



## Differences in human papillomavirus (HPV) vaccine uptake by nativity status among men aged 18–34 years

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### ABSTRACT

Annually, about 16,500 HPV-associated cancers occur in the US among men. Data regarding HPV vaccine uptake among men based on nativity status (i.e., US-versus foreign-born) is limited, yet potentially important for informing interventions. We assessed differences in HPV vaccine uptake by nativity status among men aged 18–34 years in the US. The 2014–2017 National Health Interview Survey was examined for men, aged 18–34 years ( $n = 14,056$ ). HPV vaccine initiation was defined as receipt of at least one dose of the vaccine and completion as receipt of three doses. Weighted, multivariable binary logistic regression models were used to assess the association between nativity status and HPV vaccine uptake, adjusting for demographic, socioeconomic, and healthcare factors. Analyses were performed in July 2018. Overall, 17% of men self-identified as foreign-born, 9.9% of men had initiated the HPV vaccine, and 3.3% had completed the HPV vaccine. Among foreign-born men, Asians had the highest HPV vaccination rates whereas those from Indian subcontinental region had the lowest rates. After accounting for demographic, socioeconomic, and healthcare factors, compared to US-born men, foreign-born men were 46% (adjusted odds ratio = 0.54; 95% CI = 0.39–0.72) less likely to initiate the HPV vaccine but there was no difference between the two groups in terms of vaccine completion. We found that HPV vaccine uptake among men was very low overall, and foreign-born men had lower initiation compared to US-born men. Public health interventions which improve HPV vaccination need to be developed for all men, irrespective of nativity status.

### 1. Introduction

Currently, an estimated 79 million individuals in the United States (US) are infected with at least one type of human papillomavirus (HPV), and an estimated 14 million new infections occur each year (Viens et al., 2016). There are at least 150 types of HPV, some of which are oncogenic or high-risk for causing cancer (Viens et al., 2016). Oncogenic HPV subtypes are thought to be responsible for more than 90% of anal, 70% of oropharynx, and 60% of penile cancers (National Vaccine Advisory Committee, 2016; World Health Organization, 2016). HPV infection is not only associated with primary cancers but are also attributable to second primary cancers (Adjei Boakye et al., 2018a,

2018b, 2019). More than 40% of all HPV-related cancers in the US occur in men (Viens et al., 2016). There will be an estimated 35,130 oral, 8,300 anal and 2,080 penile cancer incident cases among men in 2019 in the US (Siegel et al., 2019). Approximately 16,500 HPV-associated cancers (including anal, penile, and oropharyngeal cancers) occur among men in the US annually (Centers for Disease Control and Prevention, 2018a). HPV-associated oral cancers are more common in men, and account for the largest burden of HPV-associated cancers in the US, with an estimated 10,700 cancers occurring annually (Centers for Disease Control and Prevention, 2018a).

The foreign-born are the fastest growing population in the US. Since 1970, the foreign-born population has increased tremendously from 9.6

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million to 40 million in 2010, with most foreign-born individuals immigrating to the US from Latin America and Asia (India and China) (United States Census Bureau). There is a huge burden of HPV infection among foreign-born in the US. For example, Bhattacharya et al. recently reported the rate of any HPV infection to be 39%, high risk infection to be 22%, and vaccine preventable infection to be 12% among foreign-born men in the US (Bhattacharya et al., 2019). HPV-associated anal cancers in males are higher in Asia (India and China) than in the US, while HPV-associated penile cancers are higher in Latin America and Asia (India and China) than in the US (de Martel et al., 2017).

A factor associated with HPV and HPV-related diseases among the foreign-born is acculturation, defined as the process by which individuals adopt the attitudes, values, customs, beliefs, and behaviors of another culture (LaFromboise et al., 1993). Acculturation may affect health behaviors; the underlying assumption is that beliefs or norms concerning particular behaviors change with greater acculturation. Although there is no single measurement of acculturation in research, those that have been used include nativity or generational status, length of residence in the US, and language use. In this study, we focused on nativity status and number of years in the US. Foreign-born men may be at higher risk for HPV-associated cancers given known barriers to accessing health care and preventive services such as vaccination in their country of origin and when they immigrate to the US (Derose et al., 2009). There is a paucity of studies that have focused on men; the earliest studies included only women (Cofie et al., 2018), more recent studies seem to compare men and women (Perez et al., 2018), but studies focusing on men are rare.

The Advisory Committee on Immunization Practices (ACIP) recommends routine HPV vaccination for adolescents between 11 and 12 years of age (Markowitz et al., 2014). Catch-up vaccination is recommended for females aged 13–26 years and males aged 13–21 years, with vaccination up to 26 years for immune-compromised men or men who have sex with men (Markowitz et al., 2014). The most recent national coverage estimates indicated that 56% of 13–17-year-old males (Walker et al., 2017) and 14% of 19–26-year-old males (Adjei Boakye et al., 2018c) had initiated the HPV vaccine; and 35% of 13–17-year-old males (Walker et al., 2017) and 4% of 19–26-year-old males (Adjei Boakye et al., 2018c) had completed the HPV vaccine series. It is reasonable to expect that vaccination rates are even lower among foreign-born men as a previous study found that vaccination coverage for various routinely recommended adult vaccines in the US were lower among foreign-born individuals compared with US-born individuals (Lu et al., 2014).

With the increasing incidence rates of HPV-associated cancers as well as the rising numbers of foreign-born individuals in the US, it is important to understand patterns of HPV vaccine uptake among foreign-born individuals. Cofie et al found lower HPV vaccine initiation among foreign-born women compared with US-born women (Cofie et al., 2018) but did not examine initiation among men or HPV vaccine completion. In addition, a few studies have focused on adolescent males or men who have sex with men, but did not focus on foreign-born populations (Landis et al., 2018; Oliver et al., 2017). Little is known about the uptake of HPV vaccination among foreign-born men, differences in subgroups, and the characteristics that influence HPV vaccine uptake. We aimed to fill this gap in the literature by assessing differences in HPV vaccine initiation and completion among US-born and foreign-born men aged 18–34 years living in the US who immigrated from different regions of the world. Understanding HPV vaccine uptake based on nativity status may help identify groups for whom additional or targeted efforts are needed to achieve national goals for HPV vaccination.

## 2. Materials and methods

### 2.1. Data source

Data were obtained from the National Health Interview Survey (NHIS) (National Center for Health Statistics, 2018) from 2014 to 2017.

NHIS is a nationally representative annual health survey, conducted by the National Center for Health Statistics (NCHS) under the Centers for Disease Control and Prevention (CDC). NHIS covers a broad range of health topics and includes the civilian non-institutionalized population residing in the US. The data were collected through a personal household interview conducted by the US Census Bureau. One civilian adult per family is randomly selected for a detailed interview that includes health status, health behavior and utilization of health care. Details of survey development, design, and methodology have been published elsewhere (Parsons et al., 2014). The NHIS was approved by the research ethics review board of the NCHS. The study was deemed exempt by the Southern Illinois University School of Medicine Institutional Review Board.

A total unweighted sample of 15,350 men 18–34 years of age were included because men who were between the ages of 18 and 34 years at the time of the survey (2014–2017) would have been eligible to have received the HPV vaccine, based on the year of licensure for males in the US. For example, a man aged 25 years in 2016 was 18 years of age in 2009, when the vaccine was recommended for boys and young men. We excluded men who did not respond to questions regarding their country of birth ( $n = 7$ ) or HPV vaccination ( $n = 1287$ ) resulting in a final sample of 14,056 men for analysis.

### 2.2. Measures

The outcome variables were HPV vaccine initiation and completion. HPV vaccine initiation was assessed with the question “Ever received HPV shot/vaccine?” Participant responses were dichotomized (yes or no). Participants who responded yes were subsequently asked how many doses of the HPV vaccine they had received. Participants with three or more vaccine doses were categorized ‘yes’ for completion and those with less than three doses were categorized as ‘no’.

The main independent variable was nativity status (US-born or foreign-born). Participants were asked where they were born, and those who were not born in the US or US territory were categorized as foreign-born. Men who were born in the US were categorized as US-born.

Sociodemographic characteristics and access to health care variables potentially related to HPV initiation and completion were selected based on previous literature (Adjei Boakye et al., 2017a, 2018c; Perez et al., 2018). They include: age at time of interview, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or non-Hispanic other), marital status (married or not married), education (less than high school, high school graduate, some college, or college graduate), insurance status (yes or no), whether or not they have a usual place of getting healthcare, health care utilization (number of health care visits in the past 12 months [none, 1–5 or  $\geq 6$ ]), general health (excellent, very good, good or poor/fair), and location of residence based on Census region.

Foreign-born men were asked their country of origin, and their responses were categorized into geographic regions: Mexico/Central America/Caribbean Island, South America, Europe (including Russia), Africa, Indian Subcontinent, Asia, Southeast Asia, and Other (Middle East, unknown). Foreign-born men were also asked how long they had been in the US and categorized as:  $< 10$  years, and  $\geq 10$  years based on cutoffs from previous literature (Lu et al., 2014).

### 2.3. Statistical analysis

All analyses were performed in SAS 9.4 (SAS Institute Inc., Cary, NC) using survey-specific procedures, which incorporate survey sampling weights and stratum to account for the complex sampling design used in the NHIS (National Center for Health Statistics, 2018) and to provide representative estimates of the U.S. population. Descriptive statistics were used to analyze participants' characteristics. We compared sample characteristics by nativity status using Chi-squared tests for categorical variables and independent samples t-tests for continuous

variables. Among foreign-born men, prevalence of HPV vaccination initiation and completion were investigated by region of birth, length of residence in the US and US citizenship status. Multivariable binary logistic regression was used to examine the association between nativity status and HPV vaccine initiation and completion. Two models (initiation and completion pair) were constructed; the first model controlled for sociodemographic variables, general health and geographic region. The second model added healthcare access variables (health insurance, usual source of care, and number of doctor visits). Next, separate multivariable logistic regression models were evaluated for US-born and foreign-born males to investigate the associations between patient characteristics and HPV vaccination initiation and completion. Finally, to account for the effect of acculturation among foreign-born men, three models (initiation and completion pair) were developed for foreign-born men only. The first model controlled for U.S. citizenship status, the second model controlled for length of U.S. residency, and the third model controlled for both variables. Since the catch-up vaccination is up to 26 years, we conducted a sensitivity analyses by limiting the data to only those that were aged 18–26. We then rerun all the analyses above for this subpopulation. Statistical tests were two-tailed, and the significance level was set at  $P < 0.05$ .

### 3. Results

Table 1 summarizes demographic, socioeconomic and access to health care characteristics of US men ages 18–34, overall and by nativity status. A total of 14,056 men, with an average age of 27 years (SD = 5 years), were included in the study, of which 2,396 (17.0%) identified as foreign-born. Among the foreign-born men, 34.4% were US citizens, and approximately half (49.2%) were from Mexico/Central America/Caribbean Island.

The overall HPV initiation and completion rates were 9.9% and 3.3%, respectively (Table 1). When stratified by nativity status, HPV vaccine initiation was higher among US-born than foreign-born men (11.0% vs 4.5%); HPV vaccine completion was slightly higher among US-born men than among foreign-born men (3.7% vs 1.7%, Table 1). Among foreign-born men, both HPV vaccine initiation and completion rates were higher among those who obtained US citizenship (Table 2). Similarly, HPV vaccine uptake were higher for men who had been in the US for  $\geq 10$  years (Table 2). Foreign-born men from south-east Asia had the highest vaccine initiation while those from Europe had the highest completion rates and those from the Indian Subcontinent had the lowest rates for both initiation and completion (Table 2).

Disparities in HPV vaccination initiation and completion by nativity status assessed with two models are presented in Table 3. Model 1 adjusted for sociodemographic variables, general health and geographic region. Compared with US-born men, foreign-born men had lower odds of HPV vaccine initiation (OR = 0.48, 95% CI = 0.36, 0.65). The odds of initiation decreased slightly in Model 2 when healthcare access variables were added (OR = 0.54, 95% CI = 0.39, 0.72). However, in both Model 1 and Model 2, there were no significant difference between US-born and foreign-born men in terms of vaccine completion. As the number of healthcare visits increased, the likelihood of initiating and completing the HPV vaccination also increased.

In the adjusted analyses stratified by nativity status, among US-born men, the odds of initiating the HPV vaccine increased if they had visited the healthcare provider's office 1–5 times (OR = 2.10, 95% CI = 1.68, 2.62) or  $\geq 6$  times (OR = 3.39, 95% CI = 2.49, 4.62) as opposed to no health care visits (Table 4). Similarly, the odds of completing the 3-dose series increased if US-born men had visited the healthcare provider's office 1–5 times (OR = 2.18, 95% CI = 1.50, 3.17) or  $\geq 6$  times (OR = 4.18, 95% CI = 2.58, 6.77) as opposed to no visit to the healthcare provider. Among foreign-born men, the likelihood of initiating (OR = 1.86, 95% CI = 1.06, 3.26) and completing (OR = 4.06,

**Table 1**  
Characteristics of adult men aged 18–34 in the US overall and stratified by nativity status, NHIS (2014–2017).

	n (w%)			*p-value
	Total n = 14056	US Born Men n = 11,660 (83.0%)	Foreign Born Men n = 2396 (17.0%)	
HPV vaccine initiation:	1325 (9.9)	1206 (11.0)	119 (4.5)	< 0.0001
Yes				
HPV vaccine completion:	443 (3.3)	410 (3.7)	33 (1.7)	0.0011
Yes				
Age (Mean $\pm$ SD)	26.5 $\pm$ 4.8	26.3 $\pm$ 4.8	27.6 $\pm$ 4.5	< 0.0001
Race/ethnicity				
Non-Hispanic White	8584 (57.9)	8198 (66.5)	386 (15.8)	< 0.0001
Non-Hispanic Black	1523 (13.4)	1319 (13.9)	204 (11.2)	
Hispanic	2679 (21.8)	1578 (15.7)	1101 (51.4)	
Non-Hispanic Other	1269 (6.9)	564 (3.9)	705 (21.6)	
Marital status				
Married	5282 (41.0)	4202 (39.1)	1080 (50.5)	< 0.0001
Not Married	8759 (59.0)	7445 (60.9)	1314 (49.5)	
Educational attainment				
College graduate or higher	4006 (25.2)	3179 (24.5)	827 (29.1)	< 0.0001
Some college or associate degree	4959 (35.1)	4398 (37.2)	561 (24.7)	
High School diploma	3566 (27.2)	3054 (27.9)	512 (23.8)	
Less than high school degree	1493 (12.4)	1011 (10.4)	482 (22.4)	
Uninsured: Yes	2606 (18.8)	1779 (15.0)	827 (37.2)	< 0.0001
Has usual place of care: yes	9559 (70.0)	8185 (72.4)	1374 (58.4)	< 0.0001
Number of healthcare office visits in past year				
None	5002 (35.3)	3875 (32.8)	1127 (47.2)	< 0.0001
1–5	7684 (55.7)	6532 (57.3)	1152 (48.0)	
$\geq 6$	1353 (9.0)	1240 (9.9)	113 (4.8)	
General health				0.1200
Excellent	5658 (42.3)	4643 (42.2)	1015 (42.7)	
Very Good	5045 (33.6)	4238 (34.0)	807 (31.7)	
Good	2685 (19.3)	2197 (18.9)	488 (21.4)	
Poor/Fair	661 (4.8)	576 (4.9)	85 (4.1)	
Geographic Region				
West	4040 (25.1)	3245 (24.3)	795 (28.9)	< 0.0001
Northeast	1953 (15.5)	1582 (14.8)	371 (18.8)	
Midwest	3343 (23.4)	2943 (25.2)	400 (14.8)	
South	4719 (36.0)	3889 (35.6)	830 (37.5)	
Among Foreign-born men only				
US citizenship status				
Yes			741 (33.4)	
No			1643 (66.6)	
Years living in the US				
$\geq 10$ years			1226 (57.0)	
< 10 years			1170 (43.0)	
Birth region				
Central America			1044 (49.2)	
South America			130 (7.1)	
Europe			205 (8.5)	
Africa			134 (6.5)	
Indian Subcontinent			293 (8.7)	
Asia			217 (6.2)	
Southeast Asia			165 (5.8)	
Other			208 (8.0)	

n = frequency, w% = weighted percentage, \*p-value based on chi-square tests or independent samples t-test where appropriate; frequency or % may not add up due to missing or rounding.

NHIS = National Health Interview Survey; HPV = Human Papillomavirus; US = United States; SD = Standard Deviation.

**Table 2**  
Percentage of HPV vaccine initiation and completion among foreign-born men (aged 18–34 years), NHIS 2014–2017.

	Weighted percent (95% CI)	
	HPV Vaccine Initiation	HPV Vaccine Completion
US citizenship		
Yes	6.23 (4.19, 8.27)	2.16 (0.82, 3.50)
No	3.63 (2.44, 4.82)	1.53 (0.56, 2.49)
Years in the United States		
≥ 10 years	4.56 (3.04, 6.08)	2.23 (0.96, 3.50)
< 10 years	4.34 (3.02, 5.66)	1.05 (0.40, 1.71)
Birth region		
Central America	3.94 (2.42, 5.46)	1.68 (0.43, 2.93)
South America	5.44 (1.04, 9.83)	2.01 (0.01, 5.30)
Europe	5.54 (2.01, 9.06)	2.69 (0.01, 5.56)
Africa	4.24 (1.16, 7.32)	2.11 (0.01, 4.23)
Indian Subcontinent	2.16 (0.14, 4.18)	0.51 (0.01, 1.50)
Asia	4.67 (0.96, 8.38)	2.34 (0.01, 4.99)
South East Asia	6.67 (2.11, 11.22)	2.43 (0.01, 5.92)
Other	6.65 (2.00, 11.30)	0.75 (0.01, 2.22)

HPV = Human Papillomavirus; NHIS = National Health Interview Survey.

95% CI = 1.55, 10.63) the HPV vaccination increased if they had visited the healthcare provider’s office 1–5 times compared with no visit (Table 4).

In the analyses assessing the effects of US citizenship status and number of years living in the US for foreign-born men (acculturation), there were no significant association between US citizenship status and number of years living in the US and vaccine initiation for all models (Table 5; Model 1, Model 2, and Model 3). However, foreign-born men who had lived in the U.S. for < 10 years (OR = 0.33, 95% CI = 0.12, 0.92) were less likely to complete the vaccine compared with those who had lived in the US ≥ 10 (Model 2). The sensitivity analyses for men aged 18–26 produced similar results to main analysis (Supplemental Table 1 and 2).

**4. Discussion**

The American Society of Clinical Oncology and the American Cancer Society have released statements on cancer prevention through HPV vaccination, strengthening the call to increase HPV vaccine uptake across the United States (Bailey et al., 2016; Saslow et al., 2016). This analysis provides estimates of HPV vaccine uptake among men 18–34 years of age stratified by nativity status using a nationally

**Table 3**  
Factors associated with HPV vaccination uptake overall, NHIS (2014–2017).

	Adjusted Odds Ratio (95% Confidence Interval)			
	HPV vaccine initiation		HPV vaccine completion	
	Model 1	Model 2	Model 1	Model 2
Nativity status				
US born	Ref	Ref	Ref	Ref
Foreign born	0.48 (0.36, 0.65)	0.54 (0.39, 0.72)	0.65 (0.38, 1.12)	0.78 (0.45, 1.34)
Uninsured				
Yes	–	Ref	–	Ref
No	–	1.05 (0.80, 1.39)	–	1.24 (0.77, 1.98)
Has usual place of care				
Yes	–	Ref	–	Ref
No	–	0.96 (0.79, 1.17)	–	0.66 (0.46, 0.95)
Number of healthcare office visits in past year				
None	–	Ref	–	Ref
1–5	–	2.08 (1.69, 2.56)	–	2.35 (1.64, 3.37)
≥ 6	–	3.28 (2.45, 4.41)	–	4.38 (2.74, 6.99)

Models adjusted for age, race/ethnicity, marital status, education, general health, and geographic region. NHIS = National Health Interview Survey; HPV = Human Papillomavirus; US = United States.

representative sample. We found that men had low HPV vaccine uptake overall, and that uptake was worse for foreign-born men. Overall, only 1 in 11 men had initiated HPV vaccination (1 in 9 for US-born vs 1 in 22 for foreign-born men) and 1 in 30 men had completed the HPV vaccine series (1 in 27 for US-born vs 1 in 59 for foreign-born men). To our knowledge, this is the first study to investigate HPV vaccine uptake among foreign-born men aged 18–34 in the US. Our findings extend what is known about vaccine uptake among foreign-born individuals (as compared with US-born), essentially adding HPV to the list of vaccines (hepatitis B, pneumococcal polysaccharide, shingles, and tetanus) which foreign-born individuals have lower uptake (Lu et al., 2014).

The low HPV vaccine uptake observed in this study is concerning since about half of all HPV-associated cancers occur in men (Viens et al., 2016) and three quarters of HPV-positive oropharyngeal cancers occur in men (Chaturvedi, 2010). HPV-positive oropharyngeal cancer has recently emerged as the leading HPV-associated cancer in the US (Viens et al., 2016) and its incidence has increased by 225% in the last three decades (Chaturvedi et al., 2011). Furthermore, among men, black men have the highest incidence of HPV-associated anal and rectal cancer, while Latino men have the highest incidence of HPV-associated penile cancer (Centers for Disease Control and Prevention, 2018b). Thus, there is a need to implement public health programs that are aimed at improving HPV vaccine uptake among all men in the US. Healthcare providers are a trusted source of information regarding HPV and HPV vaccination (Mohammed et al., 2016). Therefore, healthcare providers should use every patient encounter as an opportunity to provide education regarding HPV-associated cancers, and deliver vaccination to those who are age-eligible. Additional research is needed that focuses on immigrant men to understand where and what the barriers to HPV vaccination are in this group, with particular attention to subgroup differences. This information would form the basis for targeted intervention efforts.

In adjusted analyses controlling for sociodemographic factors and healthcare access, foreign-born men still had significantly lower odds of initiating the HPV vaccine than US-born men. Analogous findings have been reported for 18–35 year old women and Asian subpopulations (Budhwani and De, 2017; Cofie et al., 2018). There are at least three potential explanations for low HPV vaccine initiation among the subgroup of foreign-born males residing in the US. First, healthcare access in the country of origin may be challenging. Access to preventive care such as HPV vaccination, may be very limited and therefore these men may arrive in the US with limited exposure to the general idea of disease prevention. In addition, immigrant men may not be familiar with

**Table 4**  
Factors associated with HPV vaccination uptake stratified by nativity status, NHIS (2014–2017).

	Adjusted odds ratio (95% Confidence Interval)			
	US born Men		Foreign Born Men	
	HPV vaccine initiation	HPV vaccine completion	HPV vaccine initiation	HPV vaccine completion
Age (in years)	0.83 (0.81, 0.85)	0.82 (0.78, 0.85)	0.82 (0.75, 0.88)	0.69 (0.58, 0.82)
Race/ethnicity				
Non-Hispanic White	Ref	Ref	Ref	Ref
Non-Hispanic Black	1.12 (0.85, 1.48)	0.79 (0.47, 1.28)	0.81 (0.31, 2.08)	1.33 (0.23, 7.52)
Hispanic	0.84 (0.66, 1.08)	0.72 (0.48, 1.07)	1.21 (0.60, 2.41)	1.87 (0.51, 6.86)
Non-Hispanic Other	1.69 (1.11, 2.55)	1.88 (1.07, 3.32)	0.75 (0.38, 1.49)	1.08 (0.30, 3.88)
Marital status				
Married	Ref	Ref	Ref	Ref
Not Married	1.21 (0.97, 1.51)	1.44 (0.93, 2.21)	1.01 (0.57, 1.81)	0.97 (0.31, 3.02)
Educational attainment				
College graduate or higher	Ref	Ref	Ref	Ref
Some college or associate's degree	0.87 (0.68, 1.12)	1.02 (0.68, 1.52)	0.62 (0.30, 1.25)	0.57 (0.13, 2.48)
High School diploma	0.76 (0.57, 1.01)	0.90 (0.57, 1.41)	0.74 (0.38, 1.47)	1.21 (0.31, 4.69)
Less than high school degree	0.75 (0.52, 1.08)	0.88 (0.49, 1.57)	0.45 (0.17, 1.19)	0.27 (0.03, 2.13)
Uninsured				
Yes	Ref	Ref	Ref	Ref
No	1.03 (0.76, 1.40)	1.54 (0.88, 2.71)	1.32 (0.71, 2.43)	0.95 (0.38, 2.38)
Has usual place of care				
Yes	Ref	Ref	Ref	Ref
No	0.99 (0.80, 1.22)	0.61 (0.40, 0.92)	0.74 (0.45, 1.21)	0.94 (0.44, 2.00)
Number of healthcare office visits in past year				
None	Ref	Ref	Ref	Ref
1–5	2.10 (1.68, 2.62)	2.18 (1.50, 3.17)	1.86 (1.06, 3.26)	4.06 (1.55, 10.63)
≥6	3.39 (2.49, 4.62)	4.18 (2.58, 6.77)	2.50 (0.91, 6.93)	6.34 (0.97, 42.51)
General health				
Excellent	Ref	Ref	Ref	Ref
Very Good	1.12 (0.92, 1.37)	0.95 (0.69, 1.30)	1.00 (0.58, 1.73)	1.16 (0.49, 2.72)
Good	0.88 (0.68, 1.13)	0.70 (0.45, 1.00)	1.15 (0.63, 2.11)	0.83 (0.29, 2.39)
Poor/Fair	0.94 (0.61, 1.44)	1.05 (0.54, 2.04)	0.79 (0.14, 4.29)	0.13 (0.01, 2.24)
Geographic Region				
West	Ref	Ref	Ref	Ref
Northeast	1.16 (0.89, 1.52)	1.17 (0.78, 1.77)	0.47 (0.21, 1.04)	0.08 (0.01, 0.68)
Midwest	0.79 (0.61, 1.02)	0.78 (0.51, 1.18)	1.25 (0.62, 2.52)	1.46 (0.47, 4.48)
South	0.78 (0.61, 0.98)	0.77 (0.52, 1.14)	0.75 (0.40, 1.41)	0.65 (0.25, 1.65)

NHIS = National Health Interview Survey; HPV = Human Papillomavirus; US = United States.

**Table 5**  
Weighted logistic regression of factors with associated HPV vaccination uptake among foreign-born men, NHIS (2014–2017).

	Adjusted Odds Ratio (95% Confidence Interval)					
	HPV vaccine initiation			HPV vaccine completion		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
US citizenship status						
Yes	Ref	–	Ref	Ref	–	Ref
No	0.61 (0.37, 1.00)	–	0.62 (0.35, 1.08)	0.54 (0.22, 1.31)	–	0.72 (0.29, 1.83)
Years living in the US						
≥ 10 years	–	Ref	Ref	–	Ref	Ref
< 10 years	–	0.79 (0.46, 1.35)	0.94 (0.52, 1.70)	–	0.33 (0.12, 0.92)	0.37 (0.13, 1.06)

Models adjusted for age, race/ethnicity, marital status, education, health insurance, usual source of care, number of doctor visits, general health, and geographic region.

NHIS = National Health Interview Survey; HPV = Human Papillomavirus; US = United States.

navigating the US healthcare system and accessing vaccines that are not required for entry into the US. For example, approximately half of the men in our study emigrated from Central America, a geographic region which has been shown to have poor healthcare access (Arredondo,

2014; Centers for Disease Control and Prevention, 2017). Second is lack of health insurance. In our study, we found that 75% of US-born men had health insurance while only 63% for foreign-born had health insurance. Although men who were insured were no more or less likely to initiate the HPV vaccine after adjusting for covariates in our study, Cofie et al found that insured women had a higher likelihood of initiating HPV vaccine (Cofie et al., 2018). Previous studies have also shown that individuals with insurance are usually more likely to receive preventive services such as vaccinations than uninsured individuals (Anandappa et al., 2018; Laz et al., 2013; Lu et al., 2014). Third, HPV vaccines were initially targeted toward women and the prevention of cervical cancer resulting from persistent infection with oncogenic HPV subtypes (Pisciotta, 2012). As a result, men in the US are less aware of HPV, the existence of a vaccine to protect against HPV, and the association between HPV and cancers relevant to men (Adjei Boakye et al., 2017b; Osazuwa-Peters et al., 2017).

To increase HPV vaccine coverage among immigrant men, public health programs aimed at providing education and instruction regarding preventive health and healthcare access should include HPV vaccination. Providing free or low-cost vaccination to eligible foreign-born men could increase vaccine uptake and ultimately reduce costs associated with treating HPV-associated cancers in men. Moreover, partnering or assisting with immunization programs in countries of origin, especially those with large numbers of US immigrants, could also improve HPV vaccination coverage among men prior to arriving to the US. In addition, targeted communication strategies are needed to reach men about HPV-associated disease and cancer, with tailoring as

needed for particular subgroups of men such as immigrants and men who have sex with men.

We found disparities in HPV vaccination rates among foreign-born men regarding region of birth, number of years in the US, and US citizenship status. In the adjusted model accounting for citizenship status and number of years in the US, the difference was not statistically significant. Immigrants from Indian subcontinent had the lowest vaccination rates, potentially reflecting low knowledge about the benefits of HPV vaccination and cost (Vohra et al., 2013); as Indians are third largest group of immigrants in the US (United States Census Bureau), further efforts to identify modifiable factors underlying low rates of HPV vaccination in this subgroup are warranted. Immigrants may not prioritize preventive care such as non-required vaccinations since they may face other, more immediate challenges upon arrival, such as securing employment or establishing residence. Foreign-born men who reported US citizenship or had been in the US for  $\geq 10$  years had higher rates of HPV vaccine initiation and completion. This may reflect the fact that foreign-born men who had been in the US for a longer period of time and/or become US citizens are more acculturated, they might have gone through school/college in the US and been exposed to more age-appropriate messaging, and wellness visits. It is also likely that they have the necessary resources to overcome barriers that may impede accessing health care, which include linguistic, cultural, and knowledge-related barriers. To decrease these disparities, interventions are needed that are culturally and linguistically sensitive and that prepare healthcare providers to effectively present and recommend HPV vaccination to foreign-born men.

#### 4.1. Limitations

Study findings should be interpreted in the context of its limitations. This analysis was limited by self-reported data for HPV vaccination which could lead to recall bias. There is also a potential time lag between receipt of vaccination and the time the interview was conducted. Patients who received the HPV vaccination when they were adolescents might not recall since their parents/guardians might have overseen their healthcare needs at that moment. We did conduct a sensitivity analyses by limiting our data to only 18–26 years since some of these might have received the vaccine as adults and the results were similar to main analyses. Future studies should focus on the association between nativity status and HPV vaccine uptake among adolescent males. Second, nativity status did not take into account acculturation. However, we used citizenship status and number of years in the US as surrogates to account for acculturation in the analyses. Third, since this was a cross-sectional study, no causal inference could be made about the findings. Moreover, as with many observational studies, there is always risk of unmeasured confounders altering the associations of interest. For example, NHIS does not collect information on factors such as provider recommendation and therefore we could not investigate if foreign-born men were less likely to have received a strong provider vaccine recommendation. We also did not have any information on the availability of the HPV vaccine in the country of origin of foreign-born men. Furthermore, there could be temporal issues with some of the variables. For example, insurance status is reported as insurance status of respondent at the time of interview and not insurance at the time of vaccination. Finally, the small number of foreign-born men who had completed the vaccination might have contributed to the non-statistically significant findings. Also, the small sample size for country of origin did prevent us from performing adjusted analyses with that variable.

#### 5. Conclusion

This study found that HPV vaccination rate was very low among all men. We also found disparities among foreign-born men by US citizenship status, number of years in US, and country of origin that require

further investigation. In this study, after adjusting for demographic, socioeconomic, and healthcare factors, foreign-born men had lower odds of having initiated the HPV vaccination compared with US-born men. If these disparities remain unaddressed, they could have long-term implications for disparities in HPV-associated cancers among US immigrant adults. There is a need for targeted outreach to foreign-born men to further understand the findings reported here and identify mechanisms through which interventions may improve HPV vaccination coverage in this population.

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#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Appendix A. Supplementary data

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#### References

- Adjei Boakye, E., Tobo, B.B., Osazuwa-Peters, N., Mohammed, K.A., Geneus, C.J., Schootman, M., 2017a. A comparison of parent- and provider-reported human papillomavirus vaccination of adolescents. *Am J Prev Med* 52 (6), 742–752.
- Adjei Boakye, E., Tobo, B.B., Rojek, R.P., Mohammed, K.A., Geneus, C.J., Osazuwa-Peters, N., 2017b. Approaching a decade since HPV vaccine licensure: racial and gender disparities in knowledge and awareness of HPV and HPV vaccine. *Hum Vacc Immunother* 13 (11), 2713–2722.
- Adjei Boakye, E., Buchanan, P., Hinyard, L.J., et al., 2018b. Incidence and risk of second primary malignancy after an index potentially-human papillomavirus-associated cancer. *J Clin Oncol* 36 (15 suppl), 1593.
- Adjei Boakye, E., Lew, D., Muthukrishnan, M., et al., 2018c. Correlates of human papillomavirus (HPV) vaccination initiation and completion among 18–26 year olds in the United States. *Hum Vacc Immunother* 14 (8), 2016–2024.
- Adjei Boakye, E., Buchanan, P., Hinyard, L., Osazuwa-Peters, N., Schootman, M., Piccirillo, J.F., 2018a. Incidence and risk of second primary malignant neoplasm after a first head and neck squamous cell carcinoma. *JAMA Otolaryngol Head Neck Surgery* 144 (8), 727–737.
- Adjei Boakye, E., Buchanan, P., Hinyard, L., et al., 2019. Risk and outcomes for second primary human papillomavirus-related and -unrelated head and neck malignancy. *Laryngoscope* 129 (8), 1828–1835.
- Anandappa, M., Adjei Boakye, E., Li, W., Zeng, W., Rebmann, T., Chang, J.J., 2018. Racial disparities in vaccination for seasonal influenza in early childhood. *Public Health* 158, 1–8.
- Arredondo, A., 2014. Type 2 diabetes and health care costs in Latin America: exploring the need for greater preventive medicine. *BMC Med* 12, 136.
- Bailey, H.H., Chuang, L.T., duPont, N.C., et al., 2016. American society of clinical oncology statement: human papillomavirus vaccination for cancer prevention. *J Clin Oncol: Official J Am Soc Clin Oncol* 34 (15), 1803–1812.
- Bhattacharya, M., Reiter, P.L., McRee, A.L., 2019. Nativity status and genital HPV infection among adults in the U.S. *Hum Vacc Immunother* 15 (7–8), 1897–1903.
- Budhwani, H., De, P., 2017. Human papillomavirus vaccine initiation in Asian Indians and Asian subpopulations: a case for examining disaggregated data in public health research. *Public Health* 153, 111–117.
- Centers for Disease Control and Prevention. Healthcare Access and Conditions in Guatemala, Honduras, and El Salvador. 2017; <https://www.cdc.gov/immigrantrefugeehealth/profiles/central-american/healthcare-diet/index.html>.
- Centers for Disease Control and Prevention. HPV-Associated Cancers Rates by Race and Ethnicity. 2018; [www.cdc.gov/cancer/hpv/statistics/race.htm](http://www.cdc.gov/cancer/hpv/statistics/race.htm). Accessed September 17, 2018.
- Centers for Disease Control and Prevention. Cancers Associated with Human Papillomavirus, United States, 2011–2015. 2018; <https://www.cdc.gov/cancer/hpv/pdf/USCS-DataBrief-No4-August2018-508.pdf>. Accessed 9/21/2018.
- Chaturvedi, A.K., 2010. Beyond cervical cancer: burden of other HPV-related cancers among men and women. *J Adolesc Health* 46 (4 Suppl), S20–26.

- Chaturvedi, A.K., Engels, E.A., Pfeiffer, R.M., et al., 2011. Human papillomavirus and rising oropharyngeal cancer incidence in the United States. *J Clin Oncol: Official J Am Soc Clin Oncol* 29 (32), 4294–4301.
- Cofie, L.E., Hirth, J.M., Guo, F., Berenson, A.B., Markides, K., Wong, R., 2018. HPV vaccination among foreign-born women: examining the National Health Interview Survey 2013–2015. *Am J Prev Med* 54 (1), 20–27.
- de Martel, C., Plummer, M., Vignat, J., Franceschi, S., 2017. Worldwide burden of cancer attributable to HPV by site, country and HPV type. *Int J Cancer* 141 (4), 664–670.
- Derose, K.P., Bahney, B.W., Lurie, N., Escarce, J.J., 2009. Review: immigrants and health care access, quality, and cost. *Med Care Res Rev: MCRR* 66 (4), 355–408.
- LaFromboise, T., Coleman, H.L.K., Gerton, J., 1993. Psychological impact of biculturalism: evidence and theory. *Psychol Bull* 114 (3), 395–412.
- Landis, K., Bednarczyk, R.A., Gaydos, L.M., 2018. Correlates of HPV vaccine initiation and provider recommendation among male adolescents, 2014 NIS-Teen. *Vacc* 36 (24), 3498–3504.
- Laz, T.H., Rahman, M., Berenson, A.B., 2013. Human papillomavirus vaccine uptake among 9–17 year old males in the United States: the National Health Interview Survey, 2010. *Hum Vacc Immunother* 9 (4), 874–878.
- P.J. Lu A. Rodriguez-Lainz A. O'Halloran S. Greby W.W. Williams Adult vaccination disparities among foreign-born populations in the U.S., 2012 *Am J Prev Med* 2014 47 6 722 733.
- Markowitz, L.E., Dunne, E.F., Saraiya, M., et al., 2014. Human papillomavirus vaccination: recommendations of the Advisory Committee on Immunization Practices (ACIP) MMWR Recommendations and reports : morbidity and mortality weekly report recommendations and reports. *Cent Dis Cont* 63, 1–30.
- Mohammed, K.A., Geneus, C.J., Osazuwa-Peters, N., Adjei Boakye, E., Tobo, B.B., Burroughs, T.E., 2016. Disparities in provider recommendation of human papillomavirus vaccination for U.S. Adolescents. *J Adolesc Health* 59 (5), 592–598.
- National Center for Health Statistics. About the National Health Interview Survey. 2018; [https://www.cdc.gov/nchs/nhis/about\\_nhis.htm](https://www.cdc.gov/nchs/nhis/about_nhis.htm). Accessed 9/6/2018.
- National Vaccine Advisory Committee. Overcoming Barriers to Low HPV Vaccine Uptake in the United States: Recommendations from the National Vaccine Advisory Committee: Approved by the National Vaccine Advisory Committee on June 9, 2015. Public health reports (Washington, DC : 1974). 2016;131(1):17-25.
- Oliver, S.E., Hoots, B.E., Paz-Bailey, G., Markowitz, L.E., Meites, E., 2017. Increasing human papillomavirus vaccine coverage among men who have sex with men-national HIV behavioral surveillance, United States, 2014. *J Acquir Immune Defic Syndr* 75 (Suppl 3), S370–S374.
- Osazuwa-Peters, N., Adjei Boakye, E., Mohammed, K.A., Tobo, B.B., Geneus, C.J., Schootman, M., 2017. Not just a woman's business! Understanding men and women's knowledge of HPV, the HPV vaccine, and HPV-associated cancers. *Prev Med* 99, 299–304.
- Parsons, V.L., Moriarity, C., Jonas, K., Moore, T.F., Davis, K.E., Tompkins, L., 2014. Design and estimation for the national health interview survey, 2006–2015. *Vital Health Stat Ser 2 Data Eval Method Res* 165, 1–53.
- Perez, A.E., Agenor, M., Gamarel, K.E., Operario, D., 2018. Nativity disparities in human papillomavirus vaccination among U.S. Adults. *Am J Prev Med* 54 (2), 248–258.
- Pisciotta, M.K., 2012. Gendering Gardasil: Framing Gender and Sexuality in Media Representations of the HPV Vaccine.
- Saslow, D., Andrews, K.S., Manassaram-Baptiste, D., et al., 2016. Human papillomavirus vaccination guideline update: American Cancer Society Guideline endorsement. *CA: Cancer J Clin* 66 (5), 375–385.
- CA A Cancer J Clin 69 (1), 7–34. <https://doi.org/10.3322/caac.v69.110.3322/caac.21551>.
- United States Census Bureau. The Foreign-Born Population in the United States. [https://www.census.gov/newsroom/pdf/cspan\\_fb\\_slides.pdf](https://www.census.gov/newsroom/pdf/cspan_fb_slides.pdf). Accessed 9/25/2018.
- Viens, L.J., Henley, S.J., Watson, M., et al., 2016. Human papillomavirus-associated cancers - United States, 2008–2012. *MMWR Morb Mortal Wkly Rep* 65 (26), 661–666.
- Vohra, R., Vohra, A., Bhardwaj, P., Srivastava, J.P., Gupta, P., 2013. Reasons for failure of immunization: a cross-sectional study among 12–23-month-old children of Lucknow India. *Adv Biomed Res* 2, 71.
- Walker, T.Y., Elam-Evans, L.D., Singleton, J.A., et al., 2017. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years - United States, 2016. *MMWR Morb Mortal Wkly Rep* 66 (33), 874–882.
- World Health Organization. Human Papillomavirus (HPV) and Cervical Cancer [Fact Sheet]. 2016; <http://www.who.int/mediacentre/factsheets/fs380/en/>. Accessed 5/20/2017.