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Nativity Disparities in Human Papillomavirus Vaccination Among U.S. Adults

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Abstract

Introduction—Several studies have identified disparities in human papillomavirus (HPV)-related outcomes by nativity status (i.e., U.S. versus foreign born). However, few studies have explored whether vaccination differences exist by nativity status. Vaccination disparities have the potential to exacerbate HPV-related cancer disparities in the long term if left unaddressed. Therefore, authors investigated whether there were significant differences in HPV vaccination initiation (one or more dose) and completion (three or more doses) between U.S.-born and foreign-born men and women.

Methods—Using the 2011 to 2015 waves of the National Health Interview Survey, data from 15,967 U.S. men aged 18–32 years and 23,794 U.S. women aged 18–35 years were analyzed in February 2017. Multivariable logistic regression models were fit to determine whether nativity status predicted (1) HPV vaccination initiation and (2) HPV vaccination completion separately among men and women after adjusting for demographic, socioeconomic, and healthcare factors.

Results—Compared with those born in the U.S., foreign-born men and women had lower prevalence of HPV vaccine initiation and completion. Furthermore, after controlling for covariates, foreign-born men (OR=0.63, 95% CI=0.47, 0.85) and women (OR=0.57, 95% CI=0.49, 0.66) had significantly lower adjusted odds of HPV vaccination initiation compared with their U.S.-born counterparts. Additionally, foreign-born women had significantly lower adjusted odds of HPV vaccination completion (OR=0.56, 95% CI=0.46, 0.69).

Conclusions—Given the demographic, socioeconomic, and healthcare factors included in this study these factors did not appear to fully account for observed disparities, future research is needed to understand other factors that may contribute to nativity status disparities in HPV vaccination.

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INTRODUCTION

Persistent human papillomavirus (HPV) infection can lead to cervical, vulvar, vaginal, penile, anal, and oropharyngeal cancers, a disproportionate burden of which are experienced by racial/ethnic minorities in the U.S.¹ During recent years, black and Latina women, respectively, experienced the highest age-adjusted incidence of HPV-associated vaginal and cervical cancer of all racial/ethnic groups.² Additionally, cervical cancer among black, Latina, and Asian and Pacific Islander women is usually diagnosed at a later stage than among white women,³ contributing to higher cervical cancer deaths observed among black and Latina women.⁴ Similar racial/ethnic disparities are observed among men. During 2008–2012, black men had the highest incidence of HPV-associated anal and rectal cancer of all racial/ethnic groups, while Latino men, followed by black men, experienced the highest incidence of HPV-associated penile cancer.²

The HPV vaccine allows for primary prevention of HPV infection and HPV-associated cancers among U.S. adolescents and young adults.⁵ In 2006, the three dose HPV vaccination was recommended for all girls aged 11–12 years and unvaccinated young women aged 13–26 years. In 2009, it became recommended for all boys aged 11–12 years, unvaccinated young men aged 13–21 years, and men who have sex with men through age 26 years.⁶ However, coverage remains suboptimal for boys and girls, with only 50% of boys and 63% of girls having initiated vaccination in 2015.^{7,8} Furthermore, several studies have reported that black and Latina women have lower odds of initiation and completion than white women.^{9,10} Although the HPV vaccination has the potential to avert adverse HPV-related health outcomes, significant racial/ethnic disparities persist.

Several studies have identified significant disparities by nativity status. For example, foreign-born Latinas have higher odds of receiving a late-stage cervical cancer diagnosis than U.S.-born Latinas.¹¹ Other research found lower prevalence of cervical cancer screening among more recent immigrants,¹² which delays cancer detection. Despite these notable disparities, to the authors' knowledge, only one study by De and Budhwani¹³ has investigated HPV vaccination initiation by nativity status. This study found that foreign-born adults had a decreased odds of HPV initiation; however, research is needed to understand whether there are disparities in HPV vaccination initiation and completion.¹³ Socioeconomic and healthcare factors may contribute to nativity status disparities in vaccination initiation and completion, given the numerous barriers faced by foreign-born persons living in the U.S. This is important because vaccination uptake is critical to ameliorating long-term nativity status disparities in HPV-related health outcomes. This study aims to address these significant literature gaps by assessing differences in HPV vaccination initiation and completion by nativity status among U.S. men aged 18–32 years and U.S. women aged 18–35 years.

METHODS

Study Population

This study used pooled data from the National Health Interview Survey (NHIS) from 2011 to 2015. NHIS is an annual U.S. survey that uses a stratified, multistage sampling design to

capture a probability sample representative of the civilian, non-institutionalized population. Included survey waves were designed to oversample black, Latino/a, and Asian participants in order to obtain more accurate estimates for these populations.¹⁴ Analyses were conducted in February 2017 and restricted to adults eligible for HPV vaccination at some point in their lives, based on national HPV vaccination guidelines at the time of the study. This inclusion criterion was determined based on the year in which participants completed the survey (2011–2015), participants' ages at the time of the survey, and the year the HPV vaccination was recommended (2006 for women, 2009 for men). For example, a woman who was aged 35 years in 2015 was age 26 in 2006, when the vaccine was recommended for girls and young women, and would be included in the study sample. Thus, men aged 18–32 years and women aged 18–35 years, with maximum age of inclusion varying by survey year, were included in analyses. Adults with missing data regarding place of birth ($n=20$, 0.05%) were also excluded, resulting in an analytic sample of 39,761, comprised of 15,967 men aged 18–32 years and 23,794 women aged 18–35 years.

Measures

Authors investigated nativity status (U.S. born vs foreign born) as a primary predictor of HPV vaccination. Nativity status was assessed by NHIS in 2011–2015 by asking participants: *Were you born in the United States?* HPV vaccination was assessed by asking if participants had ever received one or more doses of the HPV vaccine. Participants who responded *yes* were subsequently asked how many vaccine doses they received (continuous variable). In these analyses, participant responses were used to create two dichotomous outcome variables, vaccination initiation and vaccination completion, with three or more vaccine doses indicating completion. In fall of 2016, guidelines were adjusted to recommend that adolescents aged 11–14 years need only two vaccine doses received >6 months apart.¹⁵ However, given data included in these analyses were collected prior to this updated recommendation, vaccination completion was defined as receiving three or more vaccine doses. The proportion of missing HPV vaccination data in the analytic sample was 5.2% ($n=2,030$) for initiation and 6.7% ($n=2,617$) for completion.

Ecosocial theory was used to identify factors believed to impact vaccination status. Ecosocial theory is a multilevel framework that centers around the concept of embodiment or how people physically incorporate lived experiences, informed selection of covariates. Pathways of embodiment portray how social, biological, and environmental factors interact with the body, impacting population health outcomes. However, the framework also highlights that disease distribution is impacted by institutional and structural factors that result in discrimination and inequalities, which contribute to observed health disparities.^{16–18} Therefore, demographic factors (age at HPV vaccination eligibility, race/ethnicity, geographic region, and relationship status), socioeconomic factors (educational attainment and employment status), and healthcare factors (health insurance status and usual source of care) were included as covariates.

Categorization of covariates is shown in Table 1. For age at HPV vaccination eligibility, two groups were generated: those eligible for vaccination at ages 11–17 years and those already aged 18 years when the vaccination recommendation for their respective gender group was

made. These groups were determined under the assumption that adolescents aged <18 years generally have less autonomy and more parental engagement in health-related decisions than those aged ≥18 years, which may play a role in HPV vaccination prevalence.¹⁹ Furthermore, those aged >18 years are not eligible for the Vaccines for Children Program, which helps provide vaccines for children of low-income families.²⁰ Group assignment was based on the year in which participants participated in the survey (2011–2015), participants' ages at the time of the survey, and the year the HPV vaccination was recommended (2006 for women and 2009 for men). The proportion of missing covariate data in the analytic sample ranged from 0.06% ($n=23$) for working for pay to 0.82% ($n=68$) for number of years in U.S.

Statistical Analysis

Descriptive characteristics of the sample were examined by gender and nativity status. Next, prevalence of HPV vaccination initiation and completion were investigated by nativity status for the total sample, and then stratified by gender. Finally, multivariable logistic regression models were fit, separately for men and women, to investigate the association between nativity status and HPV vaccination initiation and completion. Models were first adjusted for demographic, followed by socioeconomic, and finally healthcare factors. U.S.-born men and women served as the reference groups. Post-hoc exploratory analyses were conducted to explore potential differences in vaccination among foreign-born people in the U.S. <15 years and those in the U.S. for ≥15 years. This 15-year cut off for length of U.S. residency has been utilized in many other studies.^{21,22} Rather than testing interaction by gender, all analyses were stratified by gender because of small cell sizes. Data were weighted to adjust for NHIS's complex survey design using the "svy" command in Stata, version 14.

RESULTS

Percent distributions of demographic, socioeconomic, and healthcare factors of U.S. men aged 18–32 years and women aged 18–35 years are presented in Table 1. Compared with U.S.-born persons, foreign-born men and women were older and had a higher probability of being Latino/a or Asian. Foreign-born persons also had a lower probability of living in a Midwestern state and having completed a higher level of education. Additionally, foreign-born persons had a higher probability of being uninsured and a lower probability of having a usual source of care. Both foreign-born men and women had a higher probability of being married, and foreign-born women had a lower probability of having never been married and working for pay. About one third of foreign-born men and women had lived in the U.S. for ≥15 years, and 30.8% of men and 36.5% of women were U.S. citizens.

The weighted prevalence of HPV vaccination initiation and completion in the full analytic sample were 18.1% and 10.4%, respectively (Table 2). Prevalence of both initiation and completion were significantly higher among women than men. Foreign-born men had a significantly lower probability than U.S.-born men of having initiated (3.5% vs 6.0%, $p<0.0001$) or completed (0.8% vs 1.8%, $p<0.0001$) HPV vaccination. Similarly, foreign-born women had a significantly lower probability than U.S.-born women of having initiated (13.7% vs 29.5%, $p<0.0001$) or completed (7.2% vs 18.5%, $p<0.0001$) the HPV vaccination series.

Among men, disparities in HPV vaccination initiation and completion by nativity status persisted after adjusting for demographic factors (Tables 3 and 4, Model 1). Foreign-born men had significantly lower odds of having initiated (OR=0.56, 95% CI=0.42, 0.75) and completed (OR=0.50, 95% CI=0.27, 0.91) the HPV vaccination than their U.S.-born counterparts. Further adjusting for socioeconomic factors (Tables 3 and 4, Model 2) resulted in little change in observed AORs for both initiation (OR=0.56, 95% CI=0.42, 0.75) and completion (OR=0.49, 95% CI=0.26, 0.91). Finally, the addition of healthcare factors to the models (Tables 3 and 4, Model 3) resulted in slight attenuation of the adjusted odds, but foreign-born men still had significantly lower odds of having initiated HPV vaccination than U.S.-born men (OR=0.63, 95% CI=0.47, 0.85). However, the odds of having completed the HPV vaccination were no longer significantly lower among foreign-born men. Additionally, in this final model being aged 18 to 26 years at HPV vaccine eligibility, married, or uninsured were associated with lower adjusted odds of having initiated and having completed the HPV vaccination. Living in a Midwestern or Southern state and working for pay were associated with lower adjusted odds of having initiated vaccination. By contrast, having some college/an associate's degree was associated with higher adjusted odds of having initiated and having completed HPV vaccination, whereas having a usual source of care was associated with higher adjusted odds of having completed, but not with having initiated, HPV vaccination.

Similar patterns were observed among women. After adjusting for demographic factors (Tables 3 and 4, Model 1), foreign-born women had significantly lower odds of having initiated (OR=0.51, 95% CI=0.44, 0.59) and completed (OR=0.50, 95% CI=0.41, 0.62) the HPV vaccination than their U.S.-born counterparts. After adjusting further for socioeconomic factors (Tables 3 and 4, Model 2), foreign-born women still had significantly lower odds of both having initiated (OR=0.53, 95% CI=0.45, 0.61) and completed (OR=0.51, 95% CI=0.42, 0.63) the vaccination compared with U.S.-born women. Finally, when healthcare factors were added to the models (Tables 3 and 4, Model 3), foreign-born women still had significantly lower adjusted odds of having initiated (OR=0.57, 95% CI=0.49, 0.66) and completed (OR=0.56, 95% CI=0.46, 0.69) HPV vaccination compared with U.S.-born women. In this final model, being aged 18 to 26 years at HPV vaccine eligibility; black, Latina, or Asian; married or separated, divorced, or widowed; uninsured; or living in a Midwestern or Southern state were also associated with lowered adjusted odds of having initiated and having completed vaccination. Living in a Western state was associated with lowered adjusted odds of having completed vaccination. Having some college/an associate's degree, a Bachelor's degree, or a graduate/professional degree and a usual source of care were associated with higher adjusted odds of having initiated and having completed HPV vaccination.

Post-hoc exploratory analyses were conducted to investigate whether the association between nativity status and vaccination differed by number of years in the U.S. (<15 years vs ≥15 years). Given low rates of vaccination uptake among men, there was an insufficient sample size to pursue multivariable analyses. Among women, fully adjusted odds of having initiated HPV vaccination were significantly lower in foreign-born women in the U.S. <15 years compared with those in the U.S. ≥15 years (OR=0.65, 95% CI=0.50, 0.85). In fully adjusted vaccination completion models, foreign-born women in the U.S. <15 years had

significantly lower odds of having completed vaccination than those in the U.S. 15 years (OR=0.48, 95% CI=0.33, 0.70).

DISCUSSION

In this nationally representative sample, foreign-born men had significantly lower odds of having initiated, and foreign-born women of both having initiated and having completed, the HPV vaccination compared with their U.S.-born counterparts. This extends the study by De and Budhwani¹³ who found that foreign-born women, but not men, had lower odds of HPV vaccination initiation than their U.S.-born counterparts in a single wave of NHIS data. In contrast to their findings, this study found that nativity status was significantly associated with having initiated HPV vaccination among both men and women and that it was also associated with having completed vaccination among women.

The association between HPV vaccination and nativity status was not explained by demographic or socioeconomic differences observed between U.S.- and foreign-born adults. Furthermore, adjusting for healthcare access and utilization only slightly attenuated the association. The finding that being uninsured and having a usual source of care were generally associated with HPV vaccination initiation and completion among both men and women is consistent with prior literature.²³ However, it is noteworthy that foreign-born men still had lower odds of HPV vaccination initiation and foreign-born women still had lower odds of both initiation and completion than their U.S.-born counterparts after adjusting for these healthcare factors, suggesting that immigrants may face additional barriers that contribute to lower vaccination rates. For example, foreign-born Latinos have numerous barriers to health care, including language,^{24,25} transportation,²⁶ and documentation status, both at the individual^{24–26} and family level.²⁷

Additionally, some immigrant populations may not be familiar with navigating the U.S. healthcare system or knowledgeable about U.S. preventative medical guidelines. This can be a barrier if their approach to healthcare prioritizes treating symptoms rather than seeking regular preventative services.²⁶ For those who seek care, healthcare providers have the potential to increase HPV vaccine uptake, as healthcare provider recommendation has been associated with HPV vaccination.²⁸ Studies have also shown that providers may be less likely to recommend HPV vaccination to boys and men than to girls and women²⁹ and that minority parents are less likely to report having received a provider recommendation,³⁰ which may be exacerbated by language barriers. To decrease these disparities, providers may need to develop greater comfort discussing HPV vaccination with foreign-born clients and with males. In some communities, it may be preferable that this information come from more trusted sources, such as physicians and community health workers who also identify as part of the community.

The covariates in this study did not account for the observed association between vaccination status and nativity. Thus, it is likely there are unmeasured cultural/social variables, for example acculturation^{31–33} and collectivism,^{34,35} that may be associated with vaccination uptake. Furthermore, studies have found that many parents do not vaccinate their daughters, or delay vaccination, because of fear that vaccination encourages them to engage

in sexual behavior.³⁶ Delay in vaccination results in women receiving the HPV vaccination at older ages, reducing the population-level impact of vaccination if sexual initiation occurs prior to vaccination. Community-based studies have found that racial/ethnic minority communities desire HPV educational programs that are culturally and linguistically appropriate.³⁷ Therefore, future research should investigate the potential role of social and cultural factors in nativity status disparities in HPV vaccination. Furthermore, HPV intervention programs designed with community participation are needed to ensure cultural appropriateness and integration of key cultural factors of the community of interest.

Limitations

This study had several limitations. Although this study investigated nativity status disparities, which are less often investigated than racial/ethnic disparities, both approaches aggregate subpopulations into broad categories. In this study, participants were classified into U.S. versus foreign born, which may mask important differences within the foreign-born group. Future studies should investigate whether associations between nativity status and HPV vaccination, as well as other vaccination-related factors, differ by race/ethnicity. All data were self-reported, so HPV vaccination and completion were not verified by medical records. Some characteristics, such as annual household income <\$75,000 and Latino ethnicity, have been associated with over-reporting vaccination.³⁸ However, this would likely result in underestimation of nativity status differences in HPV vaccination. Although the odds of HPV vaccination completion among foreign-born men were not significantly lower than among U.S.-born men after adjusting for healthcare factors, this finding should be interpreted with caution, as it may be due in part to small cell sizes for men who completed vaccination. Furthermore, NHIS does not collect information on factors such as provider recommendation. Based on these analyses, authors cannot investigate whether foreign-born individuals were less likely to have received a provider vaccine recommendation, whether there was differential refusal of vaccine uptake by nativity, or whether providers were perceived as culturally competent.

CONCLUSIONS

This study found that after accounting for demographic, socioeconomic, and healthcare factors, foreign-born men and women had lower odds of having initiated HPV vaccination and foreign-born women had lower odds of having completed the HPV vaccination than U.S.-born men and women. If observed vaccination disparities remain unaddressed, this could have long-term implications for nativity status disparities in HPV-associated cancers among U.S. adults. Future research should investigate other factors, such as acculturation, that may be associated with observed nativity status differences in HPV vaccination as well as factors associated with differential vaccination uptake by gender. This study found that access to health care is insufficient to reduce vaccination disparities. Therefore, there is a significant need for programs targeting clinics in predominantly foreign-born serving areas in order to ameliorate these disparities.

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Table 1
Distribution of Demographic, Socioeconomic, and Healthcare Factors in Relation to Gender and Nativity (N=39,761)

Variable (%)	Total	Men (n=15,967)		Women (n=23,794)	
		Foreign-born n=2,927 (15.13%)	U.S.-born n=13,040 (84.87%)	Foreign-born n=4,452 (15.44%)	U.S.-born n=19,342 (84.56%)
Age at time of survey (years)					
18–21	21.9	17.8	26.3	12.7	20.9
22–26	35.8	39.4	41.0	28.1	32.8
>26	42.3	42.8	32.7	59.2	46.3
Age at HPV vaccination eligibility (years) ^a					
11–17	33.0	18.9	26.3	27.8	40.7
18–26	67.0	81.1	73.7	72.2	59.3
Race/ethnicity					
White	60.6	19.7	70.6	17.9	66.4
Black	13.6	8.9	11.6	9.0	16.6
Latino/a	17.3	46.2	12.4	48.3	11.5
Asian	5.7	24.5	2.6	24.0	2.3
Native	0.6	0.3	0.5	0.2	0.7
Multiracial	2.1	0.5	2.3	0.6	2.5
Years in U.S. ^b					
<1 year	3.2	3.8	–	2.8	–
1–5 years	22.0	25.5	–	19.5	–
5–10 years	23.2	24.3	–	22.4	–
10–15 years	20.3	19.3	–	21.0	–
>15 years	31.3	27.2	–	34.3	–
U.S. citizen: yes	84.7	30.8	100.0	36.5	100.0
Geographic region					
Northeast	15.3	19.1	14.3	18.9	14.8
Midwest	24.7	16.9	27.3	15.0	25.5
South	37.3	36.0	35.6	36.5	38.9
West	22.8	28.0	22.8	29.6	20.8

Variable (%)	Total N=39,761	Men (n=15,967)		Women (n=23,794)	
		Foreign-born n=2,927 (15.13%)	U.S.-born n=13,040 (84.87%)	Foreign-born n=4,452 (15.44%)	U.S.-born n=19,342 (84.56%)
Relationship status					
Married	25.9	25.7	17.6	46.9	28.2
Living with a partner	11.6	8.6	11.4	10.1	12.4
Separated, divorced, or widowed	4.5	2.8	2.4	6.8	5.9
Never married	58.0	62.8	68.6	36.2	53.6
Educational attainment					
<High school diploma	11.0	20.6	9.5	22.8	8.6
High school diploma or GED	22.6	22.0	26.4	19.9	20.4
Some college or associate's degree	38.5	26.7	40.0	25.9	41.1
Bachelor's degree	21.1	18.8	19.6	20.4	22.5
Graduate or professional degree	6.9	11.9	4.4	11.0	7.3
Working for pay: yes	68.8	73.5	72.7	52.8	68.2
Uninsured: yes	20.7	41.3	20.4	34.7	15.8
Has usual source of care: yes	74.5	52.1	68.5	71.6	82.3

Note: Participants with missing nativity data were excluded from the sample (n=20; 0.05%). Percentages may not add up to 100 due to rounding.

^a Age at HPV vaccination eligibility was estimated based on the year the HPV vaccine was approved for use (2006 for girls and women, 2009 for boys and men), survey year, and participants' age at the time of the survey.

^b Only assessed among those not born in the U.S.

HPV, human papillomavirus; GED, general education diploma

Prevalence of HPV Vaccination Initiation and Completion in Relation to Gender and Nativity (N=39,761)

Table 2

Variable	Total sample				Men				Women			
	Total	n	% (95 % CI)	p-value	Total	n	% (95 % CI)	p-value	Total	n	% (95 % CI)	p-value
HPV vaccination initiation												
Total	39,761	6,567	18.1 (17.5, 18.8)		15,967	825	5.6 (5.0, 6.2)		23,794	5,742	27.1 (26.1, 28.1)	
Nativity												
Foreign-born	7,379	607	9.5 (8.6, 10.5)	<0.0001	2,927	89	3.5 (2.7, 4.5)	<0.0001	4,452	518	13.7 (12.4, 15.2)	<0.0001
U.S. - born	32,382	5,960	19.7 (18.9, 20.4)	ref	13,040	736	6.0 (5.4, 6.7)	ref	19,342	5,224	29.5 (28.4, 30.6)	ref
HPV vaccination completion												
Total	39,761	3,601	10.4 (9.9, 11.0)		15,967	245	1.6 (1.4, 1.9)		23,794	3,356	16.8 (15.9, 17.6)	
Nativity												
Foreign- born	7,379	273	4.5 (3.9, 5.2)	<0.0001	2,927	17	0.8 (0.5, 1.4)	0.0001	4,452	256	7.2 (6.1, 8.4)	<0.0001
U. S.- born	32,382	3,328	11.5 (10.9, 12.1)	ref	13,040	228	1.8 (1.5, 2.1)	ref	19,342	3,100	18.5 (17.5, 19.4)	ref

Note: Participants with missing nativity data were excluded from the sample (n=20; 0.05%). The proportion of missing data was 5.2% (n=2,030) for HPV vaccination initiation and 6.7% (n=2,617) for vaccination completion. P-values are based on adjusted Wald tests (reference: native-born). Boldface indicates statistical significance ($p<0.05$).

HPV, human papillomavirus

Table 3
Logistic Regression Models for Odds of HPV Vaccination Initiation in Relation to Gender and Nativity (N=39,761)

Variable	Men (n=15,967)				Women (n=23,794)			
	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Nativity								
U.S.-born (ref)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Foreign-born	0.57 (0.45, 0.73)	0.56 (0.42, 0.75)	0.56 (0.42, 0.75)	0.63 (0.47, 0.85)	0.38 (0.33, 0.43)	0.51 (0.44, 0.59)	0.53 (0.45, 0.61)	0.57 (0.49, 0.66)
Age at HPV vaccination eligibility (years) ^a								
11–17		1.0	1.0	1.0		1.0	1.0	1.0
18–26		0.31 (0.25, 0.39)	0.34 (0.27, 0.43)	0.38 (0.29, 0.47)		0.36 (0.32, 0.39)	0.30 (0.27, 0.33)	0.30 (0.27, 0.33)
Race/ethnicity								
White		1.0	1.0	1.0		1.0	1.0	1.0
Black		1.05 (0.80, 1.38)	1.03 (0.78, 1.36)	1.10 (0.82, 1.46)		0.71 (0.63, 0.79)	0.82 (0.73, 0.93)	0.83 (0.73, 0.93)
Latino/a		0.97 (0.76, 1.24)	1.04 (0.82, 1.32)	1.15 (0.90, 1.46)		0.69 (0.62, 0.77)	0.83 (0.75, 0.93)	0.87 (0.77, 0.97)
Asian		1.23 (0.87, 1.74)	1.05 (0.73, 1.50)	1.03 (0.71, 1.49)		0.77 (0.64, 0.93)	0.68 (0.57, 0.82)	0.68 (0.56, 0.82)
Native		0.55 (0.12, 2.48)	0.57 (0.13, 2.55)	0.64 (0.15, 2.84)		0.86 (0.52, 1.43)	1.08 (0.65, 1.79)	1.00 (0.61, 1.66)
Multiracial		1.18 (0.65, 2.13)	1.16 (0.63, 2.11)	1.22 (0.67, 2.20)		1.10 (0.87, 1.39)	1.16 (0.91, 1.47)	1.16 (0.91, 1.48)
Geographic region								
Northeast		1.0	1.0	1.0		1.0	1.0	1.0
Midwest		0.55 (0.37, 0.80)	0.57 (0.39, 0.83)	0.57 (0.39, 0.83)		0.70 (0.60, 0.81)	0.73 (0.63, 0.84)	0.74 (0.64, 0.86)
South		0.49 (0.34, 0.70)	0.49 (0.34, 0.71)	0.52 (0.37, 0.74)		0.59 (0.52, 0.67)	0.60 (0.53, 0.68)	0.64 (0.56, 0.72)
West		0.79 (0.55, 1.12)	0.79 (0.56, 1.12)	0.80 (0.57, 1.12)		0.84 (0.73, 0.96)	0.84 (0.73, 0.96)	0.88 (0.77, 1.00)
Relationship status								
Never married (ref)		1.0	1.0	1.0		1.0	1.0	1.0
Married		0.68 (0.51, 0.91)	0.73 (0.55, 0.98)	0.69 (0.51, 0.93)		0.54 (0.48, 0.60)	0.54 (0.48, 0.60)	0.53 (0.47, 0.58)
Living with a partner		0.77 (0.57, 1.05)	0.87 (0.64, 1.20)	0.92 (0.67, 1.26)		0.88 (0.77, 1.00)	0.93 (0.81, 1.06)	0.94 (0.83, 1.08)
Separated, divorced, or widowed		1.10 (0.59, 2.06)	1.24 (0.66, 2.34)	1.29 (0.68, 2.45)		0.60 (0.49, 0.73)	0.68 (0.55, 0.84)	0.68 (0.55, 0.84)
Educational attainment								
< High school diploma			1.0	1.0			1.0	1.0

Variable	Men (n=15,967)			Women (n=23,794)		
	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
High school diploma or GED			1.14 (0.77, 1.68)	1.12 (0.76, 1.66)		1.16 (0.99, 1.36)
Some college or associate's degree			1.61 (1.17, 2.22)	1.46 (1.05, 2.03)		1.76 (1.53, 2.03)
Bachelor's degree			1.35 (0.93, 1.97)	1.15 (0.77, 1.69)		2.68 (2.31, 3.11)
Graduate or professional degree			1.78 (1.03, 3.07)	1.47 (0.84, 2.56)		2.76 (2.29, 3.32)
Working for pay: yes			0.60 (0.49, 0.73)	0.60 (0.49, 0.75)		1.04 (0.95, 1.15)
Uninsured: yes				0.48 (0.36, 0.63)		0.68 (0.60, 0.77)
Has usual source of care: yes				1.13 (0.91, 1.40)		1.32 (1.17, 1.48)

Note: Model 1 is adjusted for survey year, age at HPV vaccination eligibility, race/ethnicity, geographic region, and relationship status. Model 2 also adjusts for educational attainment and employment status. Model 3 also adjusts for insurance status and usual source of care. Bolded values refer to ORs with 95% CIs excluding 1. ORs are based on distributions that do not include missing data.

^a Age at HPV vaccination eligibility was estimated based on the year the HPV vaccine was approved for use (2006 for girls and women, 2009 for boys and men), survey year, and participants' age at the time of the survey.

HPV, human papillomavirus; GED, general education diploma.

Table 4

Logistic Regression Models for Odds of HPV Vaccination Completion in Relation to Gender and Nativity (N=39,761)

Variable	Men (n=15,967)				Women (n=23,794)			
	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Nativity								
U.S.-born (ref)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Foreign-born	0.46 (0.27, 0.79)	0.50 (0.27, 0.91)	0.49 (0.26, 0.91)	0.61 (0.33, 1.13)	0.34 (0.29, 0.41)	0.50 (0.41, 0.62)	0.51 (0.42, 0.63)	0.56 (0.46, 0.69)
Age at HPV vaccination eligibility (years) ^a								
11–17 (ref)		1.0	1.0	1.0		1.0	1.0	1.0
18–26		0.28 (0.20, 0.39)	0.30 (0.21, 0.42)	0.35 (0.24, 0.50)		0.38 (0.34, 0.43)	0.29 (0.25, 0.32)	0.29 (0.26, 0.33)
Race/ethnicity								
White		1.0	1.0	1.0		1.0	1.0	1.0
Black		0.69 (0.42, 1.13)	0.74 (0.45, 1.24)	0.81 (0.49, 1.35)		0.35 (0.30, 0.41)	0.43 (0.36, 0.50)	0.43 (0.37, 0.50)
Latino/a		0.94 (0.63, 1.41)	1.04 (0.69, 1.58)	1.19 (0.78, 1.81)		0.52 (0.45, 0.60)	0.66 (0.57, 0.76)	0.69 (0.60, 0.80)
Asian		1.23 (0.66, 2.28)	1.01 (0.55, 1.86)	0.98 (0.53, 1.81)		0.73 (0.60, 0.88)	0.62 (0.51, 0.76)	0.61 (0.50, 0.75)
Native		0.35 (0.05, 2.39)	0.40 (0.06, 2.71)	0.47 (0.07, 3.12)		0.71 (0.39, 1.30)	0.97 (0.56, 1.68)	0.92 (0.53, 1.62)
Multiracial		1.05 (0.46, 2.39)	1.05 (0.46, 2.40)	1.13 (0.49, 2.59)		0.82 (0.62, 1.08)	0.88 (0.67, 1.16)	0.87 (0.66, 1.14)
Geographic region								
Northeast (ref)		1.0	1.0	1.0		1.0	1.0	1.0
Midwest		0.90 (0.57, 1.41)	0.92 (0.58, 1.45)	0.98 (0.62, 1.54)		0.64 (0.55, 0.76)	0.68 (0.58, 0.80)	0.70 (0.60, 0.82)
South		0.66 (0.40, 1.08)	0.65 (0.39, 1.09)	0.74 (0.44, 1.23)		0.55 (0.48, 0.64)	0.56 (0.49, 0.65)	0.60 (0.52, 0.70)
West		1.21 (0.79, 1.85)	1.22 (0.79, 1.88)	0.88 (0.50, 1.56)		0.72 (0.62, 0.85)	0.72 (0.61, 0.85)	0.77 (0.65, 0.90)
Relationship status								
Never married (ref)		1.0	1.0	1.0		1.0	1.0	1.0
Married		0.28 (0.13, 0.59)	0.30 (0.14, 0.65)	0.28 (0.13, 0.60)		0.44 (0.38, 0.51)	0.44 (0.38, 0.50)	0.43 (0.37, 0.49)
Living with a partner		0.71 (0.41, 1.23)	0.81 (0.46, 1.43)	0.88 (0.50, 1.56)		0.80 (0.69, 0.93)	0.86 (0.74, 1.00)	0.89 (0.77, 1.03)
Separated, divorced, or widowed		1.19 (0.38, 3.71)	1.39 (0.44, 4.40)	1.41 (0.44, 4.48)		0.40 (0.30, 0.53)	0.48 (0.36, 0.65)	0.48 (0.36, 0.65)
Educational attainment								
< High school diploma			1.0	1.0			1.0	1.0

Variable	Men (n=15,967)			Women (n=23,794)		
	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Unadjusted OR (95% CI)	Model 3 OR (95% CI)
High school diploma or GED			1.02 (0.53, 1.97)	0.98 (0.51, 1.90)		1.24 (0.97, 1.58)
Some college or associate's degree			2.36 (1.28, 4.34)	1.97 (1.06, 3.66)		2.11 (1.69, 2.64)
Bachelor's degree			1.43 (0.66, 3.13)	1.09 (0.49, 2.40)		3.96 (3.14, 4.98)
Graduate or professional degree			2.15 (0.63, 7.27)	1.57 (0.45, 5.42)		4.12 (3.11, 5.46)
Working for pay: yes			0.70 (0.49, 0.99)	0.70 (0.49, 1.02)		1.04 (0.93, 1.17)
Uninsured: yes				0.26 (0.14, 0.46)		0.52 (0.44, 0.61)
Has usual source of care: yes				1.64 (1.01, 2.66)		1.36 (1.18, 1.58)

Note: Model 1 is adjusted for survey year, age at HPV vaccination eligibility, race/ethnicity, geographic region, and relationship status. Model 2 also adjusts for educational attainment and employment status. Model 3 also adjusts for insurance status and usual source of care. Bolded values refer to ORs with 95% CIs excluding 1. ORs are based on distributions that do not include missing data.

^a Age at HPV vaccination eligibility was estimated based on the year the HPV vaccine was approved for use (2006 for girls and women, 2009 for boys and men), survey year, and participants' age at the time of the survey.

HPV, human papillomavirus; GED, general education diploma.