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Human papillomavirus vaccination among adults and children in five US states

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Introduction

Human papillomavirus (HPV) infection is the most common sexually transmitted infection and is also an established causal factor associated with about 5% of all human cancers.[1,2] HPV types 16 and 18 account for nearly 70% of cervical cancers, and HPV types 6 and 11 have low oncogenic potential but are nevertheless responsible for 75–90% of anogenital warts.[3] In the United States, nearly 34,000 HPV-associated anogenital and oropharyngeal cancers are diagnosed annually and the direct medical expenses for preventing and treating HPV-related diseases are estimated to be $8 billion (2010 U.S. dollars) every year.[4,5]

To reduce the health impact and financial burden due to HPV-related diseases, the U.S. Food and Drug Administration (FDA) licensed a quadrivalent vaccine against HPV types 16/18/6/11 (HPV4; Gardasil, Merck & Co. Inc.) and a bivalent vaccine against HPV types 16/18 (HPV2; Cervarix, GlaxoSmithKline) for use in females (9 to 26 years for HPV4 and 10–25 years for HPV2) in 2006 and 2009, respectively.[6,7] Both vaccines require three doses at 0, 1–2, and 6 months, and cost about $120 per dose (if without health insurance coverage). The Centers for Disease Control and Prevention (CDC) Advisory Committee for Immunization Practices (ACIP) has recommended HPV vaccines since 2007 (HPV2 in 2009) by for use in girls aged 11 or 12 years with a catch up vaccination to girls and women aged 13 to 26 years (the vaccination series can be started as young as age 9 years).[7] In 2009, the FDA licensed HPV4 for use in males aged 9 to 26 years, and in October 2011, the ACIP also recommended routine HPV4 vaccination for males aged 11 to 21 years (may be given

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to males aged 22 to 26 years.[8] However, unlike many other childhood vaccines, HPV vaccines are not required for middle school attendance except in Virginia and the District of Columbia (the mandatory HPV vaccination was once enacted but later revoked in Texas in 2007) and a school-based HPV vaccination program is generally lacking in the US.[9]

The utilization of HPV vaccines is a safe, effective and feasible measure for preventing HPV infections and HPV-related cancers or genital warts.[6,8,10,11] HPV vaccination would also be cost effective for reducing HPV-related diseases in both women and men with assumed 75% vaccine coverage and completion rates for preadolescent girls.[12] Therefore, in the Healthy People 2020 (HP2020) the national objective for HPV vaccination is 80% completion rate (3 doses) for females by age 13 to 15 years.[13] Nonetheless, current HPV vaccine coverage (>=1 dose) among US adolescents is well below the HP2020 objective (<60% in girls and <25% in boys).[14–22] Previous research indicates that the lack of health insurance, limited healthcare access, and the lack of physician recommendation may be important factors preventing routine uptake of HPV vaccination in adolescent girls.[23–26] Socioeconomic, racial, and geographic disparities also exist regarding HPV vaccine uptake and provider recommendation of HPV vaccination.[15,16,18,21,27–31] Thus, concerns have been raised that the use of HPV vaccine might actually increase health disparities as populations who are at risk for HPV-related diseases (e.g., racial-ethnic minorities or people in low socioeconomic status) may be less likely to access and receive HPV vaccines.[32–34]

In order to improve HPV vaccine coverage in the US, it is essential to understand factors associated with HPV vaccination. In this study, we wanted to: 1) examine current HPV vaccination among adults aged 18 through 26 years and among children aged 9 through 17 years; 2) identify characteristics associated with HPV vaccination among adults and children.

Materials and methods

Data source

We used the 2010 Behavioral Risk Factors Surveillance System (BRFSS) data (available at http://www.cdc.gov/brfss/annual_data/annual_2010.htm#datafiles) to examine HPV vaccination in five US states. The BRFSS is the largest population-based telephone survey to collect behavioral information from a random sample of individuals aged 18 years or older living in the US. In 2010, individuals aged 18 through 49 years in Connecticut (CT), Massachusetts (MA), Rhode Island (RI), West Virginia (WV), and Wyoming (WY) answered questions regarding HPV vaccination ("A vaccine to prevent the human papilloma virus or HPV infection is available and is called the cervical cancer or genital warts vaccine, HPV shot, [if female "GARDASIL or CERVARIX"; if male "GARDASIL"]. Have you ever had the HPV vaccination?" and "How many HPV shots did you receive?"). If there was a child in the household aged 9 through 17 years, the adult respondent in Connecticut (CT), Pennsylvania (PA), Texas (TX), West Virginia (WV), and Wyoming (WY) answered questions about child HPV vaccination ("A vaccine to prevent the human papilloma virus or HPV infection is available and is called the cervical cancer vaccine, HPV shot, or GARDASIL. Has this child EVER had the HPV vaccination" and "How many HPV shots did child receive?"). If there was more than one child in the household, the interviewer

randomly selected one child for the respondent to answer related questions. Pre-coded responses for HPV vaccination questions included: “Yes”, “No”, “Doctor refused when asked”, “Don’t know/Not Sure”, and “Refused”, and the number of shots that an individual received.

Variables of interest

We assessed the following study outcomes: (1) initiation of HPV vaccination, defined as whether an individual ever had an HPV vaccination (received >=1 dose of the 3-dose series) among eligible population; and (2) completion of HPV vaccination, defined as whether an individual had completed all three doses of HPV vaccine among those who had an HPV vaccination.

We selected covariates based on findings from previous studies and our research interests.[25,26] For adults, we examined the associations between HPV vaccination and individual’s socio-demographic characteristics (age, sex, race-ethnicity, marital status, education, employment, income, and county of residency), healthcare access indicators (health care coverage, personal doctor, “could not see doctor because of cost”), and the utilization of health services (the length of time since last routine checkup, receipt of seasonal flu vaccine, and ever had a Pap test for women). We classified Individual’s county of residency as rural or urban according to the 2003 rural-urban continuum codes defining metropolitan counties provided by the Economic Research Service.[35] For children, to minimize the potential information or recall bias, we restricted the analyses to any respondent who was the parent (biologic, step, or adoptive parent) of the child. We included both the child’s characteristics (age, sex, and seasonal flu shot) and the parent’s characteristics to assess factors associated with child HPV vaccination.

Statistical analyses

We adjusted the analyses for the final weight assigned to each adult or each child in the BRFSS data file. In the final analysis, we excluded about 4% of individuals with a missing study outcome (“Don’t know/Not sure/Refused to answer” about HPV vaccination). Due to the small sample sizes of vaccinated males, we only described HPV vaccination in males. For females, we conducted bivariate analysis using PROC SURVEYFREQ and used the Rao-Scott chi-square test to evaluate the statistical significance. To obtain stable estimates, we did not include variables with the denominators less than 50 respondents in the final analysis. We performed a multivariate logistic regression to fit the data, with initiation of HPV vaccination or completion of HPV vaccination as the dependent variable, and the remaining variables of interest as independent predictors. We evaluated two-way interactions between independent variables and did not find significant interactions (two-sided tests at $p<0.05$) between variables. Because we detected significant collinearity between healthcare access indicators, we retained the relevant variables in the multivariate model. We used the SAS® software system Version 9.3 PROC SURVEYLOGISTIC (SAS Institute, Inc., Cary, North Carolina) to fit the models. We obtained the adjusted odds ratios (aOR) and their 95% confidence intervals (CI) to examine the significant associations between HPV vaccination and independent predictors at $p<0.05$.

Results

Initiation of HPV vaccination among adults aged 18–26 years

In five US states in 2010, a total of 706 women and 560 men aged 18 through 26 years answered HPV vaccination questions. Overall 258 (41.6%) women and 21 (4.3%) men ever had an HPV vaccination (Table 1). One man answered that “doctor refused (HPV vaccination) when asked”. In women, the initiation of HPV vaccination differed by individual’s characteristics (Table 1). The prevalence of HPV vaccine initiation appeared lower among married/unmarried couples (N=44, 16.3%), women in lower socioeconomic status (represented by a lower education or a lower income), residents of West Virginia (N=17, 23.2%) or a rural county (N=41, 24.8%), and women without adequate healthcare access and utilization, indicated by not having health care coverage (N=26, 28.8%) or not having a recent routine checkup (N=56, 30.6%).

In multivariate analysis examining factors associated with HPV vaccine initiation in women, younger age (18–20 years) and marital status were strongly related to HPV vaccination (aOR=6.39, 95% CI=3.28, 12.5; and aOR=4.83, 95% CI=2.59, 9.04, respectively). The urban-rural difference in HPV vaccination also remained significant, indicating that women living in a rural county were less likely to initiate HPV vaccination (aOR=0.37, 95% CI=0.33, 0.82). Additionally, women who never had a Pap test were less likely to have an HPV vaccination (aOR=0.44, 95% CI=0.22, 0.89).

Completion of HPV vaccination among adults aged 18–26 years

Of those receiving at least one dose of HPV vaccines, 182 (75%) women and 5 (16.8%) men complete the HPV vaccine series (Table 1). The completion of HPV vaccination among women seemed lower in women with a lower income (N=64, 57%), and those who did not have a recent routine checkup (N=34, 57.2%). In multivariate analysis (Table 2), younger age (18–20 years) was the only variable significantly associated with HPV vaccine completion (aOR=2.93, 95% CI=1.01, 8.46).

Initiation of HPV vaccination among children aged 9–17 years

Child HPV vaccination questions were answered by 4,493 parents, representing 2,201 girls and 2,292 boys in five US states in 2010. Overall, 612 (24.6%) girls and 86 (5.2%) boys aged 9 through 17 years ever had an HPV vaccination. The prevalence of HPV vaccine initiation was higher among adolescents aged 13 through 17 years (N=489, 41.1% for girls and N=54, 7.7% for boys) and those who received seasonal flu shot in the past year (N=270, 29.4% for girls and N=41, 7.8% for boys).

Table 3 also showed the distribution of HPV vaccine initiation by parent’s characteristics. For girls, mothers (female respondents) reported a higher prevalence of HPV vaccination compared to fathers (male respondents) (N=454 and 29.7% versus N=158 and 18.5%). Unemployed parents were more likely to report child HPV vaccination than did employed parents (N=178 and 30.6% versus N=433 and 22.4%). HPV vaccination did not vary across geographic area but a lower prevalence was still seen in children living in a rural county (N=172, 19.2%). Parent’s health care coverage was not associated with child HPV

vaccination. However, for parents answering that they could not see a doctor due to cost, their daughters had a higher prevalence of HPV vaccination (N=137, 33.1%) compared to those without a medical cost issue (N=474, 22.9%).

In the multivariate logistic regression model (Table 4), younger girls (9–12 years: aOR=0.09, 95% CI=0.06, 0.14) or those not receiving seasonal flu shot (aOR=0.44, 95% CI=0.31, 0.64) were significantly less likely to have an HPV vaccination. Girls were more likely to be vaccinated (aOR=2.26, 95% CI=1.28, 4.00) if parents had an issue with medical cost, but were less likely to have the vaccination if parents did not have a routine annual checkup (aOR=0.51, 95% CI=0.33, 0.80).

Completion of HPV vaccination among children aged 9–17 years

About half (N=308, 50.3%) of vaccinated girls finished their vaccine series, but only 14 (10.8%) boys receiving the vaccine completed all three doses (Table 3). Pre-adolescent girls (9–12 years old) had a lower prevalence of HPV vaccine completion (N=31, 18.6%) compared to adolescent girls aged 13 through 17 years (N=277, 56.4%). The result from the multivariate analysis (Table 4) showed that younger age of the child (aOR=0.13, 95% CI=0.06, 0.31) and the length of time since parent's last routine checkup (within the past 2–5 years: aOR=0.43, 95% CI=0.21, 0.88; 5 or more years/never: aOR=0.37, 95% CI=0.14, 0.98) were negatively associated with the completion of HPV vaccination among girls.

Discussion

In 2010 the overall HPV vaccination in five US states remained well below the HP2020 national objective of 80% completion rate in girls. Even for females within the recommended age range, only 41.1% of adolescent girls aged 13 through 17 years and 41.6% of women aged 18 through 26 years have received an HPV vaccination (>=1 dose). Among those vaccinated, about 56% of adolescent girls and 75% of adult women have completed the vaccine series. It is worth noting that many of these girls and women had a healthcare encounter where they could have received "catch up" vaccines. HPV vaccination was rare in boys and adult men with only about 5% being vaccinated, but this result is likely due to the lack of recommendations of HPV vaccine for males prior to 2011. With the inclusion of HPV vaccines for males in the CDC's immunization schedule, it is anticipated that HPV vaccination in males will be greatly improved.

Possible barriers for HPV vaccination in adult women

Inadequate utilization of health services still presents a major barrier for HPV vaccination, especially in rural populations who may not have access to HPV vaccines. In our study, women who never had a Pap test or those living in a rural area are significantly less likely to initiate HPV vaccination than their counterparts. Therefore, in addition to education programs that increase women's knowledge and acceptance of HPV vaccination, interventions should include strategies that promote healthcare utilization in young women. At the healthcare settings, provider recommendation of return for further doses are also needed to encourage women to complete the vaccine series.[36]

Similar to previous research, we have identified that younger age (18 to 20 years) is associated with an increased HPV vaccine initiation and completion, but have not found significant socioeconomic or racial disparities in HPV vaccination.[19,28,34] These results could be due to a better access to HPV vaccines in younger women. Although it is not common for adults without health insurance to receive free HPV vaccines through other sources, in some states HPV vaccines may be provided to uninsured or underinsured women aged 19 to 26 years using the state funds via cervical cancer prevention programs.[32] With the implementation of the "Patient Protection and Affordable Care Act", expanded health care coverage up to age 26 years through parental health insurance could help young adult women to access HPV vaccines.

Factors associated with HPV vaccination in girls

In our study, preadolescents (<13 years) and girls who did not receive routine seasonal flu shot are less likely to initiate HPV vaccination. Moreover, indicator of limited parental inadequate utilization of preventive health services (i.e., not having a recent routine checkup) is associated with lower HPV vaccination in girls. These findings imply that parental attitudes and behaviors toward preventive health services influence child HPV vaccination.[20,22] Because parents play an important role in child HPV vaccine initiation and completion, strategies have focused on increasing parental knowledge and acceptance for HPV vaccination.[37,38] Evidence from a randomized trial has shown that interventions targeting on improving physician recommendation and educating family members about HPV vaccination are effective in promoting HPV vaccine uptake among adolescents girls aged 11 to 17 years in care.[39] Findings from our study suggest that future interventions should also aim at enhancing parental access to and utilization of healthcare services.

Interestingly, girls with a parent who has a medical cost issue are more likely to initiate HPV vaccination. This result could be due to the utilization of the national vaccine programs that are provided to underserved children in the US. For children, federally-funded the Vaccines for Children (VFC) program and the Section 317 Immunization grant program provide free vaccines, including HPV vaccines, to socioeconomically disadvantaged children aged 18 years or younger who are uninsured or underinsured.[32] However, the lack of awareness or under-utilization of these available public services may limit child HPV vaccination. For example, the ratio of VFC providers to children under 19 years was about 79 providers per 100,000 children in CT and was 103 per 100,000 children in WV (based on the VFC provider data obtained from the state health departments). In contrast, the prevalence of child HPV vaccination in 2010 was the highest in CT but was the lowest in WV, which is also a National Cancer Institute-defined geographic area with high cervical cancer burden. The reasons why some parents do not use these services need to be further explored, especially in geographic areas or subgroups at high risk for HPV-related cancers.

HPV vaccination in males

Due to the lack of recommendation of routine HPV vaccination for males until 2011, the low HPV vaccine uptake in males in 2010 mainly reflects pre-vaccination experience. Vaccinating males against HPV infections has important health benefits in preventing general warts and HPV-related cancers. Although previous studies have found high

acceptability of male HPV vaccine by adult men (especially male college students), parents of boys, and health care providers,[40–42] the actual vaccine uptake is very low in boys and men.[43,44] Low vaccine utilization may be due to misconception about the direct benefit of HPV vaccines to males, unawareness of available vaccines, and a preference to vaccinate females or older adolescents (>=16 years) among parents or providers.[40–42] With the implementation of ACIP's recommendation on HPV vaccination in males and mass media coverage of HPV vaccines for both sexes,[8,45] it is anticipated that provider practices and parental attitude will change to support male HPV vaccination.

Study limitations

Several limitations in our study need to be considered when interpreting the findings. First, although the BRFSS is the largest population-based telephone survey, response rates have been decreasing in recent years and the HPV vaccine questions were included in only five states.[46] In addition, a growing number of cellular phone only households were usually not included in the BRFSS sampling frame. Second, while the BRFSS is a well-designed national survey and the data has been widely used to study various health-related conditions including HPV vaccination,[15,47] our study outcome (HPV vaccination) is based on self-reported status. According to how the HPV vaccine questions were asked, it is doubtful that adult respondents would falsely report their HPV vaccine uptake, but it is likely that some parents may not know or recall if their child has been vaccinated. Indeed, differential response of male and female parents with respect to their children's HPV vaccination status suggests that this is a possibility. As a result, both adult and child HPV vaccination may be underestimated in this study. Last, because limited questions regarding HPV vaccination were not asked in the BRFSS, we are unable to assess other potential barriers including individuals' awareness and attitudes towards HPV vaccination or the lack of provider's recommendation. Regardless of these limitations, this study includes both adults and children with the same sampling method and provides important information about HPV vaccination in the US.

Conclusions

HPV vaccination remains well below 80% in the US, and no substantial increase is observed in HPV vaccine initiation among adolescent girls between 2011 and 2012 (53% vs. 53.8%).[48] Given the current low HPV vaccine coverage, the long-term impact of HPV vaccination on preventing HPV-related diseases is uncertain. Intensive strategies are needed to increase HPV vaccination in the US general population if the HP2020 objective of 80% HPV vaccine completion rate is to be realized.[13] Thus far, efforts have been emphasized on health communication or educational programs that promote individual acceptance and physician recommendation of HPV vaccines.[37–39] Our study indicates that in order to increase HPV vaccine uptake to the recommended levels in the US, strategies should also focus on improving access to and utilization of health services by both adults and children.

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Table 1

HPV vaccination among women aged 18–26 years in 5 US states, BRFSS 2010

Characteristics	Women				
	Total N	Ever had HPV vaccination		Completed HPV vaccination*	
		N	% (95% CI)	N	% (95% CI)
Total	706	258	41.6 (36.0,47.3)	182	74.8 (65.8,83.7)
Race-ethnicity					
White, non-Hispanic	485	187	42.6 (36.0,49.2)	139	77.4 (65.7,86.6)
Non-white	215	70	38.6 (27.3, 50.0)	42	64.0 (44.0,83.9)
Marital status					
Married/unmarried couple	236	44	16.3 (10.8,23.3)	30	---
Single/divorced/widowed/separated	468	213	50.9 (44.1,57.8) §	152	75.4 (64.1,84.6)
Educational level					
High School or less	275	85	32.9 (24.6,41.1)	50	72.1 (58.3,85.9)
Some college	240	94	51.6 (41.7,61.5)	68	75.1 (57.0,88.5)
College graduate	188	78	39.5 (29.1,50.0) †	63	76.3 (55.8,90.6)
Employment status					
Employed/self-employed	391	153	44.5 (36.6,52.5)	110	71.4 (58.3,84.5)
Not employed	312	105	38.4 (30.4,46.3)	72	79.8 (68.4,88.4)
Annual household income					
<=$50,000	364	113	32.1 (24.0,40.2)	64	57.0 (40.5,73.6)
>$50,000	194	82	45.4 (35.6,55.2)	69	85.0 (70.3,94.2)
Don’t know/refused/missing	148	63	53.2 (41.2,65.3) ‡	49	82.1 (63.9,93.6) †
Individual’s resident state					
Connecticut	118	45	45.8 (33.6,58.0)	33	---
Massachusetts	260	112	49.1 (39.7,58.6)	75	80.5 (70.2,88.5)
Rhode Island	121	53	48.0 (37.1,59.0)	40	82.5 (68.5,92.1)
West Virginia	90	17	23.2 (13.6,35.3)	16	---

Characteristics	Women				
	Total N	Ever had HPV vaccination		Completed HPV vaccination*	
		N	% (95% CI)	N	% (95% CI)
Wyoming	117	31	32.3 (22.5,42.2) ‡	18	---
County of residence					
Urban county	539	217	46.4 (39.7,53.1)	153	73.5 (63.4,83.5)
Rural county	167	41	24.8 (16.4,34.9) ‡	29	---
Any kind of health care coverage					
Yes	582	229	45.0 (38.7,51.3)	162	74.6 (64.9,84.3)
No	117	26	28.8 (16.4,41.2) †	18	---
Length of time since last routine checkup					
Within one year	483	201	46.8 (40.2,53.4)	147	79.4 (70.2,86.7)
>one year	215	56	30.6 (19.2,42.0) †	34	57.2 (31.0,82.4) †
Seasonal flu shot in the past 12 months					
Yes	245	104	43.2 (33.9,52.5)	70	78.7 (66.6,87.9)
No	451	147	39.7 (32.5,46.9)	107	71.2 (58.4,83.9)
Ever had a pap test					
Yes	567	199	39.8 (33.4,46.2)	141	73.7 (62.8,84.5)
No	133	57	46.6 (34.5,58.8)	39	76.0 (56.9,89.7)

*The completion of HPV vaccination was the proportion of individuals who received all three doses among those who ever had an HPV vaccination. Weighted percentages and their 95% confidence intervals were not calculated for cells with <50 individuals.

†P <0.05;

‡P<0.01;

§P<0.0001 (bivariate analysis Rao-Scott chi-square test).

Table 2

Factors associated with HPV vaccination among women aged 18–26 years in 5 US states

Characteristics	Women	
	HPV vaccine initiation	HPV vaccine completion
	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Age (vs. 21–26 years)		
18–20 years	6.39 (3.28, 12.5) ‡	2.93 (1.01, 8.46) *
Race-ethnicity (vs. white)		
Non-white	0.73 (0.40, 1.33)	0.52 (0.17, 1.61)
Marital status (vs. married/unmarried couple)		
Single/divorced/widowed/separated	4.83 (2.59, 9.04) ‡	---
Educational level (vs. college graduate)		
High School or less	0.58 (0.27, 1.24)	0.47 (0.13, 1.66)
Some college	1.36 (0.67, 2.75)	0.65 (0.16, 2.59)
Employment status (vs. employed)		
Not employed	0.71 (0.42, 1.20)	1.55 (0.55, 4.42)
Annual household income (vs. >$50,000)		
<=$50,000	0.77 (0.41, 1.45)	0.55 (0.16, 1.82)
Individual's county of residence (vs. urban county)		
Rural county	0.37 (0.19, 0.72) †	---
Any kind of health care coverage (vs. Yes)		
No	0.66 (0.30, 1.46)	---
Length of time since last routine checkup (vs. within one year)		
>one year	0.70 (0.37, 1.34)	---
Seasonal flu shot in the past 12 months (vs. Yes)		
No	0.82 (0.46, 1.38)	0.65 (0.25, 1.65)
Ever had a pap test (vs. Yes)		
No	0.44 (0.22, 0.89) *	0.65 (0.19, 2.28)

* P<0.05,

† P<0.01,

‡ P<0.0001 (multivariate logistic regression model).

Table 3

HPV vaccination among girls aged 9–17 years in 5 US states, BRFSS 2010

Characteristics	Girls				
	Total N	Ever had HPV vaccination		Completed HPV vaccination*	
		N	% (95% CI)	N	% (95% CI)
Child's characteristics					
Total	2201	612	24.6 (21.4,28.0)	308	50.3 (43.0,57.7)
Age					
9–12 years	1024	123	8.0 (5.7,10.8)	31	18.6 (9.7,30.9)
13–17 years	1177	489	41.1 (35.9,46.2) §	277	56.4 (48.3,64.5) §
Seasonal flu shot in the past 12 months					
Yes	761	270	29.4 (23.8,35.1)	140	48.5 (38.1,59.0)
No	1176	270	21.3 (17.1,26.0) †	138	54.0 (42.9,65.2)
Parent's characteristics:					
Age					
<35 years	242	62	19.0(11.4,28.7)	26	35.1(16.6,53.7)
>=35 years	1959	550	25.5(22.0,29.0)	282	52.0(44.3,59.8)
Sex					
Female	1460	454	29.7 (25.6,33.7)	248	56.0 (48.0,64.1)
Male	741	158	18.5 (13.7,24.2) ‡	60	39.2 (24.3,54.1)
Race-ethnicity					
Non-Hispanic white	1460	386	24.8 (20.9,28.9)	211	54.0 (45.0,63.0)
Non-Hispanic black	126	41	29.0 (15.7,42.4)	20	---
Hispanic	507	164	25.9 (18.6,33.3)	64	39.3 (23.8,54.8)
Other	82	15	7.0 (1.9,17.1)	9	---
Marital status					
Married/unmarried couple	1671	423	23.7 (20.1,27.5)	214	49.5 (40.9,58.1)
Single/divorced/widowed/separated	528	187	29.8 (23.0,36.6)	94	54.3 (42.7,65.8)

Characteristics	Girls				
	Total N	Ever had HPV vaccination		Completed HPV vaccination*	
		N	% (95% CI)	N	% (95% CI)
Educational level					
High School or less	779	218	23.5 (18.5,29.2)	104	56.9 (45.5,68.3)
Some college	577	163	24.2 (17.9,31.3)	83	49.8 (34.4,65.2)
College graduate	841	230	26.1 (20.7,31.4)	121	44.7 (33.3,56.0)
Employment status					
Employed/self-employed	1596	433	22.4 (18.9,26.2)	212	45.9 (37.4,54.3)
Not employed	600	178	30.6 (23.8,37.3) †	95	58.4 (45.2,71.7)
Annual household income					
<$15,000	191	70	23.2 (14.1,34.7)	33	63.2 (44.5,81.8)
$15,000– $50,000	685	186	24.5 (18.5,31.2)	90	50.6 (36.8,64.4)
$50,000	1163	313	25.6 (21.1,30.0)	164	47.8 (37.9,57.6)
Resident state					
Connecticut	344	97	28.9 (22.7,35.1)	45	47.0 (34.1,59.9)
Pennsylvania	468	137	25.4 (20.5,30.4)	78	54.9 (43.8,66.0)
Texas	956	260	23.9 (19.3,29.0)	117	48.7 (37.7,59.7)
West Virginia	162	38	21.8 (15.3,29.5)	19	---
Wyoming	271	80	27.1 (21.2,33.0)	49	60.3 (47.7,73.0)
County of residence					
Urban county	1547	440	25.8 (22.0,29.6)	220	48.9 (40.6,57.2)
Rural county	654	172	19.2 (14.7,24.4) †	88	59.2 (47.9,70.4)
Any kind of health care coverage					
Yes	1744	479	25.0 (21.4,28.9)	244	49.2 (41.0,57.5)
No	446	127	22.5 (15.9,30.4)	63	55.4 (39.3,71.6)
Could not see a doctor because of cost in the past 12 months					
Yes	446	137	33.1 (24.4,41.8)	69	47.0 (30.0,63.9)
No	1749	474	22.9 (19.6,26.5) †	238	51.4 (43.4,59.4)

Characteristics	Girls				
	Total N	Ever had HPV vaccination		Completed HPV vaccination*	
		N	% (95% CI)	N	% (95% CI)
Length of time since last routine checkup					
Within the past year	1322	393	27.3 (22.9,31.8)	213	53.7 (44.4,63.0)
Within the past 2–5 years	597	148	20.3 (15.1,26.4)	59	45.4 (30.4,60.4)
5 or more years ago/never	274	70	21.1 (14.0,29.9)	36	38.7 (20.2,57.2)

*The completion of HPV vaccination was the proportion of children who received all three doses among those who ever had an HPV vaccination. Weighted percentages and their 95% confidence intervals were not calculated for cells with <50 individuals.

†P <0.05;

‡P<0.01;

§P<0.0001 (bivariate analysis Rao-Scott chi-square test).

Table 4

Factors associated with HPV vaccination among children aged 9–17 years in 5 US states

Characteristics	Girls	
	HPV vaccine initiation	HPV vaccine completion
	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Child's characteristics:		
Age (vs. 13–17 years)		
9–12 years	0.09 (0.06, 0.14) ‡	0.13 (0.06, 0.31) ‡
Seasonal flu shot in the past 12 months (vs. Yes)		
No	0.44 (0.31, 0.64) ‡	0.75 (0.39, 1.44)
Parent's characteristics:		
Female sex	1.26 (0.82, 1.93)	1.43 (0.62, 3.31)
Age (vs. >=35 years)		
18–34 years	1.13 (0.65, 1.99)	0.57 (0.24, 1.36)
Race-ethnicity (vs. white)		
Non-white	1.09 (0.68, 1.75)	0.54 (0.24, 1.23)
Marital status (vs. married/unmarried couple)		
Single/divorced/widowed/separated	1.51 (0.96, 2.37)	.43 (0.71, 2.87)
Educational level (vs. college graduate)		
High School or less	0.89 (0.55, 1.45)	2.18 (0.94, 5.05)
Some college	0.91 (0.54, 1.54)	1.37 (0.59, 3.20)
Employment status (vs. employed)		
Unemployed	1.34 (0.84, 2.15)	1.40 (0.63, 3.11)
Annual household income (vs. >$50,000)		
<$15,000	0.55 (0.23, 1.29)	1.17 (0.33, 4.17)
$15,000– $50,000	0.80 (0.47, 1.38)	0.96 (0.41, 2.22)
Any kind health care coverage		
No	0.90 (0.46, 1.74)	2.35 (0.78, 7.12)
Could not see a doctor because of cost in the past 12 months (vs. No)		
Yes	2.26 (1.28, 4.00) †	0.62 (0.24, 1.58)
Length of time since last routine checkup (vs. within one year)		
Within the past 2–5 years	0.51 (0.33, 0.80) †	0.43 (0.21, 0.88) *
5 or more years ago/never	0.61 (0.35, 1.08)	0.37 (0.14, 0.98) *
Individual's county of residence (vs. urban county)		
Rural county	0.80 (0.53, 1.21)	1.00 (0.50, 1.97)

* P<0.05,

† P<0.01,

[‡] P<0.0001 (multivariate logistic regression model).