# Community-Based Interventions for HPV Vaccination

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## Overview/Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection in the USA [1]. Spread through intimate skin-to-skin contact [2], more than 40 HPV types can infect human anogenital regions and mouths and throats of people through vaginal, anal, and oral sex [3]. Sexually transmitted HPV types are categorized as either low-risk or high-risk [2, 4]. Low-risk HPV types (e.g., HPV types 6, 11, 26, 40, 42, 53, 54, 55, 57, 66, 73, 82, 83, 84, 73) can cause anogenital warts and recurrent respiratory papillomatosis, whereas high-risk HPV types (e.g., HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68) can lead to multiple types of cancers in humans [4]. The majority of HPV-related cancers are attributed to high-risk HPV

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types 16 and 18; [5] and globally by region, the two most common HPV types are types 16 and 18 [2].

Most sexually active people will be infected with at least one HPV type at some point in their lifetime [2]. The majority of individuals are infected with HPV during or shortly after their initial sexual experience [1]. Most HPV infections are asymptomatic and resolve on their own within 2 years [2]. However, in some individuals, high-risk HPV infections persist and over the course of years can develop into oropharyngeal and anal cancers regardless of gender or biological sex at birth, penile cancer among those born male, and cervical, vaginal, and vulvar cancers among those born female [2].

In the USA, approximately 34,800 cancer cases each year are caused by HPV infections [6]. From 2012 to 2016 in the USA, 91% cases of cervical cancers and 91% of anal cancers were caused by high-risk HPV types [6]. Furthermore, most vaginal (75%), oropharyngeal (71%), vulvar (69%), and penile cancers (63%) diagnosed in the USA between 2012 and 2016 were also caused by infections from high-risk HPV types [6]. Importantly, marked disparities in HPV prevalence and/or HPV-related cancers exist based on geography, rurality, gender, race/ethnicity, and sexual and gender minority status [7–9]. HPV vaccination has the potential to significantly address HPV-related cancer incidence, mortality, and disparities.

Three vaccines against HPV infection have been licensed by the US Food and Drug Administration (FDA) [10]. The bivalent vaccine (2vHPV), which prevents HPV types 16 and 18, was approved in 2009 for females ages 10–25 initially [11] and subsequently extended to include 9-year-old females [11]. The quadrivalent vaccine (4vHPV) was approved for females ages 9–26 in 2006 [12] and males ages 9–26 in 2009 [13] and guards against HPV types 6, 11, 16, and 18. The nine-valent vaccine (9vHPV), which protect against HPV types 6, 11, 16, 18, 31, 33, 45, 52, and 58, was approved in 2014 for females ages 9–26 and males ages 9–15 years [14]. Approval of the 9vHPV vaccine was later extended to include males ages 16–26 years [15]. In October 2018, the FDA further extended its approval of the 9vHPV vaccine to those ages 27–45 [16]. Since 2016, only the nine-valent vaccine has been utilized in the USA [17]. Approximately 92% of HPV-related cancers in the USA each year are caused by one of the HPV types for which the 9vHPV vaccine offers protection; thus, more than 32,000 HPV-attributed cancers in the USA could be prevented each year if those ages 9–26 years received the HPV vaccine [6].

The US Advisory Committee on Immunization Practices (ACIP) has issued recommendations related to both adolescent and adult HPV vaccine administration [10]. ACIP recommendations have included routine vaccination for 11- and 12-year-old females and males since 2006 and 2011, respectively [18]. The HPV vaccine is recommended during early adolescence due to the strong immune response experienced among young adolescents as well as decreased likelihood that adolescents have prior exposure to HPV (i.e., vaccination is most effective when given prior to sexual debut) [18]. ACIP recommendations have stated that the vaccine can be administered starting at age 9 [18]. Current ACIP recommendations state that individuals who have not previously completed the HPV

vaccine series are recommended to receive the vaccine through age 26 [18]. Among those aged 27–45 years, in June 2019, ACIP recommended shared clinical decision-making to consider benefits and limitations of vaccination in an age group where the majority will have had prior exposure to HPV [18]. Since 2016, ACIP recommendations have stated that individuals ages 9–14 receive two doses of the HPV vaccine, while individuals ages 15 years and older and those who are immunocompromised receive three doses [19].

Overall, US HPV vaccination rates have been trending upward among both adolescents and young adults (AYA) [10, 20]. HPV vaccine rates from the 2018 National Immunization Survey-Teen (NIS-Teen)—the most recent year for which data were available at the time of writing—were 68.1% for series initiation (at least one dose) of the HPV vaccine series and 51.1% for series completion (up-to-date on all recommended doses) among adolescents ages 13–17 years [21]. Like other adolescent vaccinations, HPV vaccination requires parental consent under the age of 18 years. However, it is notable that HPV vaccination receipt rates trail uptake rates for other adolescent vaccinations; rates of one or more doses of a meningococcal vaccine (MenACWY) was 86.6% and uptake of tetanus and reduced diphtheria toxoids and acellular pertussis vaccine (Tdap) was 88.9% in 2018 [21]. Among adults ages 18–26 years, HPV vaccine rates from the 2018 National Health Interview Survey (NHIS)—the most recent year for which data were available at the time of writing—were 39.9% for series initiation and 21.5% for series completion [20]. However, HPV vaccination initiation and completion rates vary across multiple factors, including geography (e.g., region, state, rural) and sociodemographic factors (e.g., biological sex, ethnicity, health insurance status) [21]. For instance, in 2018, Rhode Island had the highest HPV rate of teens ages 13–17 years receiving one or more HPV vaccine doses in the USA (89.3%), whereas Mississippi had the lowest rate of teens ages 13–17 years receiving one or more HPV vaccine doses (51.7%) [22]. Of note, as of 2019, Rhode Island was one of four locations in the USA with an HPV vaccine school entry requirement; the other locations are Virginia (females only), Puerto Rico, and Washington D.C. [23]. In 2020, an HPV vaccine school entry requirement rule will go into effect in Hawaii [24]. In addition, males have historically had lower initiation and completion rates compared to females, due in part to the delay in approval of the vaccine for males [20, 21]. Racial and ethnic minority adolescents are more likely to initiate the vaccine series but less likely to complete the series compared to non-Hispanic Whites [25]. Non-Hispanic White adults are more likely than Hispanic adults to have initiated the HPV vaccine series [20]. Variability in HPV vaccination series initiation and completion related to rural, medically underserved, and sexual and gender minority populations will be further described in subsequent sections of the current chapter, followed by a discussion of novel intervention settings to address the need for innovative strategies to increase HPV vaccine series initiation and completion.

## HPV Vaccination Among Individuals Living in Rural Communities

### *Rural vs. Urban HPV Vaccination Rates*

Rural geographic disparities in HPV vaccine coverage have persisted since the introduction of the vaccine, with lower vaccination in rural areas compared to urban and/or suburban areas, regardless of the definition of rurality used. Early studies examining HPV vaccine series initiation among females in 2006–2008, the first few years after approval for females, found significantly lower rates of initiation among girls living in rural areas compared to urban areas, based on data from self-reported surveys and Medicaid claims [26, 27]. In the first year after approval of the vaccine for males, 2011 NIS-Teen data indicated low rates for both female and male adolescents, with highest initiation (≥ 1 dose) for those living in mostly urban areas (56.9% among females; 10.3% among males), followed by suburban areas (53.1% among females; 7.2% among males), and then lowest in mostly rural areas (43.1% among females; 6.4% among males) [28]. Multiple studies detected the same pattern for adolescents in subsequent years [29–31].

According to 2018 NIS-Teen data, the HPV vaccination coverage rates for adolescents reaffirmed the pattern of lower coverage with decreasing levels of urbanicity, both for series initiation (71.9% mostly urban, 66.6% suburban, 59.5% mostly rural) and completion (56.1% mostly urban, 49.1% suburban, 40.7% mostly rural) [21]. An in-depth characterization of adolescents stratified by these three metropolitan statistical area categories found that the urban-to-rural gradient pattern was consistent across all subgroups for age, gender, immigration status, and US region [32]. The pattern was also consistent for non-Hispanic Whites and Hispanics of any race; however, for non-Hispanic Blacks, there was no difference between mostly urban and suburban residents, and the difference between mostly urban and mostly rural was not significant, potentially due to a small sample size in NIS-Teen for Blacks living in mostly rural areas.

### *Unique Challenges, Barriers, and Facilitators for Rural Populations*

Rural populations experience a number of structural, system-level barriers to accessing healthcare, such as long distance to care, lack of public transportation, shortage of healthcare providers and facilities, and limited broadband internet access [33, 34]. After accessing care, rural patients are more likely to experience provider-level barriers, such as lack of provider recommendation for HPV vaccine [35, 36] and poor-quality provider communication [37]. In 2011 NIS-Teen, rural parents were less likely than urban or suburban parents to report having a collaborative conversation with their healthcare provider about HPV vaccination, and this communication difference significantly explained, or mediated, the rural versus urban/suburban disparity in HPV vaccination rates [37].

At the individual level, rural residents delay care more often due to higher rates of poverty and unemployment, and low levels of HPV-specific knowledge compared to urban and suburban residents, as well as health beliefs [33, 36, 38–41]. An analysis of data from the 2013 to 2017 Health Information National Trends Survey (HINTS) found that rural adults were less likely than urban adults to be aware of HPV and HPV vaccine, and they were less likely to know that HPV is a sexually transmitted infection and that it causes cervical cancer [42]. Certain parental health beliefs associated with greater HPV vaccine hesitancy in rural areas include concerns about vaccine safety, beliefs that the vaccine is not necessary or that one's child is not at risk, and general fatalistic health beliefs [39, 43–46].

## *Interventions to Address Rural Disparities in HPV Vaccine Initiation and Completion*

A limited number of interventions have been developed and tested that specifically target the unique barriers to HPV vaccination experienced by rural populations, as described below.

***School-Based Interventions*** In 2012–2013, Vanderpool and colleagues tested a school-based intervention in two high schools located in a rural county in south-central Kentucky, developed in partnership with the local public health department [47]. The school nurses utilized multiple communication channels to inform parents/students of the opportunity to receive the HPV vaccine at school after completing the required consent form as well as promotional incentives for participation. Nurses implemented grade-specific immunization clinics on site during the school day. Free vaccines were provided to all interested students with consent forms, either through the federal Vaccines for Children (VFC) program or covered by the project, since the nurses could not bill private insurance companies. The intervention resulted in improvements in the schools' HPV vaccine initiation rate from 24% to 57% and the completion rate from 14% to 45%.

***Economic Incentives for Adult Women*** Cost is a substantial barrier to HPV vaccination for adults ages 18 and older since they do not qualify for free vaccines under the federal VFC program. Vanderpool and colleagues assessed rural-urban differences in the effect of removing the cost barrier for young adult women [48, 49]. In 2007–2009, the team enrolled and provided free HPV vaccine vouchers to 706 women in three clinic settings in eastern Kentucky. They observed significantly higher series initiation in the urban university clinic (50.7%) compared to a rural clinic (45.1%) and a rural community college clinic (6.8%).

***Multilevel Interventions*** In 2009, an academic-community partnership in North Carolina developed a theory-based, social culturally targeted marketing campaign for rural mothers of girls ages 11–12, as well as their healthcare providers and the media as important behavior influencers [50]. The team tested the multilevel, community-wide campaign in four rural counties, distributing materials via public

and private health clinics and via a variety of community venues. High engagement of the healthcare providers, organizations, and mothers was documented. However, the study produced mixed results. Two of the four intervention counties experienced a modest increase in HPV vaccine initiation rates at 2% points above the trend observed in control counties, while the other two counties did not improve.

Another study in North Carolina assessed a multilevel, community-wide intervention in one rural county, compared to four control counties for 12 months during 2012–2013 [51]. The two-phase intervention included the following: (1) *Phase 1* (practice-/provider-level) which is a 1-hour provider/staff education session about implementing immunization registry-driven recall with postcard reminders, optional web-based registry trainings, pre-printed postcards and posters, financial incentives for sending reminders (up to $1000), and coaching phone calls every 2 weeks and (2) *Phase 2* (school-level) which is nontargeted school-generated telephone reminders sent from school to parents of adolescents. The study resulted in significant improvements in population-level HPV initiation and completion rates for adolescents, with the largest improvements among 11- and 12-year-olds (series initiation improvement of 14.2–32.1% for boys and 27.4–43.4 for girls).

In 2010–2015, an academic-community partnership designed a multilevel intervention that was culturally targeted for predominantly rural counties in the Appalachian region of Ohio [52, 53]. The intervention components included clinic-level promotion of HPV vaccine educational materials; a 1-hour provider-level training session; and parent-level education delivered via a mailed brochure, DVD video, magnet reminder, and a telephone educational session. A group-randomized trial in 24 clinics across 12 counties demonstrated that the intervention resulted in a small but significant increase in HPV vaccination series initiation by 6 months among the enrolled patients who were not vaccinated at baseline compared to the control group (13.1% versus 6.5%, respectively).

## HPV Vaccination Among Medically Underserved Individuals and Those of Limited Financial Resources

### *HPV Vaccine Initiation and Completion Among Medically Underserved Individuals and Those of Limited Financial Resources*

Individuals are defined as being part of a medically underserved population if there is “a shortage of providers for a specific group of people within a defined geographic area.” [54] Commonly cited medically underserved populations include those who are Medicaid-eligible, low income, migrant farm workers, homeless, and Native Americans [54]. Among medically underserved adolescents (i.e., individuals receiving care at federally qualified health centers (FQHC), safety net clinics, or funded by Medicaid), HPV vaccine initiation estimates, without intervention, vary

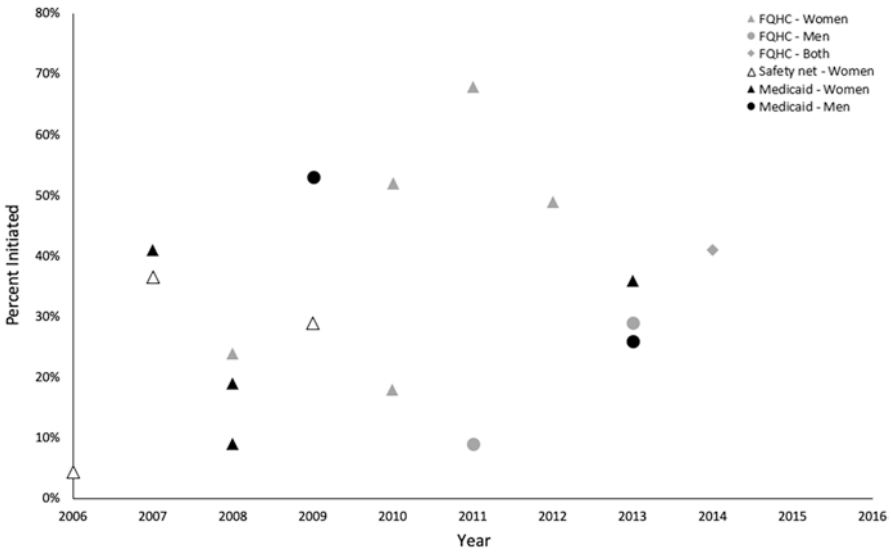


**Fig. 1** HPV vaccine initiation among adolescents and young adults from 2006 to 2016

widely across studies and show a general pattern of increasing prevalence over time (Fig. 1) [27, 55–69]. HPV vaccine initiation estimates range from a low of 4.5% among 10- to 26-year-old females attending a Kansas City safety net center between 2006 and 2009 to a high of 68% among 11- to 21-year-old females attending an urban academic health center or seven affiliated FQHCs in 2011 [58, 63]. One study in 2014 found that 41% of females and males receiving care in FQHC settings initiated the HPV vaccine. [62] Compared to Medicaid and safety net populations, FQHCs have the highest HPV vaccine initiation estimates with four studies showing initiation rates at 50% or higher [57–59]. Within safety net clinics, three studies examined HPV vaccine initiation: all three included only girls and were conducted in 2009 or earlier [63–65]. While most studies included adolescents as young as 9, 10, or 11 years, one study considered only adults ages 21 to 29 years in FQHCs between 2009 and 2013 and found initiation was approximately 4% [70].

Studies of HPV vaccine series completion among medically underserved adolescents show no discernable pattern over time, between types of medical services received, or by gender (Fig. 2) [55–59, 61, 63–67, 71]. It is clear that completion rates remain below 50%. The most recent study (conducted in 2017–2018) within an FQHC found that 46% of 9- to 26-year-olds completed the recommended doses [61]. Similar baseline completion rates were found among women in eight FQHC practices in 2011 (42%) and females in four safety net clinics in 2007–2009 (among those who initiated, 40% completed the vaccine series) [58, 64]. Very low completion rates were also found across time: 2% among females ages 10 to 26 years from 2006 to 2009, 2% among Medicaid enrolled females ages 11 to 18 years in June 2008, and 1% among 11- to 21-year-old boys attending an urban academic health center or seven affiliated FQHCs in 2011 [58, 63, 67].

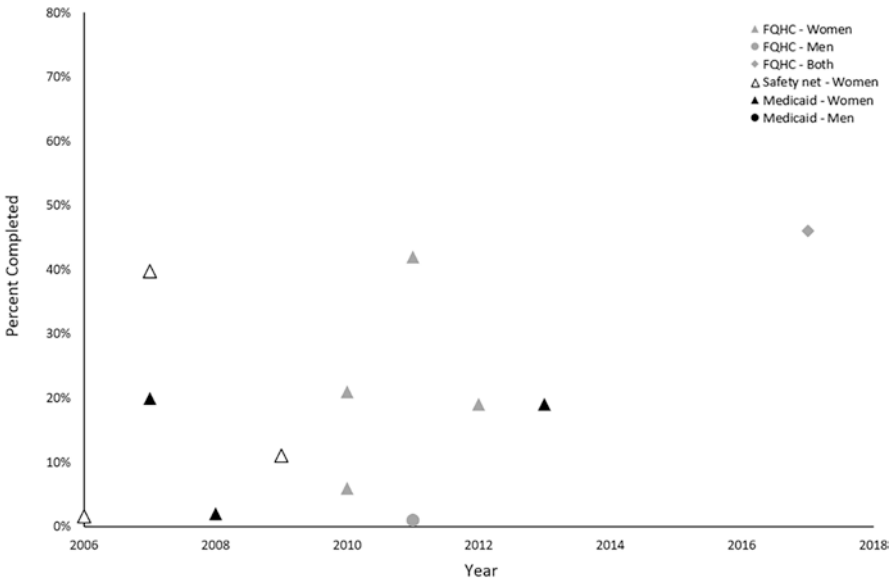


**Fig. 2** HPV vaccine completion among adolescents and young adults from 2006 to 2018

## *Barriers and Facilitators to HPV Vaccination Among Medically Underserved Individuals and Those of Limited Financial Resources*

Similar to the general population, physician recommendation, increased age, and receipt of other adolescent vaccines are common facilitators of HPV vaccination among medically underserved AYAs [56, 59–61, 65, 72, 73]. Within FQHC and Medicaid populations, the most commonly identified and strongly associated facilitator of HPV vaccination was physician discussion and recommendation of the vaccine [56, 59–61, 72]. For instance, in a study of Latina mothers with a daughter between the ages of 9 and 18 attending an FQHC, after adjusting for age, mother's education, interview language, acculturation, and HPV vaccine knowledge, a physician recommendation was associated with a 493 times increased odds of HPV vaccine initiation [56]. Older age is also associated with an increased percentage of adolescents receiving the HPV vaccine [56, 59, 60, 65, 73]. However, adolescents who initiated the series at a younger rather than older age were more likely to complete the series [55, 74]. Finally, adolescents who received the other recommended vaccines for their age, especially the non-school entry required meningococcal conjugate vaccine, had higher rates of HPV vaccine receipt [58, 64].

Medically underserved adolescents are also eligible for programs providing access to affordable vaccines that can serve as facilitators of HPV vaccination. Two mechanisms provide access to vaccines for low-income adolescents: availability of

the federal universal vaccine coverage program (VFC) and participation in certain health insurance plans. States can leverage the VFC program to offer vaccines recommended by the ACIP at no cost to individuals who are 18 years of age and younger universally or only those who are Medicaid-eligible, uninsured, underinsured, or American Indian or Alaskan Native [75, 76]. Underinsured individuals have to receive vaccines at FQHCs or rural health clinics to qualify for no cost vaccinations given by a VFC provider. HPV vaccination rates are higher among providers who participate in VFC and in states that expanded VFC eligibility to all children [77, 78].

Health insurance influences HPV vaccine initiation and completion within medically underserved individuals at several levels. First, compared to those who are uninsured, insured individuals, regardless of whether through Medicaid or private insurance, are more likely to initiate the HPV vaccine [55, 70]. Among insured 11- to 18-year-old males, compared to privately insured, those with Medicaid insurance were more likely to initiate the vaccine but less likely to complete the series [68, 79]. Finally, among adolescents with Medicaid insurance, participation in different plans influences rates of vaccine initiation and completion [27, 74].

Barriers to HPV vaccination among medically underserved populations are both similar and distinct from the general population. Like the general population, parents' lack of awareness of the HPV vaccine, especially among parents of boys, can be a barrier to initiation for patients in safety net and FQHC populations [60, 65]. Practical barriers may be more important among medically underserved populations as some parents attending FQHCs worry about the cost of the vaccine and/or have competing demands of work or child care [56, 80]. Adolescent girls from households where the household income was less than 100% of the federal poverty level have been found to be less likely to complete the HPV vaccine series [55].

## *Interventions to Increase HPV Vaccination Among Medically Underserved Individuals and Those of Limited Financial Resources*

Nine interventions have been conducted to increase HPV vaccination rates among medically underserved populations (Table 1) [57, 58, 62, 69, 73, 81–84]. Three interventions were conducted within each population of interest (i.e., FQHC, safety net, and Medicaid). Interventions have targeted parents ($n = 4$), providers ($n = 2$), parents and providers simultaneously ($n = 2$), and providers and clinics ($n = 1$). Interventions aimed to increase parents' decision to vaccinate ($n = 1$), initiation ($n = 3$), receipt of dose two or three ($n = 1$), and initiation and completion ($n = 4$). Among the nine interventions, seven showed evidence of intervention effectiveness.

**Table 1** HPV vaccine interventions among medically underserved adolescents and young adults

| First author | Years of study | Underserved type | Population | Intervention | Outcome | Effect |
|---|---|---|---|---|---|---|
| *Parent-level interventions* | | | | | | |
| Baldwin [81] | 2013 | Safety net | 11- to 17-year-olds | Self-persuasion tasks on a tablet | Parents' decision stage | 81.8% (27/33) wanted child vaccinated after intervention |
| Rand [82] | 2013–2014 | Medicaid | 11- to 16-year-olds | HPV vs. general text message | Initiation | 30% increase |
| Richman [83] | 2014–2016 | Medicaid and uninsured | 9- to 17-year-olds | Text or email reminders vs. postcard | Receipt of dose 2 and 3 | No difference |
| Tiro [73] | 2011 | Safety net | Females 11- to 18-year-olds | Vaccine vs. HPV brochure, calls to declined parents, recalls for overdue | Initiation, dose 2, and dose 3 | Initiation increased among Hispanics only (AOR 1.43; 95% CI 1.02–2.02)<br>Recalls were effective for 3-dose completion (AOR 1.99; 95% CI 1.16–3.45), regardless of race/ethnicity |
| *Provider-level interventions* | | | | | | |
| Moss [57] | 2010 | FQHC | Females 12- to 17-years-old | Webinar with CDC's AFIX | 1-month initiation and completion | 1.6% increase in initiation ($p < 0.05$)<br>1% increase in completion ($p < 0.01$) |
| Perkins [58] | 2011–2013 | FQHC | 11- to 21-year-olds | Monthly meetings with HPV-focused education, audit/feedback, maintenance of certification part IV credit | Initiation and next needed dose completion | Initiation increased: girls OR 1.6, boys OR 11; $p < 0.001$ for both<br>Next needed dose increased: girls OR 1.4, boys OR 23; $p < 0.05$ for both |

**Table 1** (continued)

| First author | Years of study | Underserved type | Population | Intervention | Outcome | Effect |
|---|---|---|---|---|---|---|
| *Multilevel interventions* | | | | | | |
| Sanderson [84] | 2013–2015 | Safety net | Black or Hispanic aged 9–18 years | Parent education video and flyer<br>Provider and staff training | Initiation and completion | No difference |
| Staras [69] | 2013 | Medicaid and Children's Health Insurance Program | 11- to 17-year-olds | Postcards sent to parents<br>Provider tablet-based prompt | Initiation | Increases with interventions<br>Postcards (girls AOR =1.6; 95% CI 1.1–2.3)<br>Tablet (girls, AOR = 1.5; 95% CI 1.0–2.3 and boys, AOR = 1.4; 95% CI 1.0–2.0)<br>Postcard and tablet (girls, AOR = 2.4; 95% CI 1.4–4.3 and boys, AOR = 1.6; 95% CI 1.0–2.5) |
| Fisher-Borne [62] | 2014–2015 | FQHC | 11- to 12-year-olds | Provider education and recommendation training<br>Clinic-level audit feedback<br>Money for EHR modifications (randomized to technical assistance, $10,000 3-month grant, or $90,000 2-year grant). | Pre-post initiation | 14.6 percentage point increase<br>Driven by 18.4% increase in $90,000 group |

*AOR* adjusted odds ratio, *OR* odds ratio, *CDC* Centers for Disease Control and Prevention, *FQHC* federally qualified health center, *EHR* electronic health records

## HPV Vaccination Among Individuals from Racial/Ethnic Minority Groups and/or Individuals Born Outside of the USA

### *HPV Vaccination Rates Among Racial/Ethnic Minority Groups and/or Individuals Born Outside of the USA*

Compared to non-Hispanic Whites, racial/ethnic minority groups have demonstrated differences in HPV vaccination initiation versus completion. A systematic review indicated that Black and Hispanic adolescents were more likely to have initiated the HPV vaccine series compared to non-Hispanic White adolescents when studies were restricted to provider-verified vaccinations [25]. Despite higher vaccination initiation rates, rates of receiving subsequent doses remain significantly lower among Black and Hispanics, as compared to Whites, with disparities in vaccination completion greater among Blacks than Hispanics [25].

### *Unique Challenges, Barriers, and Facilitators for Racial/Ethnic Minority Groups and/or Individuals Born Outside of the USA*

Several factors may influence vaccine initiation and completion rates among racial/ethnic minority groups such as differences across groups in foreign-born status, socioeconomic status, insurance coverage, healthcare access, and provider recommendation. Knowledge may also play a role in HPV vaccination among individuals from these racial/ethnic subgroups. Higher levels of knowledge about Pap testing, HPV infection, and vaccination among African American women have been associated with greater likelihood of HPV vaccination [85]. In a 2015 study, mothers of Latina, Chinese, Korean, and Black adolescent girls from low-income households, most of whom were foreign-born, had relatively low awareness of HPV and the HPV vaccine [86]. In the large, nationally representative 2013–2014 HINTS survey, non-Hispanic Black and Hispanic men and women were less likely to have heard of HPV and the HPV vaccine than non-Hispanic Whites [87]. In another study, compared to non-Hispanic White women, Black women demonstrated lower knowledge about HPV transmission and lower awareness of the HPV vaccine, but greater awareness of the link between HPV infection and cervical cancer compared to non-Hispanic White women [88]. Parents of non-Hispanic Black and Hispanic adolescents and racial/ethnic minority adolescents are significantly less likely to receive a recommendation for the HPV vaccine compared to parents of non-Hispanic White patients or non-Hispanic White patients [89, 90]. Although recommendation rates have improved among these racial/ethnic groups over time, the rate of increase in vaccine recommendation for Hispanic males ages 13–17 has remained low [91]. A systematic review conducted in 2020 identified three primary themes of barriers of vaccination among racial/ethnic minority groups when compared to non-Hispanic Whites [92]. Themes identified in articles published from July 2010 through July

2020 included differences in (1) provider recommendation and differences in patient/parent HPV/HPV vaccine knowledge and awareness, (2) mistrust in the healthcare system as well as HPV vaccine safety concerns, and (3) religious and cultural beliefs, especially among those born outside of the USA [92].

Foreign-born status may also influence disparities in HPV vaccination. In the 2011–2015 NHIS sample, 18–31-year-old foreign-born Asian and Latina women were less likely to initiate the HPV vaccine series compared to foreign-born White women, and foreign-born White, Black, Asian, and Latina women were also less likely to initiate the series than US-born White women [93]. Similarly, in 2013–2015 NHIS data of 18–35-year-old women, all foreign-born women were less likely to initiate vaccination compared with US-born women (14% vs. 30%, respectively) [94]. That same study found that foreign-born women with US citizenship status were more likely to initiate the HPV vaccine series compared to non-citizens [94]. Among young adults, vaccine initiation is often associated with having a usual source of care, OB/GYN provider, or previously receiving a Pap test, regardless of region of birth [94]. However, foreign-born women are often more likely to experience barriers related to health insurance coverage and access to care, which may account for some differences in vaccination initiation and completion among women in the AYA group [93, 94].

Trust in one's provider and the healthcare system may also play an important role in HPV vaccination among racial/ethnic minorities. Black men and women (ages 18–73) who participated in focus groups to discuss their experiences with trustworthiness of healthcare providers reported that trust was largely based upon perceived lack of physicians' interpersonal and technical competence [95]. Racism and experiences of discrimination were also cited as barriers to trust in physicians [95]. The authors of this qualitative study concluded that distrust is associated with decreased adherence to physician recommendations [95]. Indeed, Black men and women who report low levels of trust in healthcare providers are less willing to receive the HPV vaccine [96]. Compared to non-Hispanic White women, Black women report less trust in cancer-related information from media sources and charitable organizations but are more likely to trust cancer-related information from government health agencies, family members, religious organization and leaders, and television compared to non-Hispanic White women [88]. These findings provide insight into potential intervention strategies at the patient, provider, system, and community levels.

## *HPV Vaccine Interventions for Racial/Ethnic Minority Groups and/or Individuals Born Outside of the USA*

There remains a need for culturally targeted interventions in preferred languages to increase vaccine acceptance, initiation, and completion among racially and ethnically diverse groups, including those who are born outside of the USA. Many prior interventions targeting these groups focus on increasing HPV knowledge among

patients and/or parents. For instance, in a study conducted among Hispanic women and their daughters aged 11–17 from 2011 to 2013, individuals received either an HPV vaccine educational brochure coupled with a cervical cancer educational prevention program in their preferred language (English or Spanish) or the educational brochure in their preferred language only [97]. The educational program was delivered to both mothers and daughters by a community health educator and included components about HPV infection, vaccination, cervical cancer, screening, and reproductive health. Learning activities and tips for talking to daughters about sex were also included. In addition, participants were provided with a resource sheet containing information about referrals to local clinics, how to make an appointment to receive the vaccine, and vaccine cost and received follow-up phone calls [97]. Those in the intervention group were 2.24 times more likely to complete the vaccine series than the brochure-only group. Another intervention focused on the development of culturally and linguistically appropriate educational videos targeted to Latino and Korean-American parents of 11–17-year-olds [98]. The intervention was available in multiple languages and addressed the association between HPV infection and cervical cancer and important points about the HPV vaccine, with core elements across both parent groups, as well as elements targeted specifically for Korean and Latino parents. Individuals in the educational video intervention demonstrated significantly improved informed decision-making, increased knowledge, and decreased decisional conflict compared to those in the control condition. In addition, among Haitian mothers of adolescents, a brief motivational interviewing intervention resulted in significantly increased HPV-related knowledge but was not effective in improving initiation and completion rates [99].

Several interventions have demonstrated efficacy in increasing knowledge/awareness about HPV vaccination, specifically among females from racial/ethnic minority groups. An educational lecture series at colleges with predominantly Black students that aimed to improve knowledge about HPV vaccine, HPV infection, cervical cancer, and cancer screening significantly improved knowledge among Black female students and influenced intentions to receive the HPV vaccine [100]. During a study conducted among a group of Black and Hispanic women at high risk of cervical cancer, an educational video was presented during a visit to a colposcopy clinic with topics including HPV infection, prevalence, symptoms, HPV vaccine, cervical cancer screening, and cervical dysplasia. Knowledge was assessed pre- and post-video viewing and significantly increased, as did vaccine acceptability [101].

There are fewer multilevel interventions targeted toward racial/ethnic minority groups. However, one 2015–2016 multilevel intervention focused on improving vaccination among patients of an urban family medicine clinic which served primarily low-income and African American patients. The clinic incorporated consistent and positive HPV vaccine messaging targeted toward patients and focused on engaging community members, providers, and clinic staff [102]. Over time, this project significantly increased vaccine initiation (12.8 percentage point increase in males, 10.6 percentage point increase in females) and completion (16 percentage point increase in males, 10.9 percentage point increase in females) [102]. Significant increases in HPV vaccine completion rates were observed in young adult patients, but not adolescents [102].

## HPV Vaccination Among Young Adults

### *HPV Vaccination Rates Among Young Adults*

The period of young adulthood (aged 18–26) is often characterized by sexual exploration and autonomous decision-making [103]. The average age at which individuals in the USA report initiating sexual activity is age 18.1 among men and 17.8 among women [104]. Among sexually active adults, young women (ages 20–24) and young men (ages 25–29) [18, 19, 110–112] have the highest prevalence of HPV compared to other age groups [113]. Additionally, many young adults either enroll in college or begin military service, both of which impact healthcare access and related decision-making [114]. For instance, college students and military personnel are provided health insurance coverage and/or have access to designated health centers [115, 116]. In addition to increased access, the frequency of healthcare utilization often increases for young women in accordance with reproductive health guidelines [117]. For instance, the US Preventive Services Task Force recommends that women begin screening for cervical cancer starting at age 21 and continue to receive cervical cancer screenings at appropriate intervals through age 65 [118]. As individuals transition to young adulthood, they can potentially override their parents' decisions to decline the HPV vaccine during adolescence [119]. As of 2018, 39.9% of adults aged 18–26 had initiated the HPV vaccine series, and only 21.5% had completed the recommended number of doses [20]. Overall, HPV vaccine initiation and completion rates in the USA are higher for young women ages 18–26 (53.6% and 35.3%, respectively) compared to young men ages 18–26 (27.0% and 9.0%, respectively) [20]. In addition, young adults who have previously been diagnosed with cancer are at risk for developing a second cancer (including an HPV-related cancer) and thus can greatly benefit from HPV vaccination [120]. However, prior studies have demonstrated low rates of initiation and completion among AYA cancer survivors [121]. In short, young adults are a priority population in efforts to promote the HPV vaccine due to high HPV prevalence, increased healthcare utilization (among women), low HPV vaccination rates, and self-directed healthcare decision-making.

### *Barriers, Facilitators, and Challenges to HPV Vaccination for Young Adults*

Patient-level factors associated with HPV vaccination among young adults include HPV knowledge, attitudes, and beliefs about the HPV vaccine (e.g., perceived benefits, safety concerns, etc.), education level, health literacy, religious beliefs, relationship status, sexual activity, and perceptions of HPV risk [105, 115, 122–125]. Healthcare system-level factors influencing HPV vaccination primarily include access to healthcare (e.g., health insurance status, vaccine cost, etc.) and provider

recommendation [89, 105–107, 115]. In fact, provider recommendation is the strongest predictor of HPV vaccination among young adults, regardless of gender, biological sex at birth, or sexual orientation [89, 106]. Unfortunately, low HPV knowledge among many healthcare providers, along with discomfort discussing sexual behavior, may prevent providers from recommending the vaccine [108]. Additionally, providers are less likely to recommend the HPV vaccine to young men compared to women [115].

Risk perception is an important patient-level factor associated with HPV vaccination among all young adults; however, reasons underlying perceptions of risk tend to vary for men and women. Young heterosexual women who are in committed relationships are less likely to be vaccinated compared to their counterparts who are single or dating, and this is largely attributed to perceptions of monogamy as protective against HPV infection [123]. Among sexually active individuals, the prevalence of any type of HPV infection is highest among men [103], yet, HPV knowledge and risk perception are low among young heterosexual men compared to women [115]. Barnard and colleagues found that many young adults did not view themselves at risk for HPV [115]. Given that contextual factors associated with HPV vaccination can vary among young adults, targeted interventions are necessary to increase HPV vaccination initiation and completion in this population.

## *Targeted HPV Vaccination Interventions for Young Adults*

Very few interventions focused on HPV vaccine series initiation have exclusively targeted young adults or been rigorously tested in randomized controlled trials (RCTs), and only one of these studies included men [110, 111]. In a systematic review of HPV vaccine interventions conducted among college students, Barnard and colleagues found that uptake of at least one dose of the HPV vaccine ranged from 5% to 53%; but only one intervention significantly increased vaccine uptake compared to the control condition [111]. In addition to college-based interventions, a few studies have demonstrated efficacy in increasing HPV vaccine initiation and completion in clinic and community-based samples of young adults using patient reminders [110, 111].

Most interventions tested among young adults involved patient-level strategies (e.g., HPV education and/or patient reminders). In particular, individual HPV education provided through video appears to be efficacious at increasing HPV vaccine initiation and completion among young adult women [112, 126]. In an RCT, college women (aged 18–26) shown narrative HPV educational videos featuring both peers and medical experts were twice as likely to initiate the vaccine compared to those in the control group (OR = 2.07; 95% CI = 1.05, 4.10; $p = 0.036$), whereas the peer-only and medical expert-only videos did not improve vaccination rates [126]. In another RCT, young women (aged 18–26) recruited from community settings who had received the first dose of an HPV vaccine and who were prompted to watch a 13-minute HPV education video were more than twice as likely than control

participants to complete the vaccine series (OR = 2.44; 95% CI = 1.47, 4.05; $p = 0.001$) [112]. Study participants were provided vaccinations at no cost, limiting external validity [112]. Importantly, both aforementioned interventions addressed patient education alone, which is not recommended by the Community Guide to Preventive Services [127]. Additionally, reminder letters sent directly to patients or their parents have demonstrated efficacy at improving HPV vaccine completion among females aged 9–26 who had already initiated the first dose (56.4% vs. 46.6%, $p < 0.01$), although the intervention effect was not as strong among young women aged 18–26 (43.5% vs. 37.0%, $p < 0.01$) compared to girls aged 9–17 (66.2 vs. 53.5%, $p < 0.01$) [128].

Very few HPV vaccination interventions involving young adults have been rigorously tested at the provider or systems level, and only one has shown efficacy at increasing HPV vaccine series initiation and completion [110, 111]. Ruffin and colleagues found that provider prompts generated through clinics' electronic health record systems increased HPV vaccine series initiation and series completion among females aged 9–26 [129]. It is important to note that no provider or system-level interventions to date have focused exclusively on young adults, and only two included men (but only up to the age of 22) [110]. As system-level barriers related to access to healthcare may be mitigated by targeting young adults in college settings [115], interventions combining patient, provider, and system-level strategies in college health centers represent an emerging opportunity. Furthermore, Healthy Campus 2020 identified HPV vaccination as a health-related priority among college students [130]. Based on available research, college health centers could be enhanced to facilitate greater HPV vaccination series initiation and completion among young adults by incorporating digital patient education (e.g., videos) combined with health system-generated patient reminders and provider prompts [110–112, 126, 128, 129]. More research is necessary to identify intervention strategies that are most efficacious among young men, as well as to test the effectiveness of multilevel interventions specifically targeting young adult populations.

## HPV Vaccination Among Sexual and Gender Minority Individuals

### *HPV Vaccination Rates Among Sexual and Gender Minority Individuals*

As summarized from the Institute of Medicine report published in 2011 [131], researchers face three important challenges in attempting to gather valid and reliable data for describing sexual and gender minority groups in assessing their health: (1) operationally defining and measuring sexual orientation and gender identity, (2) overcoming the reluctance of some lesbian, gay, bisexual, or transgender (LGBT) individuals to identify themselves to researchers, and (3) obtaining representative

samples of relatively small populations. Although there are scarce data that describe HPV vaccination rates across these vulnerable subgroups, it is well established that men who have sex with men (MSM) have a high risk for anal cancer [132], which is even greater if they are living with HIV [133]. Lesbian and bisexual women report a significant history of cervical abnormalities [135–137]; however, lesbian and bisexual women have also reported low perceived risk of HPV infection due to lack of male sexual partners [125]. Sexual minority women are less likely to receive regular Pap tests compared to heterosexual women [109, 138], placing them at risk for the development of cervical cancer. In some groups, such as the transgender community, empirical data assessing HPV-related cancer incidence and mortality are lacking primarily because of an absence of large-scale observational studies in this population [139].

Although HPV comorbidities and HPV-related cancers disparities are documented in a few sexual and gender minority groups, little research has addressed HPV vaccination among these populations. Available epidemiological studies indicate that HPV vaccine initiation and completion are low among sexual and gender minorities prior to and after the recommendation from the ACIP updated in late 2011 [140–142]. At that time, a routine recommendation was made for males at age 11 or 12, and catch-up vaccination through age 21 for all males, and through age 26 for MSM and for immunocompromised persons, including those with HIV infection [134, 142]. In 2015, recommendations for use of the nine-valent vaccine (9vHPV) were made for the same populations [143]. It is also important to note that US studies varied in their methodological approaches, some with relatively small sample sizes and variability in the year the studies were conducted (Table 2). Indeed, when interpreting the study findings, it is important to consider the temporality in which the study was conducted with regard to ACIP recommendations. Table 2 shows epidemiological studies conducted in the USA which explore HPV vaccination uptake among sexual and gender minorities. An online study of 1457 young MSM in the USA aged 18–26 reported that only 6.8% had received one or more vaccine doses [144]. During the same time period, The National HIV Behavioral Surveillance Study, a behavioral study implemented through a series of cross-sectional surveys [145], reported that for 18–26-year-old MSMs, the HPV vaccination initiation rate was 4.9% (2.7% initiation rate among MSMs 18 years and older overall) [146]. This rate increased to 17.2% among MSM aged 18–26 during the 2014 study [147]. A 2014 national sample of young adult (18–26-year-old) gay and bisexual men found that only 13% had initiated the HPV vaccine series [140]. Of those who initiated the series, more than half (56%) completed the three-dose series [140]. Conversely, a prospective study conducted from 1996 to 2014 using data from 10,663 males and females enrolled in the Growing Up Today Study reported that HPV vaccination initiation was especially low among heterosexual males, compared to bisexual or gay men [148].

In women identifying as sexual and gender minorities, similar lack of estimates for HPV vaccination initiation and completion is also observed in the literature, despite the documented burden for HPV-related comorbidities. Data from the 2006 to 2010 National Survey of Family Growth (NSFG), which used a stratified,

**Table 2** HPV vaccination (initiation and completion) rates among sexual and gender minority population groups

| Author (publication date) | Year study | Sample | Results |
|---|---|---|---|
| Gorbach (2017) [151] | 2012–2014 | Young Men's HPV study<br>Multisite, clinic-based study<br>Total sample ($n$ = 808) | HPV ≥ 1 = 13.7%<br>4.6% completed doses |
| Reiter (2015) [140] | Fall 2013 | National sample of gay and bisexual men<br>Total sample: 428 (18–26 years old)<br>72% identified as gay | HPV ≥ 1 = 13%<br>54% completed doses |
| Meites (2014) [146] | 2011 | National HIV Behavioral Surveillance System<br>Venue-based sampling<br>Total sample: $n$ = 9819 | 4.9% initiated HPV vaccine<br>No data on HPV completion |
| Oliver (2017) [147] | 2014 | National HIV Behavioral Surveillance System<br>Venue-based sampling<br>Total sample = 2892 | HPV ≥ 1 = 17.2%<br>HPV ≥ 1 = 37.2% in HIV+ MSM |
| Cummings (2015) [144] | December 2011 | Online survey YMSM 18–26 years old<br>Total sample: $n$ = 1457 | HPV ≥ 1 = 6.7% |
| Polek (2017) [141] | 2013–2014 | National Health Interview Survey 2013–2014<br>Total sample n = 5695 ($n$ = 135 lesbian) | HPV ≥ 1 = 16.8% in lesbians<br>HPV ≥ 1 = 26.8% in bisexuals |
| McRee (2014) [150] | October to November 2013 | Online survey: lesbian 18–26 years old<br>$N$ = 543 | HPV ≥ 1 = 45%<br>70% of initiators reported completing the series |
| Halkitis (2019) [177] | Fall 2015 | P18 Cohort Study of young gay, bisexual, and other men who have sex with men<br>Analytic sample ($n$ = 486) | 18.1% completed doses |
| Charlton (2017) [148] | 1996–2014 | Prospective cohort study of females and males enrolled in the growing up today study<br>(Total sample = 10,663; lesbian $n$ = 149; gay $n$ = 169) | HPV ≥ 1 (lesbians) = 6.8%<br>HPV ≥ 1 (gay) = 5.9% |

three-stage cluster sampling strategy to establish a national probability sample, only 8.5% of lesbians and 33.2% of bisexual individuals who had heard of the HPV vaccine had initiated the HPV vaccine [149]. In 2013, data from the National Sample of Lesbian and Bisexual Women ($n$ = 543) reported that 45% of respondents initiated the HPV vaccine series and 70% of initiators completed the series [150]. Although studies have included transgender women in their sample [151], specific information regarding vaccine uptake in this group is limited. It is also important to note that there are no HPV vaccine recommendations specifically targeting transgender individuals [152].

### *Barriers and Facilitators for HPV Vaccine Series Initiation and Completion Among Sexual and Gender Minority Individuals*

Several studies have examined barriers to HPV vaccination among individuals from sexual minority groups using qualitative and quantitative methods [153–155] at the patient, provider, and system levels. Despite the lower rates of HPV initiation and completion, gay and bisexual men have indicated their willingness to receive the HPV vaccine, with estimates ranging from 36% to 74% [153, 154, 156, 157]. In a national sample of lesbian and bisexual women, 32% had completed the three dose series, and among those who had initiated, but not yet completed the series, 47% intended to complete the series [150]. At a patient level, modifiable factors such as low awareness of HPV infection, HPV-related cancers (other than cervical cancer), and HPV vaccine knowledge are consistent barriers to HPV vaccination in sexual and gender minorities [155]. Other individual-level barriers are cost, lower perceived risk of infection, and perceived benefits of the vaccine [154, 158] and, among transgender women, belief that HPV/HPV vaccination was not relevant to them [155]. At the provider and system levels, the lack of LGBT-trained providers (HPV vaccine knowledge/expertise) and identity-affirming and culturally appropriate healthcare setting deter HPV vaccination uptake among these individuals [155]. The latter barriers have also been identified in the literature across a variety of LGBT health issues, representing consistent, yet modifiable barriers to overall LGBT health [159]. Notably, studies among gender and sexual minorities have reported high rates of having a routine medical checkup in the past year (ranging from 40% to 80%) [140, 146, 160], suggesting missed opportunities for HPV vaccination among this population.

Overwhelmingly, recommendation by healthcare providers is one of the most important facilitators for HPV vaccine initiation and completion [134, 144, 150, 151, 155]. Among young adult MSM, disclosure of sexual behavior to their healthcare providers is a strong mediator of HPV uptake [161]. Although limited studies explore correlates of HPV vaccine acceptability and uptake among the LGBT community, findings from studies focused on MSM address the need for targeted educational and interventional efforts among providers and healthcare systems for culturally sensitive, affirming, and effective communication in this community [155]. Moreover, an online survey conducted in 2009 among gay/bisexual ($n = 312$) and heterosexual men ($n = 296$) found that men may be more accepting of HPV vaccine when it is framed as both preventing genital warts and an HPV-related cancer, regardless of which of the three most common HPV-related cancers in men was described (anal, oral, or penile cancers) [162]. Although only 42% of men were willing to receive the HPV vaccine when framed as preventing genital warts alone, 60% were willing to get it when it was framed as preventing cancer in addition to genital warts ($p < 0.001$) [162]. In the comparison performed between groups (gay/bisexual vs. heterosexual men), their findings suggest that men respond similarly to different ways of framing HPV-related disease regardless of sexual orientation

($p = 0.35$). However, gay and bisexual men were more willing to get the HPV vaccine than their heterosexual counterparts ($p < 0.001$) [162].

### *Interventions to Address Disparities in HPV Vaccine Initiation and Completion Among Sexual and Gender Minority Individuals*

Among young adults, despite ACIP recommendations [134], many age-eligible individuals are not receiving the HPV vaccine, making efforts to increase vaccination important in this age group. The percentage of adults aged 18–26 who received the recommended number of doses of HPV vaccine increased from 13.8% in 2013 to 21.5% in 2018 [20], however these rates remain suboptimal. Most of the epidemiological and behavioral studies among sexual and gender minorities focus on HPV uptake target young adults (older than 18 years). This approach is expected as adolescents are engaged in an ongoing process of sexual development [163]; many adolescents may be unsure of their sexual orientation, while others have been clear about it since childhood [131]. Several interventions target HPV vaccine uptake among young adults at the individual, provider, and clinic levels; however, those interventions do not address clinic- or provider-level barriers for sexual and gender minorities [126, 128, 129, 164–174].

Of the interventions addressing HPV vaccine uptake for young adults, only one addresses sexual and gender minorities (Table 3) [135, 175, 176]. The Outsmart HPV intervention (ClinicalTrials.gov identifiers: NCT04032106 and NCT02835755) is a web-based intervention targeted to young gay and bisexual men was first pilot-tested to examine the acceptability for these individuals in influencing HPV vaccination knowledge, attitudes, and beliefs using the protection-motivation theory (PMT) as the theoretical framework [135, 175, 176]. The intervention, which includes vaccine reminders, aims at increasing HPV vaccine initiation and completion among young individuals who report having a history of same-sex partners, being sexually attracted to males, or identify as gay, bisexual, or queer (i.e., sexual minority males) [135, 175, 176]. The results of the pilot study showed that HPV vaccine initiation was higher among participants in the intervention group (45%) than those in the control group (26%; $p = 0.02$) [135]. HPV vaccination completion rates in the intervention group (11%) were higher than in the control group, although the difference was not statistically significant (3%; $p = 0.07$) [135]. Findings from the posttest survey show positive effects on several attitudes and beliefs such as greater perception that MSM are at higher risk for anal cancer relative to other men; greater HPV vaccination self-efficacy; and lower perceived harms of the HPV vaccine on posttest surveys in the intervention group compared to those in the control group (all *ps* < 0.05) [176].Overall, intervention participants reported high levels of acceptability and satisfaction with the *Outsmart HPV* intervention [176]. As of the writing of this chapter, the efficacy of the *Outsmart HPV* in increasing HPV vaccination rates is currently being tested in a larger trial [175].

**Table 3** HPV vaccine interventions among sexual and gender minorities

| Author, year | Study design, period; intervention type | Population; venues | Modifiable factors assessed |
|---|---|---|---|
| **Outcome:** *Vaccine initiation and completion* | | | |
| Reiter, 2018 [135] | Randomized clinical trial conducted from July and September 2016<br>Web-based intervention (*outsmart HPV*) consisted of two components: (1) population-targeted, individually tailored content about HPV and HPV vaccine and (2) monthly HPV vaccination reminders sent via email and/or text message | 150 young gay and bisexual men between the ages 18 and 25 years<br>National sample recruited via Facebook advertisement | *Individual*:<br>Attitudes and beliefs<br>Acceptability<br>Communication with health provider about HPV vaccine |
| **Outcome:** *Vaccine series initiation and completion* | | | |
| Reiter, 2020 [175]<br>Fall 2019–ongoing<br>Intervention | Three-arm prospective randomized clinical trial<br>Web-based intervention | Young gay, bisexual, and other men who have sex with men (YGBMSM) between the ages 18 and 25<br>Recruitment was made through paid advertisements on social media sites<br>USA | *Individual:*<br>Perceived vulnerability, perceived severity, response efficacy, rewards of the maladaptive response, self-efficacy, response costs, intention, knowledge, worry, stigma |

Given the higher burden of HPV infection and disease, as well as the documented lack of evidence-based interventions, culturally appropriate interventions to promote HPV vaccine uptake among sexual and gender minorities are needed. Specifically, interventions designed to improve vaccine uptake should consider a multilevel approach, to address structural and social stigma, cultural competencies, and effective patient-provider communication to support physician recommendations [131]. Further, these findings underscore a missed prevention opportunity for these at-risk and underserved population and might also suggest, in parallel, the need for proactive strategies at a clinic, provider, or policy (e.g., school-entry requirement) level, to increase HPV vaccination uptake in young SGM, particularly prior the onset of sexual behavior.

## HPV Vaccination in Novel Settings

As researchers and health professionals seek to increase HPV vaccination, interventions in novel settings for implementation of interventions will become important to reach sociocultural groups with lower rates of HPV vaccination rates. Promising

novel settings to improve HPV vaccination rates in the USA include pharmacies, schools, and dental practices [178]. The use of immunization registry data is also important for increasing HPV vaccination rates.

## *Settings*

### Pharmacies

HPV vaccination provision in pharmacies has potential for considerable reach given the large number of pharmacies in the USA and their locations throughout rural and underserved areas [178]. Pharmacies are widely trusted by consumers, have longer hours, and can provide similar quality of care at comparable or lower cost than HCPs [178]. This model has been leveraged to deliver vaccines to a large segment of the population for seasonal influenza vaccination. As of 2019, in 47 states, pharmacies have the capability to vaccinate adolescents and adults against HPV within their scope of practice [179], enhancing the overall accessibility of HPV vaccinations. Restrictions exist in some states, however, including the need for a prescription (3 states) and age restrictions for adolescents (22 states) [179], which reduces the ability of age-eligible individuals to obtain the vaccine at their local pharmacy. In addition, other potential barriers exist. For instance, pharmacies may not be considered an "in-network" care provider, thereby placing the financial burden/out of pocket costs of vaccination on the patient/family [178]. Similarly, one study interviewing HPV vaccination stakeholders highlighted pharmacies as a potential strategy for improving vaccination rates, although noted that lack of insurance company reimbursement to pharmacies can be a barrier [40]. The authors of that study concluded that policy changes are needed surrounding HPV vaccination at the pharmacy level, including ensuring that all healthcare providers, including pharmacists, can administer the HPV vaccine and that pharmacies are included as providers in the VFC program [40]. In one national survey of adolescent boys and their parents on comfort with alternative settings for HPV vaccine delivery, half of parents and a third of their sons reported comfort with vaccination in pharmacy or school settings [180]. In another large, national sample, 29% of parents expressed willingness to get their child's HPV vaccine at a pharmacy [181]. Pharmacists report positive perceptions of the HPV vaccination series but report barriers such as inadequate insurance coverage, low demand for the vaccine in pharmacies, and the subsequent expiration of vaccine before use in the pharmacy setting [182]. Studies examining effectiveness of pharmacy-based interventions for HPV vaccination are limited. In one program serving underinsured Hispanic college students, 89 (mostly female) students received the first HPV dose and 43 (48%) completed all three doses, demonstrating acceptability of pharmacy-based vaccine programs for this population [167]. Another "pharmacist-led" intervention in a clinic setting utilized an HPV vaccination strategy where the pharmacist led the education of clinic staff, stocking of HPV vaccine product, review of upcoming patients for HPV vaccine eligibility,

and electronic medical record prompts for providers [183]. RCTs of pharmacy interventions compared with interventions in other traditional and novel settings are needed to demonstrate feasibility, acceptability, and efficacy.

### Schools

Another promising setting for HPV vaccination is within schools with students ages 9–18. School health centers provide comprehensive medical care to students but exist in less than 10% of schools in the USA [178]. Despite this lower reach, school health centers may be more convenient for parents who have access to them, increasing the likelihood that all HPV doses will be completed. Compared with community health centers, adolescents who received HPV vaccination in school health centers were more likely to complete the series [184]. Barriers to vaccination in school health centers may include parent out-of-pocket costs, school health center costs to purchase vaccines, and obtaining parent consent. Schools hosting or promoting interventions implemented by others with dedicated staff are potential solutions, along with school distribution of HPV vaccine campaign materials and parent reminder letters about vaccine follow-up [185]. Large-scale, voluntary vaccination programs in school settings have been effective in other countries for increasing HPV vaccination (e.g., Canada, Australia) [186–188]. A similar program in the USA with smaller groups of schools has shown promise in rural and Appalachian Kentucky [47].

### Dental Practices

Provision of HPV vaccination in dental practices may be a practical and sustainable alternative to provision in traditional settings due to the link between HPV and oral cancer. The substantial reach to adolescents who attend clinics for dental and orthodontia care may provide a large population eligible for vaccination [178]. However, feasibility of vaccination in dental practices may be lower than other novel settings given the training of dental staff [178]. Despite awareness of the link between HPV and oral cancer in the dental field, one systematic review highlighted the lack of communication about, and recommendation for, HPV vaccination by dental providers [189]. The lack of in-depth knowledge and health literacy surrounding HPV in dental providers may be a barrier to discussing the link between the virus and oral caners [190]. Dental opinion leaders reported possible facilitators of HPV vaccination in the dental setting including increasing HPV knowledge for dental providers and for parents and promoting HPV prevention as within the scope of dental care [191]. In one large, national sample of parents of adolescents, only 23% of parents indicated comfort with their teen receiving an HPV vaccination at a dentist [192]. HPV vaccination interventions in dental practices have potential for increasing vaccination rates, but both dental staff and parent comfort and knowledge must be addressed.

### Using Immunization Registry and Immunization Information Systems Data

State immunization registries or immunization information systems (IIS) are computer-based systems that confidentially collect and summarize immunization data on a population level [193]. State IIS are tools that can facilitate HPV vaccination through tracking immunization doses and their timing, including series initiation, completion, up-to-date status, and missing/late doses. Registries may enable tracking HPV vaccination across multiple providers and settings (e.g., primary care providers, gynecological care, pharmacies) and enable identification of regions, health systems, or clinics with low initiation and completion rates [40]. In 2016, 49 states used IIS to track childhood immunizations [193]. IIS can potentially be integrated with electronic health records and can include decision support tools. Immunization registries are effective in increasing vaccination due to their ability to track immunizations, increase accountability for providers and practices, and support other vaccine interventions (e.g., patient and provider reminders) [194]. Currently, however, not all US providers are required to use IIS, and IIS have considerable costs in terms of necessary state-level funding, time, effort, and staff dedicated to upkeep [194, 195]. The continued use of IIS is vital for the acceleration of HPV vaccination in AYAs. The use of additional IIS capabilities has been used to improve HPV vaccination [196], including generation of patient/parent HPV vaccine reminders (via mail or phone), provider performance feedback on HPV vaccine rates, and provider reminder prompts via the electronic medical record about needed HPV doses [194].

## Gaps and Future Directions

The potential for HPV vaccination to address cancer health disparities has not yet been fully realized. In general, uptake of HPV vaccination has fallen short of targets in national initiatives. Despite the potential to reduce the burden of HPV-related cancers, vaccine series initiation and completion by race/ethnicity, biological sex at birth, gender, socioeconomic status, geography, age, and sexual orientation remain suboptimal. Extensive research suggests the most effective interventions will be targeted approaches that consider multiple levels of influence, including the unique individual, interpersonal, systems, community, and policy-level factors that act as barriers and facilitators to HPV vaccine uptake. State immunization registries have the potential to identify disparities in individual states and might inform the development of targeted interventions for adolescents, parents, young adults, and providers. At the individual level, knowledge, beliefs, and attitudes can play a powerful role in understanding vaccine behaviors. As such, developing messaging and materials that are reflective of the sociocultural characteristics and language preferences of the target communities is essential. Education and messaging must consider the unique audiences involved in HPV vaccination decision-making. For instance, in

the case of adolescents, parents often are the vaccine decision-makers; thus, HPV vaccination education materials must consider that parents will be a key part of the audience for this information. At the interpersonal level, communication and messaging from healthcare providers are vital. Given the well-established role of provider recommendation in HPV vaccine uptake, it is crucial that recommendation strategies are evidence-based and consider the unique context of local communities. At the systems level, leveraging well-established strategies such as reminder and recall systems can support individual and interpersonal interactions in the clinic setting. Additionally, reaching communities in settings where they are most comfortable and have established trust should also be considered in order to reduce barriers to access. Thus, at the policy level, school entry policies as well as consideration of the broader contexts or settings for vaccine delivery such as pharmacies or schools can help to remove barriers to access. Coverage for vaccination beyond age 18 through public financing mechanisms may also be an important strategy for unique populations that were not vaccinated during adolescence, such as AYA cancer survivors or LGBTQ communities.

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