Sexual Orientation Disparities in Human Papillomavirus Vaccination in a Longitudinal Cohort of U.S. Males and Females

Brittany M. Charlton, ScD,^{1,2} Sari L. Reisner, ScD,^{2–5} Madina Agénor, ScD, MPH,^{6,7}
Allegra R. Gordon, ScD, MPH,^{1,2} Vishnudas Sarda, MPH,¹ and S. Bryn Austin, ScD^{1,2,7,8}

Abstract

Purpose: This study sought to examine how human papillomavirus (HPV) vaccination may differ across sexual orientation groups (e.g., bisexuals compared to heterosexuals)—particularly in boys and men, about whom little is known.

Methods: Data were from a prospective cohort of 10,663 U.S. females and males enrolled in the Growing Up Today Study followed from 1996 to 2014. Participants were aged 11–24 years when the vaccine was approved for females in 2006 and 14–27 years when approved for males in 2009. In addition to reporting sexual orientation identity/attractions, participants reported sex of lifetime sexual partners. Log-binominal models were used to examine HPV vaccination across sexual orientation groups.

Results: Among females, 56% received ≥ 1 dose. In contrast, 8% of males obtained ≥ 1 dose; HPV vaccination initiation was especially low among completely heterosexual males. After adjusting for potential confounders, completely heterosexual (risk ratio [RR]; 95% confidence interval [CI]: 0.45 [0.30–0.68]) and mostly heterosexual (RR; 95% CI: 0.44 [0.25–0.78]) males were half as likely to have received even a single dose compared to gay males. Compared to lesbians, no differences were observed for completely heterosexual or bisexual females, but mostly heterosexual females were 20% more likely to have received at least one dose.

Conclusions: HPV vaccination rates in the U.S. are strikingly low and special attention is needed for boys and men, especially those who do not identify as gay. Vaccinating everyone, regardless of sex/gender and/or sexual orientation, will not only lower that individual's susceptibility but also decrease transmission to partners, females and/or males, to help eradicate HPV through herd immunity.

Keywords: adolescence, bisexuality, cancer, gay, lesbian, sexually transmitted infections

Introduction

HUMAN PAPILLOMAVIRUS (HPV) is the most common sexually transmitted infection in the United States. An estimated 75% of people will be infected with HPV at some point in their lifetime,¹ putting them at risk for genital warts and cancers of the head, neck, anus, cervix, vulva, vagina, and penis. Three vaccines, Gardasil[®], Gardasil[®] 9, and Cervarix[®], are currently available to prevent new HPV infections. The vaccine has been so effective that there has already

been observation² of some herd immunity or indirect protection that occurs when enough of the population is immune.

However, vaccination uptake in the United States is well below what is needed for full herd immunity (an estimated 80% vaccination for girls and boys³). Compared to the Healthy People 2020 goal of 80% vaccination^{4,5} of girls and boys across the United States, an estimated 40% of girls and 22% of boys under the age of 18 years were fully vaccinated in 2014.⁶

The Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices (ACIP) recommends

¹Division of Adolescent/Young Adult Medicine, Boston Children's Hospital, Boston, Massachusetts.

²Department of Pediatrics, Harvard Medical School, Boston, Massachusetts.

³Division of General Pediatrics, Boston Children's Hospital, Boston, Massachusetts.

⁴The Fenway Institute, Fenway Health, Boston, Massachusetts.

⁵Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, Massachusetts.

⁶Dana-Farber Cancer Institute, Boston, Massachusetts.

⁷Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, Massachusetts.

⁸Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital, Boston, Massachusetts.

routine vaccination for all children ages 11–12 years, with catch-up vaccination up to age 26 years for women as well as for men who have sex with men and up to age 21 years among all other men.⁷ Despite specific recommendations pertaining to men with same-sex partners, little is known about HPV vaccination initiation and completion among sexual minorities (i.e., lesbian, gay, and bisexual individuals). We do know that, in comparison to heterosexual women, certain subgroups of sexual minority women have an elevated risk of acquiring HPV, due to having more sexual partners^{8–11} and increased sexual violence,¹² and of developing cervical cancer, due to fewer Pap tests.^{8,13–22} Due to the lack of discussion of sexual minority women in sexual health education and promotion efforts, they also report lower levels of awareness about HPV risk factors,²³ vulnerability,^{16,24,25} and prevention,²⁶ all of which are known barriers to HPV vaccination,^{27,28} relative to their heterosexual peers.

Two cross-sectional studies^{29,30} found that U.S. lesbians and girls and women with only female past-year sexual partners were less likely than their heterosexual counterparts and those with only male past-year sexual partners to have initiated HPV vaccination. However, we know little about sexual orientation disparities in HPV vaccination completion among females and males, nor about differences in HPV vaccination initiation among males. Furthermore, longitudinal data across adolescence and young adulthood are rare in HPV vaccination research, as are large datasets offering comparisons by sexual orientation subgroups; such data are needed to inform future public health campaigns and vaccination efforts.

This study aims to fill these research gaps by utilizing data from a U.S. longitudinal cohort with 20 years of follow-up, three times as many participants as the previous cross-sectional studies^{29,30} on sexual minority females. Data include a simultaneous examination of different dimensions of sexual orientation among both females and males, which is novel in the sexual orientation literature, as are data on both HPV vaccination initiation and completion.³¹ We hypothesized that, compared to their sexual minority peers, heterosexual females would be more likely and heterosexual males less likely to receive HPV vaccination.

Methods

Study population

The Growing Up Today Study (GUTS) is a U.S.-based longitudinal cohort of adolescents and young adults. Women from the Nurses' Health Study II, who were the mothers of the GUTS participants, enrolled their female and male children who were 9–14 years old in 1996 (GUTS 1) and then enrolled any other children who were 9–16 years old in 2004 (GUTS 2). The current analysis was limited to GUTS 1 and 2 participants who reported their sexual orientation as well as information on HPV vaccination ($N=10,663$). More detailed information on the recruitment is available elsewhere.³² This study was approved by the Brigham and Women's Hospital institutional review board.

Measures

Detailed information about sexual orientation has been collected on every questionnaire starting in 1999 for GUTS 1 participants and in 2011 for GUTS 2. The item was adapted from

the Minnesota Adolescent Health Survey³³ and asks about feelings of attraction and identity in a single item, a recommended approach for adolescents^{34,35} and one we have repeated across all years of data collection for consistency. Research about the timing of sexual orientation developmental milestones³⁶ further supports this method of assessment; adolescents first report attractions followed by an identity label and, therefore, it is important to allow surveys to capture both dimensions of experience to identify sexual minority adolescents.

Response options to this item included six mutually exclusive categories (completely heterosexual, mostly heterosexual, bisexual, mostly homosexual, completely homosexual, and unsure). Sexual orientation identity/attraction was assigned based on reports from the 2014 questionnaire (the same questionnaire year as the outcome variable, when participants were 19–32 years old) with the following categories: completely heterosexual, mostly heterosexual, bisexual, and lesbian/gay (including the mostly homosexual and completely homosexual groups [reference]).

Sensitivity analyses using sexual orientation reports from previous years returned identical results. Given our hypothesis that heterosexual males would be less likely to be vaccinated compared to their sexual minority peers, we used gay participants as the reference for the male analyses; similarly, lesbian participants were the reference group for the female analyses. We also explored an additional item about the sex of lifetime sexual partners (only males [reference for male participants], only females [reference for female participants], males and females, and no sexual partners). These measures allowed us to uniquely assess different dimensions of sexual orientation simultaneously (identity/attractions and behavior) as recommended by the Institute of Medicine.³⁷

We developed a two-part question for the 2014 GUTS 1 and 2 questionnaire about HPV vaccination initiation and completion. The items were preceded by an introductory paragraph that stated the following: "A vaccine to prevent the human papillomavirus (HPV) infection is available and is called the cervical cancer vaccine, HPV shot, Gardasil[®], or Cervarix[®]. It is given in 3 separate doses over 6 months." The survey then asked if participants had ever had the HPV vaccination and how many doses they had received (ranging from one to three).

As has been done previously, we considered anyone who responded to having had the vaccine, regardless of the number of doses, as initiating the vaccine and counted those who reported all three doses as having completed the vaccination. Two outcome variables were specified: a dichotomous outcome of any HPV vaccine (initiated + completed), and a categorical outcome of HPV doses coded as none (referent), initiated but not completed, and completed. Participants were 11–24 years old in 2006 when the vaccine was first approved for females and 14–27 years old in 2009 when the vaccine was approved for males. Therefore, the vast majority of participants would have been eligible for catch-up vaccination (up to age 26 years), since they were above the recommended age of 11–12 years.

Potential confounders included baseline age (continuous), race (White, non-White), region of residence in 2009 (the year the vaccine was approved for both females and males; West, Midwest, South, and Northeast), and socioeconomic position (based on annual household income during childhood in 2001; <\$50,000, \$50,000–\$74,999, \$75,000–\$99,999, and ≥\$100,000). If data were missing for potential confounders,

they were imputed from previous questionnaire years; if no such data were available, multiple imputation procedures were used.

Statistical analysis

There are two levels of correlation in the GUTS data: repeated measures within subject and clusters of siblings. To correctly estimate the variance of effect estimates in this analysis, generalized estimating equations models were specified with an appropriate working correlation matrix that accounts for these two nested levels of clustering.^{38,39} Log-binominal models were produced using SAS 9.3 (SAS Institute Inc., Cary, NC). Among males, where HPV vaccination was uncommon, log-Poisson models were used, which provide consistent, but not fully efficient estimates of the risk ratio (RR) and its 95% confidence interval (CI).

Results

Among 10,663 participants, most of whom identified their race as White, 69% ($N=7321$) were female and 31% ($N=3342$) were male. Among females, 56% had received at least one dose of the HPV vaccine. In contrast, only 8% of males had received at least one dose; this was especially low in completely heterosexual males (7%) compared to their gay male peers (16%; see Table 1).

After adjusting for potential confounders, completely heterosexual (RR; 95% CI: 0.45 [0.30–0.68]) and mostly heterosexual (RR; 95% CI: 0.44 [0.25–0.78]) males were about half as likely to have received at least one dose of the vaccine compared to gay males. These disparities were even more striking for HPV vaccination initiation only. We did not observe any difference in HPV vaccination initiation or completion between bisexual and gay males, likely due to the small number of bisexual boys and men ($N=27$) in this study (see Table 2).

Compared to lesbians, no statistically significant sexual orientation differences in HPV vaccination initiation or completion were observed for completely heterosexual females (receipt of at least one dose, RR; 95% CI: 1.12 [0.95–1.31]) or bisexual females (RR; 95% CI: 1.03 [0.84–1.26]). However, mostly heterosexual females were 20% more likely than lesbians to have received at least one dose (RR; 95% CI: 1.20 [1.02–1.41]; see Table 2).

We observed similar results as the sexual orientation identity/attraction findings when examining HPV vaccination differences by sex of sexual partners for both males and females. For example, females who reported having both female and male sexual partners in their lifetime were about 25% more likely to have been vaccinated compared to those with only female sexual partners (receipt of at least one dose, RR; 95% CI: 1.27 [1.04–1.54]; see Table 3). Among male and female participants who initiated vaccination, almost 90% of them completed vaccination.

Discussion

HPV vaccination rates in the United States are strikingly low and are nowhere near the 80% level needed to reach full herd immunity.³ This study reveals that HPV vaccination is particularly insufficient among males, especially those who do not identify as gay.

The sex/gender differences in HPV vaccination that we observed are well documented. One reason for this underco-

verage is the limited awareness of the vaccine's use for boys and men.^{40–42} The vaccine was approved first for girls in 2006, but was not approved for boys until 3 years later. Moreover, the vaccine's well-known role in helping to prevent cervical cancer, which is highlighted in one of the vaccination's names (Cervarix), does not directly apply to boys. The vaccine's other benefits, namely, the prevention of genital warts and cancers of the head, neck, anus, and penis, are not as well advertised.⁴³

Another reason for these sex/gender differences is that few healthcare providers are recommending the vaccine, especially to boys.⁴⁴ Providers may not be recommending, nor parents seeking, vaccination if they believe the sexual minority adolescent is sexually inactive when, in actuality, the adolescent may not have disclosed their sexual orientation. It remains to be seen how provider recommendations have changed for boys and men after ACIP altered its recommendation from a permissive to a routine stance.⁷

Finally, unlike boys and men, many girls and women enter the healthcare system to obtain contraception, at which point they also obtain primary care, including HPV vaccination. Our previous research¹³ documents that, compared to their heterosexual peers, less hormonal contraception use by sexual minority girls and women accounted for some of the sexual orientation disparities in Pap test use. Future research should explore this and any other potential mediators of sexual orientation-related HPV vaccination disparities, which may be important considerations for future interventions to increase screening uptake.

Our findings do support our hypothesis about heterosexual males being less likely to be HPV vaccinated compared to their sexual minority peers. Mostly heterosexual and completely heterosexual males may not be vaccinated as frequently as gay males due to a perception, their own and/or that of their healthcare providers, of a low risk of HPV infection and subsequent complications.⁴³ While certain HPV-related diseases, such as anal cancer, are more common among those having receptive anal sex,⁴⁵ HPV infections require only skin-to-skin contact. HPV infections are so prevalent and comparable among men and women¹ that everyone, regardless of sex/gender and sexual orientation, should follow the ACIP recommendation to vaccinate at the appropriate age.

Furthermore, research shows that, compared to their gay peers, heterosexual males are less willing to receive the HPV vaccine and they report less (1) awareness of the vaccine; (2) worry about HPV-related diseases; (3) perceived effectiveness of the vaccine; and (4) anticipated regret if they declined vaccination and later developed HPV-related disease.⁴⁶ A recent study restricted to men who had sex with men identified the strongest predictor of HPV vaccination uptake as a provider recommendation.⁴⁷ Another recent study using nationally representative National Health Interview Survey data documented that heterosexual men were about half as likely to initiate and complete HPV vaccination compared to gay men.³¹ Finally, ACIP recommends that men who have sex with men get catch-up vaccination for five additional years compared to all other males, giving them more uptake opportunities.⁷

Two previous studies documenting sexual orientation disparities in HPV vaccination among girls and women used cross-sectional data from the National Survey of Family

TABLE 1. AGE-STANDARDIZED CHARACTERISTICS OF A COHORT OF FEMALES AND MALES IN THE UNITED STATES (N = 10,663)

	Females (N = 7321)					Males (N = 3342)				
	All females (N = 7321)	Completely heterosexual (N = 5782)	Mostly heterosexual (N = 1197)	Bisexual (N = 193)	Lesbian (N = 149)	All males (N = 3342)	Completely heterosexual (N = 2860)	Mostly heterosexual (N = 286)	Bisexual (N = 27)	Gay (N = 169)
Baseline ^a age, years (range: 9–16), mean (SD)	12.2 (1.9)	12.2 (1.9)	12.2 (1.9)	12.1 (1.8)	12.2 (1.8)	12.1 (1.9)	12.2 (1.9)	12.0 (1.8)	11.7 (1.5)	12.3 (1.9)
White race ^b	93.5 (6749)	94.1 (5358)	91.4 (1082)	94.1 (176)	89.9 (133)	93.1 (3083)	93.8 (2658)	90.8 (257)	92.3 (24)	86.8 (144)
Geographic region ^b										
West	16.7 (1221)	15.6 (903)	21.5 (257)	20.2 (39)	14.8 (22)	18.7 (624)	18.4 (526)	23.4 (67)	22.2 (6)	14.8 (25)
Midwest	33.3 (2431)	34.4 (1985)	29.9 (357)	26.4 (51)	25.5 (38)	34.3 (1147)	34.2 (977)	36.7 (105)	22.2 (6)	34.9 (59)
South	17.5 (1278)	17.8 (1030)	16.3 (195)	14.5 (28)	16.8 (25)	16.0 (533)	16.4 (468)	10.8 (31)	22.2 (6)	16.6 (28)
Northeast	32.6 (2382)	32.2 (1857)	32.3 (386)	38.9 (75)	43.0 (64)	31.0 (1036)	31.0 (887)	29.0 (83)	33.3 (9)	33.7 (57)
Socioeconomic position, childhood annual household income ^b										
<\$50,000	12.7 (763)	12.8 (599)	11.5 (115)	18.3 (31)	14.0 (18)	12.3 (343)	12.3 (294)	15.7 (37)	15.4 (4)	5.6 (8)
\$50,000–\$74,999	23.5 (1411)	23.8 (1116)	22.6 (227)	24.9 (42)	20.2 (26)	23.5 (654)	23.6 (563)	21.3 (50)	19.2 (5)	25.4 (36)
\$75,000–\$99,999	22.6 (1355)	23.1 (1087)	21.3 (214)	18.3 (31)	17.8 (23)	21.5 (599)	22.0 (525)	18.3 (43)	11.5 (3)	19.7 (28)
≥\$100,000	41.2 (2470)	40.3 (1895)	44.6 (448)	38.5 (65)	48.1 (62)	42.7 (1190)	42.0 (1001)	44.7 (105)	14.0 (53.9)	49.3 (70)
Outcomes										
Any HPV vaccination (1+ dose)	55.8 (4086)	55.3 (3197)	59.7 (714)	51.3 (99)	51.0 (76)	7.7 (257)	7.2 (205)	7.3 (21)	14.8 (4)	16.0 (27)
HPV vaccination doses										
None	44.5 (3235)	45.0 (2585)	40.7 (483)	49.0 (94)	49.3 (73)	92.5 (3085)	93.1 (2655)	92.7 (265)	85.2 (23)	84.0 (142)
Initiated, but not completed	5.7 (414)	5.2 (301)	7.4 (88)	7.8 (15)	6.8 (10)	2.1 (71)	1.9 (54)	2.1 (6)	3.7 (1)	5.9 (10)
Completed	49.8 (3622)	49.8 (2859)	51.9 (615)	43.2 (83)	43.9 (65)	5.4 (179)	5.1 (144)	5.2 (15)	11.1 (3)	10.1 (17)

^aGUTS 1 enrollees were 9–14 years old at their enrollment in 1996 and GUTS 2 enrollees were 9–16 years old at enrollment in 2004. Participants ranged in age from 11 to 24 years when the vaccine was approved for females in 2006 and were aged 14–27 years when the vaccine was approved for males in 2009.

^bMultiple imputation was used during analyses for any missing covariates data.

GUTS, Growing Up Today Study; HPV, human papillomavirus; SD, standard deviation.

TABLE 2. ASSOCIATION OF SEXUAL ORIENTATION IDENTITY/ATTRACTION AND HUMAN PAPILLOMAVIRUS VACCINATION IN A COHORT OF FEMALES AND MALES IN THE UNITED STATES (N = 10,663)

	Females (N = 7321)				Males (N = 3342)			
	Completely heterosexual (N = 5782)	Mostly heterosexual (N = 1197)	Bisexual (N = 193)	Lesbian (N = 149)	Completely heterosexual (N = 2860)	Mostly heterosexual (N = 286)	Bisexual (N = 27)	Gay (N = 169)
	RR ^a (95% CI)				RR ^a (95% CI)			
Any HPV vaccination (1+ dose)	1.12 (0.95–1.31)	1.20 (1.02–1.41)	1.03 (0.84–1.26)	Ref.	0.45 (0.30–0.68)	0.44 (0.25–0.78)	0.87 (0.30–2.50)	Ref.
HPV vaccination doses Initiated, but not completed	0.91 (0.50–1.68)	1.31 (0.70–2.46)	1.17 (0.55–2.49)	Ref.	0.29 (0.15–0.58)	0.29 (0.11–0.81)	0.58 (0.07–4.58)	Ref.
Completed	1.13 (0.95–1.35)	1.20 (1.01–1.44)	1.01 (0.81–1.27)	Ref.	0.52 (0.37–0.75)	0.49 (0.30–0.81)	1.02 (0.43–2.45)	Ref.

^aAdjusted for age, race, geographic region, and childhood socioeconomic position.
RR, risk ratio.

TABLE 3. ASSOCIATION OF SEX OF LIFETIME SEXUAL PARTNERS AND HUMAN PAPILLOMAVIRUS VACCINATION IN A COHORT OF FEMALES AND MALES IN THE UNITED STATES (N = 10,619)

	Females (N = 7289)				Males (N = 3330)			
	No sex partners (N = 890)	Males only (N = 6151)	Males and females (N = 120)	Females only (N = 128)	No sex partners (N = 469)	Females only (N = 2683)	Females and males (N = 25)	Males only (N = 153)
	RR ^a (95% CI)				RR ^a (95% CI)			
Any HPV vaccination (1+ dose)	1.08 (0.93–1.27)	1.08 (0.93–1.26)	1.27 (1.04–1.54)	Ref.	0.58 (0.36–0.93)	0.38 (0.25–0.56)	0.22 (0.03–1.63)	Ref.
HPV vaccination doses Initiated, but not completed	0.73 (0.41–1.30)	0.68 (0.40–1.16)	1.27 (0.61–2.63)	Ref.	0.34 (0.15–0.82)	0.24 (0.12–0.48)	0.52 (0.07–4.07)	Ref.
Completed	1.13 (0.94–1.34)	1.12 (0.95–1.33)	1.31 (1.05–1.63)	Ref.	0.69 (0.46–1.03)	0.42 (0.29–0.60)	N/A ^b	Ref.

^aAdjusted for age, race, geographic region, and childhood socioeconomic position.

^bEstimate not available due to a zero frequency in one of the cells.

Growth (NSFG). The first study²⁹ reported that 9% of lesbians and 33% of bisexual females initiated vaccination, compared to 28% of their heterosexual peers. The second study³⁰ reported the rate of HPV vaccination initiation being 6% among females with only female past-year sexual partners, compared to 27% in females with only male past-year sexual partners. Our results are not consistent with these findings. The higher prevalence of HPV vaccination observed among females in our cohort relative to those who participated in the NSFG may be due to all of our participants being the children of nurses or that, in the NSFG, participants had to report being aware of the vaccine before being prompted to report initiation.

The NSFG data were collected only through 2010 in comparison to our data, which go through 2014. Our results are consistent with the latest study using National Health Interview Survey data that show bisexual women are more likely, while heterosexual women are no more likely, compared to lesbians, to initiate vaccination.³¹ Vaccination uptake among males in our cohort, as in the National Health Interview Survey,³¹ is lower than current U.S. national averages that are available for adolescents younger than 18 years.⁶ This is likely a result of the HPV vaccine not having been approved for males when most of our participants were 11–12 years old and, instead, these males were only eligible for catch-up vaccination.

Our study was limited in that all data, including HPV vaccination, were self-reported. However, this is unlikely to introduce differential misclassification by sexual orientation; so if anything, this would attenuate any sexual orientation-related difference findings. Furthermore, the majority of participants self-identified as White (93%), which limits the generalizability of our findings to people of color, especially as research shows that knowledge,⁴⁸ healthcare provider recommendation,⁴⁹ and initiation of HPV vaccination^{50,51} differ across racial/ethnic groups.⁵² Although our results are consistent with more diverse cross-sectional samples,³¹ future longitudinal studies utilizing diverse samples are needed to generate findings that are generalizable to the U.S. population and investigate how sexual orientation and race/ethnicity simultaneously influence HPV vaccination disparities among male and female adolescents.^{53–55}

Relatedly, this study focused on sexual orientation and did not examine HPV vaccination initiation and completion by transgender identity; this represents an important study population for future HPV-related research. We also lacked data on the mechanisms driving sexual orientation disparities in HPV vaccination in this study; however we are currently collecting these data, including GUTS participant's reports of any healthcare provider recommendation and timing of vaccine doses.

Despite these limitations, we do analyze a large sample with three times as many participants as previous cross-sectional studies.^{29,30} In addition, our study is one of the first to examine simultaneously the association between different dimensions of sexual orientation (e.g., identity/attractions and behavior), with consistent results across multiple dimensions. Another strength of our approach includes having available data on both HPV vaccination initiation and completion in both females and males as recommended by the Institute of Medicine³⁷ for research on sexual minority health.

One of the strongest predictors of HPV vaccination,^{41,49,51} especially among sexual minority men⁴⁷ and women,⁵⁶ is a healthcare provider recommendation of the vaccine. There-

fore, it is essential that providers recommend this preventive service to all patients, regardless of sex/gender and sexual orientation. The potential reductions in the burden of HPV-related diseases are profound: for cervical cancer alone, it is estimated that 50,000 excess cases will occur among women alive today if we do not reach 80% vaccination.⁵⁷ It is imperative that vaccination uptake increases, including among boys and men who do not identify as gay, who are particularly underserved by current HPV vaccination efforts.

Conclusions

Additional public health efforts are needed to increase HPV vaccination in the United States, and special attention is needed to promote uptake of the vaccine among boys and men, especially those who do not identify as gay. Vaccinating all boys, regardless of their sexual orientation, will not only lower their own susceptibility but will also decrease HPV transmission to their partners, females and/or males, and help eradicate HPV through herd immunity.

Acknowledgments

Dr. Charlton was supported by Grant No. F32HD084000 and Dr. Austin by R01HD057368 and R01HD066963 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health. Additional funds were provided to Dr. Charlton by GLMA: Health Professionals Advancing LGBT Equality's Lesbian Health Fund. Dr. Reisner was partly supported by Grant No. CER-1403-12625 from the Patient-Centered Outcomes Research Institute. Everyone is listed as an author who contributed significantly to the work.

Disclaimer

An abstract of this work was presented at the Society for Pediatric and Perinatal Epidemiologic Research Annual Meeting on June 15, 2015, and at the Society for Epidemiologic Research Annual Meeting on June 17, 2015, both in Denver, Colorado.

Author Disclosure Statement

No competing financial interests exist.

References

1. Koutsky L: Epidemiology of genital human papillomavirus infection. *Am J Med* 1997;102:3–8.
2. Drolet M, Bénard É, Boily MC, et al.: Population-level impact and herd effects following human papillomavirus vaccination programmes: A systematic review and meta-analysis. *Lancet Infect Dis* 2015;15:565–580.
3. Brisson M, Bénard É, Drolet M, et al.: Population-level impact, herd immunity, and elimination after human papillomavirus vaccination: A systematic review and meta-analysis of predictions from transmission-dynamic models. *Lancet Public Health* 2016;1:e8–e17.
4. HealthyPeople.gov: IID-11.4 Increase the vaccination coverage level of 3 doses of human papillomavirus (HPV) vaccine for females by age 13 to 15 years. Data Details. Washington, DC, U.S. Department of Health and Human Services. Last updated November 7, 2016. Available at www.healthypeople.gov/node/4657/data_details Accessed January 1, 2016.

5. HealthyPeople.gov: IID-11.5 Increase the vaccination coverage level of 3 doses of human papillomavirus (HPV) vaccine for males by age 13 to 15 years. Data Details. Washington, DC, U.S. Department of Health and Human Services. Last updated November 7, 2016. Available at www.healthypeople.gov/node/10676/data_details Accessed January 1, 2016.
6. Reagan-Steiner S, Yankey D, Jeyarajah J, et al.: National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years—United States, 2014. *MMWR Morb Mortal Wkly Rep* 2015;64:784–792.
7. Markowitz LE, Dunne EF, Saraiya M, et al.: Human papillomavirus vaccination: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2014;63(RR-05):1–30.
8. Charlton BM, Corliss HL, Missmer SA, et al.: Reproductive health screening disparities and sexual orientation in a cohort study of U.S. adolescent and young adult females. *J Adolesc Health* 2011;49:505–510.
9. Mercer CH, Bailey JV, Johnson AM, et al.: Women who report having sex with women: British national probability data on prevalence, sexual behaviors, and health outcomes. *Am J Public Health* 2007;97:1126–1133.
10. Saewyc EM, Poon CS, Homma Y, Skay CL: Stigma management? The links between enacted stigma and teen pregnancy trends among gay, lesbian, and bisexual students in British Columbia. *Can J Hum Sex* 2008;17:123–139.
11. Tornello SL, Riskind RG, Patterson CJ: Sexual orientation and sexual and reproductive health among adolescent young women in the United States. *J Adolesc Health* 2014;54:160–168.
12. McCauley HL, Silverman JG, Decker MR, et al.: Sexual and reproductive health indicators and intimate partner violence victimization among female family planning clinic patients who have sex with women and men. *J Womens Health (Larchmt)* 2015;24:621–628.
13. Charlton BM, Corliss HL, Missmer SA, et al.: Influence of hormonal contraceptive use and health beliefs on sexual orientation disparities in Papanicolaou test use. *Am J Public Health* 2014;104:319–325.
14. Tracy JK, Schluterman NH, Greenberg DR: Understanding cervical cancer screening among lesbians: A national survey. *BMC Public Health* 2013;13:442.
15. Moegelin L, Nilsson B, Helström L: Reproductive health in lesbian and bisexual women in Sweden. *Acta Obstet Gynecol Scand* 2010;89:205–209.
16. Marrazzo JM: Genital human papillomavirus infection in women who have sex with women: A concern for patients and providers. *AIDS Patient Care STDS* 2000;14:447–451.
17. Cochran S, Mays V, Bowen D, et al.: Cancer-related risk indicators and preventive screening behaviors among lesbians and bisexual women. *Am J Public Health* 2001;91:591–597.
18. Diamant AL, Wold C, Spritzer K, Gelberg L: Health behaviors, health status, and access to and use of health care: A population-based study of lesbian, bisexual, and heterosexual women. *Arch Fam Med* 2000;9:1043–1051.
19. Kerker BD, Mostashari F, Thorpe L: Health care access and utilization among women who have sex with women: Sexual behavior and identity. *J Urban Health* 2006;83:970–979.
20. Agénor M, Krieger N, Austin SB, et al.: Sexual orientation disparities in Papanicolaou test use among US women: The role of sexual and reproductive health services. *Am J Public Health* 2014;104:e68–e73.
21. Roberts SJ, Patsdaughter CA, Grindel CG, Tarmina MS: Health related behaviors and cancer screening of lesbians: Results of the Boston Lesbian Health Project II. *Women Health* 2004;39:41–55.
22. Bowen DJ, Bradford JB, Powers D, et al.: Comparing women of differing sexual orientations using population-based sampling. *Women Health* 2004;40:19–34.
23. Ben-Natan M, Adir O: Screening for cervical cancer among Israeli lesbian women. *Int Nurs Rev* 2009;56:433–441.
24. O'Hanlan KA, Crum CP: Human papillomavirus-associated cervical intraepithelial neoplasia following lesbian sex. *Obstet Gynecol* 1996;88(4 Pt 2):702–703.
25. Price JH, Easton AN, Telljohann SK, Wallace PB: Perceptions of cervical cancer and Pap smear screening behavior by women's sexual orientation. *J Community Health* 1996;21:89–105.
26. Diamant AL, Schuster MA, Lever J: Receipt of preventive health care services by lesbians. *Am J Prev Med* 2000;19:141–148.
27. Ben-Natan M, Maor S: Factors related to Israeli lesbian women's intention to be vaccinated against human papillomavirus. *Int J STD AIDS* 2014;25:800–805.
28. Pelullo CP, Di Giuseppe G, Angelillo IF: Human papillomavirus infection: Knowledge, attitudes, and behaviors among lesbian, gay men, and bisexual in Italy. *PLoS One* 2012;7:e42856.
29. Agénor M, Peitzmeier S, Gordon AR, et al.: Sexual orientation identity disparities in awareness and initiation of the human papillomavirus vaccine among U.S. women and girls: A national survey. *Ann Intern Med* 2015;163:99–106.
30. Agénor M, McCauley HL, Peitzmeier SM, et al.: Sex of sexual partners and human papillomavirus vaccination among U.S. girls and women. *Am J Prev Med* 2016;50:318–327.
31. Agénor M, Peitzmeier SM, Gordon AR, et al.: Sexual orientation identity disparities in human papillomavirus vaccination initiation and completion among young adult US women and men. *Cancer Causes Control* 2016;27:1187–1196.
32. Field AE, Camargo CA Jr, Taylor CB, et al.: Overweight, weight concerns, and bulimic behaviors among girls and boys. *J Am Acad Child Adolesc Psychiatry* 1999;38:754–760.
33. Remafedi G, Resnick M, Blum R, Harris L: Demography of sexual orientation in adolescents. *Pediatrics* 1992;89(4 Pt 2):714–721.
34. Saewyc EM, Bauer GR, Skay CL, et al.: Measuring sexual orientation in adolescent health surveys: Evaluation of eight school-based surveys. *J Adolesc Health* 2004;35:345.e1–e15.
35. Sexual Minority Assessment Research Team (SMART): *Best Practices for Asking Questions About Sexual Orientation on Surveys*. Los Angeles CA: The Williams Institute, 2009.
36. Rosario M, Meyer-Bahlburg HFL, Hunter J, et al.: The psychosexual development of urban lesbian, gay, and bisexual youths. *J Sex Res* 1996;33:113–126.
37. Institute of Medicine (US) Committee on Lesbian, Gay, Bisexual, and Transgender Health Issues and Research Gaps and Opportunities. *The Health of Lesbian, Gay, Bisexual, and Transgender People: Building a Foundation for Better Understanding*. Washington, DC: National Academies Press, 2011.
38. Fitzmaurice GM, Laird NM, Ware JH: Applied longitudinal analysis. In: *Wiley Series in Probability and Statistics*. Hoboken, NJ: Wiley-Interscience, 2004, p xix, 506.
39. Zeger SL, Liang KY: Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986;42:121–130.

40. Reiter PL, McRee AL, Kadis JA, Brewer NT: HPV vaccine and adolescent males. *Vaccine* 2011;29:5595–5602.
41. Reiter PL, Gilkey MB, Brewer NT: HPV vaccination among adolescent males: Results from the National Immunization Survey-Teen. *Vaccine* 2013;31:2816–2821.
42. Zimet GD, Rosenthal SL: HPV vaccine and males: Issues and challenges. *Gynecol Oncol* 2010;117(2 Suppl):S26–S31.
43. Brewer NT, Ng TW, McRee AL, Reiter PL: Men's beliefs about HPV-related disease. *J Behav Med* 2010;33:274–281.
44. Malo TL, Giuliano AR, Kahn JA, et al.: Physicians' human papillomavirus vaccine recommendations in the context of permissive guidelines for male patients: A national study. *Cancer Epidemiol Biomarkers Prev* 2013;18:1199–1216.
45. Palefsky J: Human papillomavirus and anal neoplasia. *Curr HIV/AIDS Rep* 2008;5:78–85.
46. Gilbert P, Brewer NT, Reiter PL, et al.: HPV vaccine acceptability in heterosexual, gay, and bisexual men. *Am J Mens Health* 2011;5:297–305.
47. Gerend MA, Madkins K, Phillips G, Mustanski B: Predictors of human papillomavirus vaccination among young men who have sex with men. *Sex Transm Dis* 2016;43:185–191.
48. Gelman A, Nikolajski C, Schwarz EB, Borrero S: Racial disparities in awareness of the human papillomavirus. *J Womens Health (Larchmt)* 2011;20:1165–1173.
49. Ylitalo KR, Lee H, Mehta NK: Health care provider recommendation, human papillomavirus vaccination, and race/ethnicity in the US National Immunization Survey. *Am J Public Health* 2013;103:164–169.
50. Kester LM, Zimet GD, Fortenberry JD, et al.: A national study of HPV vaccination of adolescent girls: Rates, predictors, and reasons for non-vaccination. *Matern Child Health J* 2013;17:879–885.
51. Bednarczyk RA, Birkhead GS, Morse DL, et al.: Human papillomavirus vaccine uptake and barriers: Association with perceived risk, actual risk and race/ethnicity among female students at a New York State university, 2010. *Vaccine* 2011;29:3138–3143.
52. Daley EM, Marhefka S, Buhi E, et al.: Ethnic and racial differences in HPV knowledge and vaccine intentions among men receiving HPV test results. *Vaccine* 2011;29:4013–4018.
53. Bowleg L: The problem with the phrase “women” and “minorities”: Intersectionality—An important theoretical framework for public health. *Am J Public Health* 2012;102:1267–1273.
54. Agénor M, Krieger N, Austin SB, et al.: At the intersection of sexual orientation, race/ethnicity, and cervical cancer screening: Assessing Pap test use disparities by sex of sexual partners among black, Latina, and white U.S. women. *Soc Sci Med* 2014;116:110–118.
55. Agénor M, Austin SB, Kort D, et al.: Sexual orientation and sexual and reproductive health among African American sexual minority women in the U.S. south. *Womens Health Issues* 2016;26:612–621.
56. McRee AL, Katz ML, Paskett ED, Reiter PL: HPV vaccination among lesbian and bisexual women: Findings from a national survey of young adults. *Vaccine* 2014;32:4736–4742.
57. Markowitz LE, Hariri S, Lin C, et al.: Reduction in human papillomavirus (HPV) prevalence among young women following HPV vaccine introduction in the United States, National Health and Nutrition Examination Surveys, 2003–2010. *J Infect Dis* 2013;208:385–393.

Address correspondence to:

Brittany M. Charlton, ScD

Division of Adolescent/Young Adult Medicine

Boston Children's Hospital

300 Longwood Avenue

Boston, MA 02115

E-mail: bcharlton@mail.harvard.edu