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Sexual orientation differences in cervical cancer prevention among a cohort of U.S. women

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Abstract

Background: While much has been published in recent years on differences in Papanicolaou (Pap) tests across sexual orientation, other aspects of cervical cancer prevention remain underexplored, such as HPV vaccination, HPV co-tests, or abnormal Pap tests.

Methods: Data came from participants (aged 24–54 years) enrolled in an ongoing, longitudinal, U.S.-based cohort study, the Nurses' Health Study 3 (N=12,175). Analyses were restricted to participants who met the current guidelines for care (e.g., at least 21 years of age for Pap tests).

Results: Mostly heterosexual women were more likely to initiate HPV vaccination than completely heterosexual women with no same-sex partners. All other comparisons across sexual orientation for HPV vaccination initiation and completion and the age of initiation were not statistically significant. Compared to completely heterosexual women with no same-sex partners, mostly heterosexual and lesbian women had lower odds of having a Pap test within the past two years. Completely heterosexual women with same-sex partners, mostly heterosexual, and bisexual women had their first Pap test at an earlier age, had higher odds of having an HPV co-test, and higher odds of having a positive HPV or abnormal Pap test compared to completely heterosexual women with no same-sex partners. In contrast, lesbian women had lower odds of having positive

HPV or abnormal Pap results (odds ratio [95% confidence interval]: 0.65 [0.49–0.86]) than completely heterosexual women with no same-sex partners.

Conclusions: There are significant differences across sexual orientation groups in cervical cancer prevention for Pap test timing and positive HPV and abnormal Pap tests but few differences in HPV vaccination initiation, completion, and age at initiation. Interventions should focus on increasing routine Pap testing among mostly heterosexual and lesbian women.

INTRODUCTION

Sexual minority women may be at greater risk for cervical cancer and other cancers caused by the human papillomavirus (HPV). They are less likely to be aware of the risks posed by HPV, take preventive measures such as Papanicolaou (Pap) tests, and discuss safer sex practices than heterosexual women (Charlton et al. 2011; Solazzo, Gorman, and Denney 2017; Agénor et al. 2017; Charlton et al. 2014; Power, McNair, and Carr 2009). Bisexual women additionally are more likely than heterosexual women to have an HPV infection or abnormal Pap test (Reiter and McRee 2016). Prior research has suggested that differences in cervical cancer prevention and HPV risk are due in part to discrimination based on sexual orientation from health care providers and heterosexual-centrist sex education (Solazzo et al. 2019; Agénor et al. 2019).

Yet, while much has been published in recent years on differences in Pap tests across sexual orientation, identity, and behavior, research on other aspects of cervical cancer prevention across sexual orientation groups remain underexplored (Charlton et al. 2011; Agénor et al. 2015; Agénor et al. 2018). Researching cervical cancer prevention methods across the life course such as HPV vaccination allows us to understand when and how disparities in cervical cancer prevention for sexual minorities may emerge. For instance, parents and health care providers may underestimate an adolescent's HPV risk, particularly for sexual minorities, which can possibly delay HPV vaccination initiation and increase their risk of HPV infection or an abnormal Pap test (Power, McNair, and Carr 2009; Brown et al. 2003). Sexual minority women are also less likely to be insured later in life, which may make reducing gaps in HPV vaccination uptake more challenging as adults (Buchmueller and Carpenter 2010).

There are contradictory findings of HPV vaccination initiation and completion (i.e., having the first dose of the HPV vaccine as well as the two subsequent doses) across sexual orientation groups. Some studies find that lesbian women and women who have sex with women are less likely to initiate HPV vaccination than heterosexual women and women who have had male sexual partners, with no difference in HPV vaccination initiation between bisexual and heterosexual women (Agénor et al. 2015; Agénor et al. 2018; Agénor, McCauley, et al. 2016). In contrast, other studies find that lesbian women are equally likely to initiate and complete HPV vaccination as heterosexual women, but that bisexual or mostly heterosexual women are more likely to initiate and then complete the HPV vaccine than heterosexual women (Agénor, Peitzmeier, et al. 2016; Charlton et al. 2017b). No research has yet examined whether age at HPV vaccination initiation differs across sexual orientation, which may place certain sexual orientation groups at higher risk of HPV infection.

Even within the relatively rich literature on sexual orientation and Pap tests, there are no studies looking at whether sexual minorities have their first Pap tests at later ages or have had an HPV co-test (i.e., HPV test alongside a Pap test), and there is limited research about sexual orientation differences in abnormal Pap test results. Having a Pap test at a later age or not having an HPV co-test may result in a woman being at higher risk for HPV complications, such as later stage at diagnosis and poorer cancer outcomes for those who do end up with HPV-related cervical cancer (Dobbs et al. 2000). It is possible that there are differences in these aspects of cervical cancer prevention across sexual orientation since there are also differences in Pap tests across sexual orientation. Cervical cancer prevention is multi-faceted and occurs across the life course, so elucidating all of these issues can help inform public health campaigns, medical education and training, as well as clinical guidelines. Each one of these cervical cancer prevention methods also reflects a possible intervention opportunity to reduce disparities in care and health status across sexual orientation through a woman's reproductive life course.

In response to the gap in this literature and contradictory findings within already completed studies, we investigated the association between sexual orientation and a range of cervical cancer prevention outcomes that occur over the course of a woman's life. We accessed information on HPV vaccination initiation and completion and the age of initiation. Pap test data included age at first Pap test, lifetime use, use within last two years, and receipt of an HPV co-test. We also collected data on HPV infections via reports of positive HPV co-tests and abnormal Pap tests. By including more than one aspect of cervical cancer prevention, we can directly compare differences in care gaps across sexual orientation, better elucidate the relationship between HPV and sexual orientation, and inform targeted interventions for sexual minority women.

MATERIALS AND METHODS

Study Population

Data come from the Nurses' Health Study 3 (NHS3), an ongoing, U.S.-based longitudinal cohort study of women nurses (aged 24–54 years). Enrollment started in 2010 and is ongoing. Follow-up takes place on a personalized schedule tied to the date when participants last responded to a questionnaire. Sexual orientation was measured in NHS3's fifth biannual questionnaire. All outcome variables were asked in NHS3's eighth biannual questionnaire, which participants completed from 2015 to 2019, and covariates were measured in the first NHS3 questionnaire. At the time of our analysis, May 10, 2019, 30,448 women are enrolled in NHS3, yet only 14,607 have reached the eighth biannual questionnaire.

The analytic sample included NHS3 participants who had information on sexual orientation and at least one of the outcome variables, creating an analytic sample of 12,175. Analysis on a specific outcome variable was limited to those who met the current guidelines for care. For instance, the first HPV vaccine, Gardasil, was recommended by the Centers for Disease Control and Prevention (CDC) for women aged 9 to 26 years in 2006 (Centers for Disease Control and Prevention 2007). Based on this, our analytic sample for the HPV vaccination analysis was limited to females who were 26 years old or younger in 2006. Analysis on Pap tests included those who were within USPSTF recommendations, or between the ages of 21

and 65 years (U.S. Preventive Services Task Force 2018; American Cancer Society 2018). Finally, HPV co-testing is recommended by the National Cancer Institute for women aged 30 to 65 years old so our analysis is limited to women in that age group (National Cancer Institute 2019). The study protocol was approved by the Institutional Review Boards of the Brigham and Women's Hospital and the Harvard T.H. Chan School of Public Health.

Measures

Sexual orientation—Detailed information about sexual orientation was collected using a measure adapted from the Minnesota Adolescent Health Survey (Remafedi et al. 1992), which asks about feelings of attraction and identity with six mutually exclusive response options (completely heterosexual, mostly heterosexual, bisexual, mostly homosexual, completely homosexual, and unsure). Mostly homosexual and completely homosexual were combined into a single group (lesbian) due to small sample size. Mostly heterosexual respondents, however, were categorized separately from completely heterosexual respondents due to potential experiences of minority stress and because the sample allowed for cells large enough to provide adequate power. The question of sexual attraction and identity was combined with a question about the sex of sexual partners to create an additional sexual minority group (completely heterosexuals with same-sex partners). There were too few participants who identified as lesbian and had exclusively same-sex partners to include as a separate category. In total, there are five sexual orientation groups: completely heterosexual with no same-sex partners (reference), completely heterosexual with same-sex partners, mostly heterosexual, bisexual, and lesbian.

HPV vaccination initiation and completion—HPV vaccination initiation and completion were assessed through a two-part question. The items assessing HPV vaccination were preceded by an introductory paragraph that stated: "A vaccine to prevent the human papillomavirus (HPV) infection is available and is called the cervical cancer vaccine, HPV shot, GARDASIL®, or CERVARIX®; and it is given in 3 separate doses over 6 months." The questionnaire then asked if participants had ever had the HPV vaccine and how many doses they had received (ranging from one to three). We created two separate, dichotomous dependent variables: vaccination initiation and vaccination completion. Vaccination initiation was defined as having had the vaccine regardless of the number of doses, and vaccination completion was defined as having the first dose of the HPV vaccine as well as the two subsequent doses. Participants who were not sure on one or both questionnaire measures were treated as missing.

Due to concerns that sexual orientation patterns in HPV vaccination would differ for people who were older and more sexually developed when Gardasil was released versus later generations who were in earlier puberty stages when Gardasil was released, we conducted sensitivity analysis for HPV vaccination for people who were 14 years old or younger when Gardasil was released and those who were 15 years or older when Gardasil was released.

Age at HPV vaccination initiation—The questionnaire also asked participants who reported ever having the HPV vaccine at what age they received the first dose (under 11 years, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, or older than 21 years).

Pap test use—Participants were asked if they had ever had a Pap test (no, yes, not sure), and the timing since their last Pap test (less than 1 year ago, in the past 1 to 2 years, in the past 3 to 4 years, in the past 5 years, more than 5 years). We created two separate, dichotomous dependent variables: (1) ever having had a Pap test and (2) having a Pap test within the past two years. We categorized Pap test timing as within two years due to USPSTF recommendations that people with a cervix should have Pap tests every three years (U.S. Preventive Services Task Force 2018). Participants who were not sure were treated as missing in both variables. We conducted two separate sensitivity tests for this outcome. First, we defined timely Pap tests as occurring within the past 3 to 4 years since response options did not precisely match with USPSTF recommended timelines. Second, the USPSTF guidelines also say people with a cervix over the age of 30 who have had a negative HPV test and normal Pap test can wait five years until their next Pap test. We therefore conducted sensitivity tests with timely Pap test use inclusive of women who had an HPV test and a Pap test within the past five years.

Age at first Pap test—Participants reported how old they were when they first had a Pap test (under 16 years old, 16, 17, 18, 19, 20, 21, 21 years old, don't remember). Those who did not remember were treated as missing.

HPV co-testing—The questionnaire asked participants if they have "ever had a test for the human papillomavirus (HPV) (also known as co-testing)?" with no, yes, and not sure as response options. Those who were not sure were treated as missing.

Positive HPV co-test or abnormal Pap test—Participants were asked if they have "ever had an abnormal Pap or HPV test?" with no, yes, and not sure as response options. Those who were not sure were treated as missing.

Covariates—Potential confounders included race/ethnicity (non-Hispanic White [reference], another race/ethnicity) and age (continuous). Missing covariate data were multiply imputed using fully conditional statements and 20 stacked data sets. Sensitivity analyses were also conducted with education as a covariate.

Statistical Analysis

We produced descriptive statistics, overall and stratified by sexual orientation. We next used multivariable logistic regression to predict differences by sexual orientation in HPV vaccination initiation and completion, ever having a Pap test, having a Pap test within the past two years, ever having an HPV co-test, and ever having a positive HPV test or abnormal Pap test. We used multivariable ordinary least squares regressions to predict age of HPV vaccination initiation and age at first Pap test. All models adjusted for race/ethnicity and age, and were conducted in SAS 9.3. Results of the final regression models are displayed in a table with odds ratios (OR), least-squared means (LS-means), and 95% confidence intervals (CI).

RESULTS

Descriptive statistics of the entire analytic sample stratified by sexual orientation are in Table 1. The average age of the 12,175 participants was 38.7 years with a standard deviation of 7.1, and 89.7% of participants identified as Non-Hispanic White.

Table 2 presents odds ratios and LS-means predicting outcome variables. We found that there were overall very few statistically significant differences across sexual orientation groups in HPV vaccination, with more differences emerging for Pap test timing, HPV co-testing, and Pap and HPV test results. Mostly heterosexual women had higher odds (OR=1.38, CI=1.17–1.64) of initiating the HPV vaccine than completely heterosexual women with no same-sex partners, with no other significant comparisons across sexual orientation for HPV vaccination initiation, vaccination completion, and age at vaccination initiation. Women had similar odds of ever having had a Pap test regardless of sexual orientation.

Statistically significant differences across sexual orientation began to appear once we examined Pap tests timing and results. Mostly heterosexual (OR=0.75, CI=0.64–0.87) and lesbian women (OR=0.58, CI=0.42–0.78) had far lower odds of having a Pap test within the recommended screening period than completely heterosexual women with no same-sex partners. Yet, mostly heterosexual women alongside bisexual and completely heterosexual women with same-sex partners had their first Pap test at earlier ages than completely heterosexual women with no same-sex partners. Completely heterosexual women with same-sex partners, mostly heterosexual women, and bisexual women also had higher odds of having ever had an HPV co-test and a positive HPV or abnormal Pap test than completely heterosexual women with no same-sex partners. Lesbian women had significantly lower odds of having positive HPV or abnormal Pap results than completely heterosexual women with no same-sex partners (OR=0.65, CI=0.49–0.86).

We conducted several sensitivity tests. Results were identical to those presented when we included education as a covariate. HPV vaccination results were similar to those presented when we considered possible cohort effects (i.e., analyzing separately those younger than 14 years when Gardasil was released versus those older than 14 years). However, since there were fewer than 35 sexual minority women who were 14 years or younger when Gardasil was released and who reported initiating the HPV vaccine, those results may be underpowered. Results regarding whether or not a participant had a Pap test within screening guidelines were the same when having a Pap test within the recommended screening time included those who were over 30 years and reported ever having an HPV co-test. There were only marginally statistically significant differences across sexual orientation, however, when we measured Pap tests as occurring within the screening guidelines when participants reported a Pap test within the past 3 to 4 years rather than within the past 1 to 2 years. Compared to completely heterosexual women with no same-sex partners, completely heterosexual women with same-sex partners had marginally higher odds of having a Pap test within 3 to 4 years (OR=2.09, CI=0.92–4.74), and lesbian women had marginally lower odds (OR=0.64, CI=0.39–1.07).

DISCUSSION

In recent years, scholars have increasingly studied differences in cervical cancer prevention across sexual orientation. This research has highlighted the possibility that sexual minority women may be at increased risk of cervical cancer, and other cancers caused by HPV. Earlier research shows bisexual women are more likely to experience an HPV infection than heterosexual women, and women who have same-sex partners are also less likely to be aware of the risks posed by HPV and take preventive measures such as Pap tests and discussing barrier use during sex (Charlton et al. 2011; Solazzo, Gorman, and Denney 2017; Agénor et al. 2017; Charlton et al. 2014; Power, McNair, and Carr 2009; Reiter and McRee 2016). However, the majority of research on cervical cancer prevention and sexual orientation has focused on differences in Pap test timing. Yet, there are other important areas of cervical cancer prevention that have not received as much attention as Pap test timing, including HPV vaccination initiation and completion, age at HPV initiation, age at first Pap test, HPV co-testing, and HPV diagnosis. Researching cervical cancer prevention methods across the life course such as HPV vaccination allows us to understand when and how disparities in cervical cancer prevention for sexual minorities may emerge. This is helpful in informing public health campaigns, medical education and training, as well as clinical guidelines. Additionally, each one of these cervical cancer prevention methods also reflects a possible intervention opportunity to reduce disparities in care and health status across sexual orientation through a woman's reproductive life course.

In our study, the only significant contrast across sexual orientation in HPV vaccination initiation, HPV vaccination completion, and age at HPV vaccination initiation was that mostly heterosexual women had higher odds of vaccination initiation compared to completely heterosexual women with no same-sex partners (OR=1.38, CI=1.17–1.64). This largely reflects prior results that showed only significant differences in HPV vaccination initiation between mostly heterosexual and lesbian women compared to heterosexual women, with no other significant comparisons across sexual orientation for HPV vaccination initiation or vaccination completion (Charlton et al. 2017a). The absence of sexual orientation differences in age of HPV vaccination initiation, and overall lack of difference in HPV vaccination initiation and completion, suggest that women experience similar protection against HPV infections regardless of sexual orientation. The absence of differences across sexual orientation could be due to the HPV vaccine normally being administered prior to the development of sexual orientation (Ott et al. 2011; Center for Disease Control and Prevention 2016). However, Gardasil was released when the average NHS3 participant who met CDC guidelines for HPV vaccination was 22 years old. This means that the average NHS3 participant who initiated HPV vaccination was nearly 20 years old at time of initiation, a time when sexual orientation development was likely already underway. Sensitivity analyses additionally did not detect a cohort effect, or differences in patterns across sexual orientation based on the age of women when the HPV vaccine was released or administered. This suggests that timing of Gardasil being released or administered in regards to sexual development does not affect our findings.

We also found that compared to heterosexual women with no same-sex partners, specific sexual minority groups had lower odds of having a Pap test within the past two years (mostly

heterosexual, lesbian) and having their first Pap test at an earlier age (completely heterosexual with same-sex partners, mostly heterosexual, bisexual). The findings are again similar to research that found mostly heterosexual and lesbian women had far lower odds of having a timely Pap than completely heterosexual women with no same-sex partners (Charlton et al. 2011; Solazzo, Gorman, and Denney 2017). Although differences in Pap test initiation are small, they could represent an extra year of HPV growth or pre-cancerous changes, potentially resulting in more complications, such as later stage at diagnosis and poorer cancer outcomes for those who do end up with HPV-related cervical cancer, and higher medical costs (Dobbs et al. 2000). Further, these small but significant differences may reflect differences in other forms of health care access for sexual minorities. A new addition to the literature, the absence of differences in age at first Pap test for lesbian women suggests that lesbian women are not placed at outsized risk due to not yet receiving a Pap test. It is possible that the absence of differences is due to women not yet identifying as lesbian and therefore they did not yet perceive a need for, or received, differential treatment.

Certain sexual minority groups also had higher odds of having an HPV co-test (completely heterosexual women with same-sex partners, mostly heterosexual, bisexual). There is no research on HPV co-testing across sexual orientation, making this a new addition to the literature on sexual orientation and cervical cancer prevention. Recent research has found that health care providers are more likely to recommend completely heterosexual women with same-sex partners, mostly heterosexual, and bisexual women to have STI or Pap tests than heterosexual women (Solazzo et al. 2019). It is possible that health care providers view women who identify as completely heterosexual women with same-sex partners, mostly heterosexual women, and bisexual women as being more likely to have an HPV infection, and therefore encourage them to have HPV co-tests more regularly.

In contrast to previous work that found that all non-heterosexual women were more likely to have an HPV infection than heterosexual women (Reiter and McRee 2016), we found instead that lesbian women had lower odds of having an abnormal Pap or positive HPV test (OR=0.65, CI=0.49–0.86) compared to heterosexual women with no same-sex partners; completely heterosexual women with same-sex partners, mostly heterosexual, and bisexual women had greater odds. The magnitude of disparities for abnormal Pap or positive HPV test were large and represent meaningful clinical differences—bisexual women had over two times the odds (OR=2.03, CI=1.54–2.67) of having an abnormal Pap or positive HPV co-testing compared to completely heterosexual women with no same sex partners, while completely heterosexual women with same-sex partners had 1.71 times the odds (CI=1.35–2.16). In comparison, lesbian women had 0.65 times the odds (CI=0.49–0.86) of an abnormal Pap or positive HPV co-test compared to completely heterosexual women with no same sex partners. This suggests that bisexual, mostly heterosexual, and completely heterosexual women with same-sex partners face outsized risk of cervical cancer compared to completely heterosexual women with no same-sex partners. These findings line up with research that shows women who are attracted to both men and women perceive themselves as having higher risk of STIs than women who are attracted only to women or only to men (Kaestle and Waller 2011). Additionally, it reflects a lack of knowledge surrounding and participation in safer sex practices for sexual minority women (Doull et al. 2018). Focus groups with younger sexual minority women reveal that they often perceive lower risk of

STIs in sex with women than men, and do not know about dental dams and other contraceptive barrier methods of preventing STI transmission (Doull et al. 2018).

Comparing cervical cancer prevention differences in sexual orientation allows us not only to have a clearer understanding of the breadth of disparities, but also give us a clearer understanding of how sexual orientation disparities arise. For instance, differences appeared mostly in outcomes that would occur due routine gynecologic care (having a Pap test in the past two years, HPV co-test) or result from less barrier use during sex (abnormal Pap or positive HPV test). HPV vaccination outcomes, which are more closely linked to general preventive or pediatric care rather than gynecologic care or sexual activity, display less evidence of differences across sexual orientation (Center for Disease Control and Prevention 2016; American College of Obstetrics and Gynecology 2017). This suggests that disparities in cervical cancer prevention across sexual orientation are due to seeking routine gynecologic care, or lack of LGBT-inclusive sex education. Findings surrounding the role of routine gynecologic care reflect research that found differences in Pap testing across sexual orientation are due in part to hormonal contraceptive use (Charlton et al. 2014).

Although this paper represents an important step to understanding differences in cervical cancer prevention across sexual orientation, it does have limitations. First, the sample consists of nurses and is predominately White and middle class. It is possible that our findings may not be applicable to the general population, and that they may differ by specific intersectional positionality. For instance, other scholars have found that black lesbian women had lower odds of HPV vaccination compared to White heterosexual women than did White lesbian women (Agénor et al. 2018). It is also possible that differences across sexual orientation in cervical cancer prevention may be larger among groups that are less connected to the health care system. Future research should further explore how these patterns present among a more diverse sample, and the ways in which they may vary by intersectional positionality, including more detailed measures of race and class. Second, we do not test sexual identity development with timing of outcome variables. It may be that few differences were found in HPV vaccination because many women were not yet “out.” This is somewhat less likely because participants were on average 20 years old when they initiated HPV vaccination. Third, our measure of Pap test timing did not allow us to measure if women received a Pap test within the precise amount of recommended time (measurement options included 1 to 2 years and 3 to 4 years rather than 3 years as is recommended by USPSTF). We also were not able to distinguish whether or not a woman received a positive HPV co-test or an abnormal Pap test since the questionnaire combines both options.

IMPLICATIONS FOR PRACTICE

Public health interventions should be developed to encourage lesbian women to receive more routine gynecologic care in an effort to reduce differences in routine Pap test timing. This can be done in part by providers recommending cervical cancer prevention measures to all patients and asking questions about sexuality that actually reflect sexual risk. Providers can also play a part in educating patients regarding sexual risk and safer sex measures, and specifically educating patients who identify as lesbian on the need for routine Pap tests. Providers must be trained to make their lesbian patients more comfortable, which may

reduce the length of time between Pap test visits. They can do this by using language that is less invasive [i.e., “let your legs drop to either side” rather than “open your legs”, or “you may feel a little pressure” rather than “you’re going to feel a little poke” (Potter et al., 2015). Providers should also consider if they are over-prescribing certain preventive care to people based on stereotypes surrounding their sexual orientation—completely heterosexual women with same-sex partners, mostly heterosexual, and bisexual women were more likely to have had certain tests than completely heterosexual women with different-sex partners. Sex education should also be inclusive of sexual and gender minorities so that all people understand the need for Pap tests and contraceptive barrier use during sex, regardless of the gender of their sexual partner. Increased sex education surrounding barrier use may also reduce certain sexual minority subgroups’ higher odds of having a positive HPV or abnormal Pap test.

CONCLUSION

Significant differences exist across sexual orientation groups in cervical cancer prevention for Pap test timing and positive HPV or abnormal Pap tests, with few differences in HPV vaccination initiation, completion, and age at initiation. These findings highlight that many disparities in cervical cancer prevention occur due to lack of differences in routine gynecologic care and non-LGBT inclusive sexual education. Interventions should focus on increasing routine Pap testing among mostly heterosexual and lesbian women and increasing sexual and gender minority inclusive sex education.

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Table 1:

Sociodemographic and outcome characteristics by sexual orientation in a cohort of U.S. women aged 24 to 54 years (N=12, 175)

% (N), unless noted	Total (N=12,175)	Completely heterosexual with no-same-sex partners (N=9,986)	Completely heterosexual with same-sex partners (N=302)	p^a	Mostly heterosexual (N=1,418)	P^a	Bisexual (N=223)	P^a	Lesbian (N=246)	P^a
Age (range: 24 to 54 years), mean (SD)[b]	38.7 (7.1)	38.8 (7.2)	38.7 (6.7)	0.8100	37.4 (6.7)	<.0001	38.5 (6.3)	0.4752	40.1 (7.2)	0.0082
Race/ethnicity[c]										
Non-Hispanic White	89.7 (10859)	90.0 (8929)	91.6 (274)	0.3366	88.7 (1249)	0.1506	87.4 (194)	0.2109	87.3 (213)	0.1748
HPV vaccination initiation[c]	43.0 (2270)	42.0 (1787)	43.1 (53)	0.8072	48.7 (348)	0.0008	42.0 (42)	0.9980	46.5 (40)	0.4002
HPV vaccination completion[c]:	85.9 (1932)	86.7 (1534)	84.6 (44)	0.6686	83.2 (287)	0.0876	85.7 (36)	0.8577	79.5 (31)	0.1942
Age at HPV vaccination initiation (range: 10 to 22 or older), mean (SD)[b]	19.8 (2.6)	19.8 (2.6)	19.7 (2.7)	0.6988	20.0 (2.5)	0.2961	20.1 (2.5)	0.4282	19.6 (2.9)	0.5454
Ever had Pap test[c]	99.9 (12019)	99.0 (9852)	99.7 (300)	0.2640	99.2 (1404)	0.6697	99.1 (220)	0.9230	98.8 (243)	0.6876
Had Pap test within past two years[c]	85.5 (10218)	86.0 (8427)	86.5 (257)	0.7940	83.3 (1167)	0.0070	83.5 (182)	0.2912	77.1 (185)	<.0001
Age at first Pap test (range: 15 to 22 or older), mean (SD)[b]	18.2 (2.1)	18.2 (2.1)	17.5 (1.9)	<.0001	17.7 (2.0)	<.0001	17.5 (2.0)	<.0001	18.4 (2.3)	0.3604
Ever had HPV co-test[c]	77.1 (7416)	76.2 (5977)	82.6 (204)	0.0192	81.4 (933)	<.0001	83.8 (160)	0.0145	74.4 (142)	0.5613
Ever had positive HPV or abnormal Pap test[c]	42.8 (5079)	41.6 (4043)	54.6 (160)	<.0001	48.0 (671)	<.0001	58.7 (128)	<.0001	32.5 (77)	0.0051

SD standard deviation, *HPV* human papillomavirus;

[a]Completely heterosexual with no same-sex partners is reference group;

[b]Independent t-test used to generate p values;

[c]Chi-square tests used to generate p-values

Table 2:

Adjusted* odds ratios and LS-means of cervical and cervical cancer prevention outcomes among a cohort of U.S. women aged 24 to 54 years (N=12,175)

	Completely heterosexual with no same-sex partners	Completely heterosexual with same-sex partners	Mostly heterosexual	Bisexual	Lesbian
HPV vaccination initiation (*N*=5,237)[a]	1.00	1.16 (0.79, 1.71)	**1.38 (1.17, 1.64)**	1.26 (0.83, 1.92)	1.28 (0.81, 2.03)
HPV vaccination completion (*N*=2,221)[a]	1.00	0.86 (0.40, 1.84)	0.77 (0.56, 1.05)	0.97 (0.40, 2.33)	0.58 (0.26, 1.28)
Age at HPV vaccination initiation (*N*=2,221)[a,b]	19.90 (19.74, 20.06)	19.60 (19.00, 20.20)	19.97 (19.71, 20.23)	19.75 (19.08, 20.41)	19.86 (19.17, 20.54)
Ever had Pap test (*N*=12,204)[a]	1.00	2.90 (0.40, 20.90)	1.22 (0.67, 2.23)	1.08 (0.27, 4.42)	0.75 (0.24, 2.40)
Had Pap test within past two years (*N*=12,020)[a]	1.00	1.03 (0.73, 1.45)	**0.75 (0.64, 0.87)**	0.80 (0.56, 1.16)	**0.58 (0.42, 0.78)**
Age at Pap test initiation *(N=1*1,067)[a,b]	18.41 (18.34, 18.47)	**17.66 (17.40, 17.91)**	**17.90 (17.77, 18.02)**	**17.64 (17.35, 17.94)**	18.55 (18.26, 18.83)
Ever had HPV co-testing (*N*=9,550)[a]	1.00	**1.49 (1.07, 2.08)**	**1.35 (1.16, 1.59)**	**1.61 (1.09, 2.37)**	0.91 (0.66, 1.27)
Ever had abnormal Pap or HPV test (*N*=11,941)[a]	1.00	**1.71 (1.35, 2.16)** *A*	**1.35 (1.21, 1.51)**	**2.03 (1.54, 2.67)**	**0.65 (0.49, 0.86)**

*Adjusted for age and race/ethnicity; *HPV* human papillomavirus;

[a]Sample sizes vary due to restricting sample to include only those who were eligible for care and not missing on outcome data;

[b]Results from LS-means; **Bolded** values refer to estimates with p-value<.05 in reference to completely heterosexual with no same-sex partners; Numbers in parentheses are 95% confidence intervals.