 (52.6)	ref.	ref.
Non-Hispanic black	128/202 (63.5)	1.57 (1.05–2.35) ^b	1.59 (1.01–2.48) ^b
Hispanic	96/193 (50.0)	0.90 (0.60–1.36)	1.43 (0.86–2.38) ^a
Other	29/73 (45.1)	0.74 (0.42–1.29)	1.07 (0.57–2.01)
Relationship/marital status			
Not married	255/432 (58.1)	ref.	ref.
Married/living with a partner	195/398 (48.7)	0.68 (0.50–0.93) ^b	0.66 (0.46–0.96) ^b
Education			
Less than a high school degree	113/215 (55.9)	ref.	—
High school degree	101/165 (61.7)	1.28 (0.76–2.14)	—
More than a high school degree	236/449 (50.3)	0.80 (0.51–1.26)	—
Poverty level			
Below	139/232 (61.5)	ref.	ref.
At or above	288/551 (51.6)	0.67 (0.43–1.03) ^a	0.76 (0.46–1.25)
Health characteristics			
Healthcare visit in the last year			
No	66/120 (55.7)	ref.	—
Yes	384/709 (53.1)	0.90 (0.55–1.48)	—
Smoking status			
Never smoker	173/376 (44.6)	ref.	ref.
Former smoker	86/150 (55.2)	1.53 (0.98–2.38) ^a	1.19 (0.73–1.93)
Current smoker	191/304 (62.0)	2.03 (1.37–3.01) ^c	1.34 (0.84–2.14)
Sexual health characteristics			
Age at first sexual intercourse			
15 or younger	216/347 (61.7)	ref.	ref.
16 or older	232/480 (47.0)	0.55 (0.39–0.77) ^c	0.79 (0.55–1.15)
Total number of sexual partners during lifetime			
4 or fewer	66/199 (29.8)	ref.	ref.
5 or more	381/624 (58.2)	3.27 (2.07–5.18) ^c	4.59 (2.14–9.86) ^c
Sexual identity			
Heterosexual	177/297 (58.6)	ref.	ref.
Bisexual	151/243 (57.7)	0.96 (0.62–1.49)	0.79 (0.48–1.29)
Lesbian	33/87 (35.5)	0.39 (0.23–0.64) ^c	0.38 (0.21–0.68) ^c
Other	89/203 (44.5)	0.57 (0.36–0.90) ^b	1.00 (0.46–2.18)
Sexual behavior			
Male partners only	74/159 (47.8)	ref.	ref.
Male and female partners	342/577 (56.5)	1.42 (0.93–2.16)	0.83 (0.39–1.77)
Female partners only	9/23 (34.0)	0.56 (0.20–1.57) ^a	0.83 (0.19–3.66)
No sex	21/63 (30.6)	0.48 (0.24–0.97) ^b	1.05 (0.40–2.73)
Sexual identity/behavior concordance			
Concordant	174/303 (53.0)	ref.	—
Discordant, identity only	95/222 (43.6)	0.79 (0.46–1.22)	—
Discordant, behavior only	177/297 (58.6)	1.26 (0.86–1.85)	—

Totals may be less than stated sample size due to missing data. The multivariable model included data on 776 women due to missing data on correlates and controlled for NHANES survey cycle. The multivariable model did not include variables with dashes (—). Sexual minority women were women who either reported a history of female sexual partners or identified as nonheterosexual.

^a $p < 0.20$.

^b $p < 0.05$.

^c $p < 0.01$.

HPV, human papillomavirus; OR, odds ratio; CI, confidence interval; ref., referent group.

TABLE 3. CORRELATES OF INFECTION WITH A HIGH-RISK HPV TYPE AMONG SEXUAL MINORITY WOMEN (N=830)

	<i>No. of women infected with a high-risk HPV type^a/total No. of women in category (weighted%)</i>	<i>Bivariate OR (95% CI)</i>	<i>Multivariable OR (95% CI)</i>
Overall	313/830 (36.8)	—	—
Demographic characteristics			
Age (years)			
20–29	141/296 (47.5)	ref.	ref.
30–39	68/191 (37.0)	0.65 (0.37–1.15) ^b	0.62 (0.32–1.17)
40–49	58/186 (33.2)	0.55 (0.36–0.84) ^c	0.51 (0.32–0.81) ^c
50–59	46/157 (22.1)	0.31 (0.18–0.56) ^c	0.27 (0.14–0.53) ^c
Race/ethnicity			
Non-Hispanic white	136/362 (36.2)	ref.	ref.
Non-Hispanic black	91/202 (45.2)	1.45 (0.97–2.18) ^b	1.22 (0.78–1.91)
Hispanic	65/193 (32.2)	0.84 (0.55–1.28)	1.07 (0.63–1.82)
Other	21/73 (33.0)	0.87 (0.45–1.67)	1.14 (0.58–2.25)
Relationship/marital status			
Not married	184/432 (42.0)	ref.	ref.
Married/living with a partner	129/398 (31.7)	0.64 (0.47–0.88) ^c	0.62 (0.44–0.89) ^c
Education			
Less than a high school degree	75/215 (38.4)	ref.	ref.
High school degree	73/165 (46.9)	1.42 (0.86–2.34) ^b	1.25 (0.72–2.16)
More than a high school degree	165/449 (33.5)	0.81 (0.49–1.32)	0.73 (0.41–1.30)
Poverty level			
Below	97/232 (44.0)	ref.	ref.
At or above	197/551 (34.8)	0.68 (0.42–1.09) ^b	0.90 (0.55–1.47)
Health characteristics			
Healthcare visit in the last year			
No	47/120 (39.8)	ref.	—
Yes	266/709 (36.4)	0.87 (0.55–1.37)	—
Smoking status			
Never smoker	124/376 (31.3)	ref.	ref.
Former smoker	51/150 (32.4)	1.05 (0.66–1.66)	1.05 (0.60–1.83)
Current smoker	138/304 (45.5)	1.83 (1.22–2.74) ^c	1.29 (0.84–1.99)
Sexual health characteristics			
Age at first sexual intercourse			
15 or younger	142/347 (39.5)	ref.	ref.
16 or older	170/480 (34.8)	0.82 (0.61–1.09) ^b	1.25 (0.88–1.77)
Total number of sexual partners during lifetime			
4 or fewer	44/199 (19.4)	ref.	ref.
5 or more	267/624 (40.3)	2.80 (1.80–4.35) ^c	5.07 (2.26–11.42) ^c
Sexual identity			
Heterosexual	114/297 (36.5)	ref.	ref.
Bisexual	113/243 (43.6)	1.35 (0.88–2.07) ^b	0.94 (0.60–1.47)
Lesbian	25/87 (26.7)	0.64 (0.35–1.17) ^b	0.58 (0.28–1.21) ^b
Other	61/203 (31.6)	0.81 (0.50–1.30)	1.23 (0.60–2.56)
Sexual behavior			
Male partners only	56/159 (37.3)	ref.	ref.
Male and female partners	233/577 (38.0)	1.03 (0.66–1.61)	0.66 (0.35–1.27)
Female partners only	8/23 (29.7)	0.71 (0.24–2.07)	0.78 (0.17–3.53)
No sex	13/63 (19.3)	0.40 (0.17–0.95) ^d	0.62 (0.19–2.07)
Sexual identity/behavior concordance			
Concordant	127/303 (39.1)	ref.	—
Discordant, behavior only	114/297 (36.5)	0.90 (0.62–1.29)	—
Discordant, identity only	69/222 (32.9)	0.76 (0.50–1.16)	—

Totals may be less than stated sample size due to missing data. The multivariable model included data on 776 women due to missing data on correlates and controlled for NHANES survey cycle. The multivariable model did not include variables with dashes (—). Sexual minority women were women who either reported a history of female sexual partners or identified as nonheterosexual.

^aHigh-risk (*i.e.*, oncogenic) HPV types included types 16, 18, 26, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 64, 66, 67, 68, 69, 70, 73, 82, and IS39.

^b $p < 0.20$.

^c $p < 0.01$.

^d $p < 0.05$.

HPV, human papillomavirus; OR, odds ratio; CI, confidence interval; ref., referent group.

aged 20–29), married or living with a partner (aOR=0.66, 95% CI: 0.46–0.96), or identified as lesbian (aOR=0.38, 95% CI: 0.21–0.68; compared to those who identified as heterosexual). Non-Hispanic black women (aOR=1.59, 95% CI: 1.01–2.48; compared to non-Hispanic white women) and those who reported five or more sexual partners during their lifetime (aOR=4.59, 95% CI: 2.14–9.86) were more likely to be infected with some type of HPV.

High-risk HPV infection

Over one-third (37%) of women were infected with a high-risk HPV type. In multivariable analyses (Table 3), women aged 40–49 (aOR=0.51, 95% CI: 0.32–0.81) or 50–59 (aOR=0.27, 95% CI: 0.14–0.53) were less likely to be infected with a high-risk HPV type compared to women aged 20–29. Infection with a high-risk HPV type was also less common among women who were married or living with a partner (aOR=0.62, 95% CI: 0.44–0.89). Women who reported five or more sexual partners during their lifetime (aOR=5.07, 95% CI: 2.26–11.42) were more likely to be infected with a high-risk HPV type.

Discussion

Past studies have shown that HPV infection is common among sexual minority women.^{19–23} Most of these studies defined sexual minority women strictly by sexual behavior (*i.e.*, women who report female sexual partners), and few examined correlates of HPV infection among this population. This study examined HPV infection and correlates of infection among a population-based national sample of sexual minority women, using a more inclusive definition of sexual minority women that was based on sexual behavior and sexual identity. Our findings reiterate that many sexual minority women are infected with HPV and identify several key demographic and health-related correlates. Furthermore, correlates were mostly similar for infection with any type of HPV and infection with a high-risk HPV type.

The strongest correlate of both HPV infection outcomes examined was whether participants reported a history of at least five sexual partners during their lifetime. The strong associations found are likely due to a higher number of sexual partners, increasing the risk of a person being exposed to HPV.²⁸ Over 80% of women in our study reported at least five sexual partners during their lifetime; so it is important that sexual minority women are educated about HPV transmission and the association between number of sexual partners and infection. Past studies have shown that many sexual minority women lack knowledge about HPV (*e.g.*, transmission and diseases caused by HPV) and perceive themselves to be at relatively low risk for infection.^{29–32} Indeed, about 30% of sexual minority women are not aware that HPV can be transmitted by female-to-female sexual contact.²⁹ Future efforts should therefore inform these women that HPV can be transmitted between female partners¹⁶ and through various forms of contact.^{17,18} It is especially important that such efforts include information about transmission occurring between female partners through oral-genital contact and the sharing of sex toys, as these practices are common among sexual minority women.^{33,34}

Sexual identity was correlated with infection with any type of HPV, with infection being less common among women who identified as lesbian compared to those who identified as het-

erosexual. This finding is similar to past studies examining STIs among sexual minority women.¹⁰ Importantly, the association between sexual identity and infection with any type of HPV remained after controlling for additional variables, including sexual behavior. Although the reason for the underlying difference is not clear from this study, this finding demonstrates the importance of considering and assessing sexual identity, in addition to sexual behavior, when examining HPV infection among sexual minority women, as several past studies have focused primarily on sexual behavior.^{19–21} We also found a meaningful amount of discordance between sexual identity and sexual behavior, which coincides with past studies examining these different dimensions of sexual orientation.^{27,35} Interestingly, although discordance has been associated with poorer health outcomes in previous research,²⁷ it was not associated with a greater risk of either HPV infection outcome in this study. Taken together, these findings reiterate the complex relationship that exists between the different dimensions of sexual orientation. Future research needs to continue to examine the interplay of sexual identity and sexual behavior and their effects on health outcomes.

Consistent with past studies,^{19,25} HPV infection was more common among sexual minority women in our study who were younger or not married or living with a partner. HPV infection may be more common among younger and unmarried women due to different sexual practices (*e.g.*, a greater number of recent sexual partners). Although HPV infection was more prevalent among younger women, infection remained fairly common among women of all ages. This underscores the importance of ensuring that sexual minority women, regardless of age, receive age-appropriate HPV and cervical cancer prevention services. Recent data suggest that less than half of sexual minority women within the recommended age range for HPV vaccination³⁶ have not received any vaccine doses.^{37–39} Cervical cancer screening is also suboptimal among this population, as findings from several studies suggest that sexual minority women may be less likely to have received a recent cervical cancer screening test compared to other women.^{40–43} Cervical cancer screening is particularly low among younger sexual minority women,^{40,42} which is concerning since results of the current study show that HPV infection is more common among these younger women.

Non-Hispanic black women in our sample were more likely to be infected with any HPV type compared to non-Hispanic white women, which is similar to past findings among women from the general population.²⁵ Although not significantly different from other racial and ethnic groups, non-Hispanic black women also had the highest prevalence of infection with a high-risk HPV type. These findings may help explain, in part, why non-Hispanic black women have elevated cervical cancer incidence (10.0 cases per 100,000 vs. 7.1 cases per 100,000) and mortality (4.1 deaths per 100,000 vs. 2.0 deaths per 100,000) rates.⁴⁴

Study strengths include a large population-based sample of sexual minority women from throughout the US, HPV infection data based on DNA testing, and examining multiple outcomes related to HPV infection. Our study also has several limitations. HPV DNA testing allows for examining current HPV infections, but does not allow for examining lifetime history of HPV infections. We were also not able to examine the persistence or clearance of HPV infection. Data on sexual identity and behavior were based on self-reported data and

may be subject to social desirability bias, although the NHANES used ACASI software to help increase response accuracy. We were not able to examine HPV infection among women aged 60–65 (who are still within the recommended age range for cervical cancer screening⁴⁵) because women in this age range were not asked to self-collect cervicovaginal samples for HPV testing. The NHANES did not collect information on whether marriages were to males or females, whether participants or their sexual partners were transgender, or on some behaviors that may be relevant to HPV transmission between sexual partners (*e.g.*, history of sharing of sex toys).¹⁸ We were also unable to examine HPV vaccination status since it was not assessed for all NHANES survey cycles. However, HPV vaccine was not available until 2006 in the US and uptake was very low among adult women during the years examined in our study.⁴⁶

Conclusion

HPV infection was prevalent among sexual minority women and many were infected with a high-risk HPV type. Several characteristics were associated with HPV infection outcomes, including number of sexual partners, age, relationship/marital status, and race/ethnicity. Results also indicate that the risk of HPV infection among sexual minority women may vary by sexual identity. These findings can help inform future HPV prevention efforts for sexual minority women by providing information about the risk factors for HPV infection among this population, as well as subgroups of women who may be at especially high risk for infection.

Acknowledgment

This study was supported by the National Cancer Institute of the National Institutes of Health under Award Number R03CA198115. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Author Disclosure Statement

P.L.R. has received past research grants from Merck Sharp & Dohme Corp. and Cervical Cancer-Free America, via an unrestricted educational grant from GlaxoSmithKline. These funds were not used to support this research study.

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