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Article

ARTICLE

Beliefs About HPV Vaccine's Success at Cervical Cancer Prevention Among Adult US Women

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Abstract

Background: Beliefs are known to be a key determinant in vaccines' uptake. However, little is known about beliefs surrounding the success of the human papillomavirus (HPV) vaccine in preventing cervical cancer in the United States.
Methods: Data from the Health Information National Trends Survey 5 Cycle 1 (2017) were analyzed for 1851 female respondents aged 18 years and older. Weighted multinomial logistic regression was employed to determine predictors of beliefs in the success of the HPV vaccine in preventing cervical cancer.
Results: Overall, 29.8% of women believed that HPV vaccine is successful in preventing cervical cancer, 6.6% believed it is not successful, and 63.6% did not know if the HPV vaccine is successful. Non-Hispanic blacks (adjusted odds ratio [aOR] = 1.80, 95% confidence interval [CI] = 1.16 to 2.79), women with no more than 12 years of education (aOR = 2.05, 95% CI = 1.17 to 3.60), those who did not know if they were advised by a health-care provider to get an HPV shot within the last 12 months (aOR = 4.19, 95% CI = 1.39 to 12.60), and those unaware of a family cancer history (aOR = 5.17, 95% CI = 1.48 to 18.21) were more likely to not know whether the HPV vaccine prevents cervical cancer. Women younger than 65 years were more likely than elderly to believe that the HPV vaccine is not successful at preventing cervical cancer.
Conclusions: A substantial proportion of US women are uninformed about the HPV vaccine. To accelerate progress in the HPV vaccine's uptake, future interventions should incorporate educational programs, particularly targeting Non-Hispanic blacks, women with a lower level of education, and those younger than 65 years. Health-care providers' participation in promotion of patient education about HPV vaccination should also be increased.

Human papillomavirus (HPV) is the most common sexually transmitted agent in the United States and is primarily known for the causal role it plays in the development of cervical cancer (1,2). Virtually all cervical cancers are caused by 14 strains of HPV, leading to about 13 240 new cases and 4170 deaths in the United States each year (3). Although population-level screening programs have substantially reduced the burden of cervical cancer, geographic, ethnic, and racial disparities in cervical cancer morbidity and mortality still exist in the United States (4). These disparities are indicative of inequities in access to preventive care, largely stemming from barriers such as access to health care, cultural influences, and education (5).

Despite documented benefits of HPV vaccination such as evidence of safety and high efficacy in preventing HPV-associated cancers, attaining high coverage has been a challenging task in the United States, with recent trends suggesting that the Healthy People 2020 goal of 80% HPV vaccination coverage will not be achieved. More than a decade since the introduction of the HPV vaccine in the United States (6), less than half of eligible adolescents are up to date with HPV vaccination (7). More so, inequities have been observed in HPV vaccination access and uptake. For example, fewer people receive the HPV vaccine in rural areas compared with urban dwellings (7), and blacks have been shown to be less likely to initiate or complete the HPV vaccination schedule compared with whites (8–10).

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Beliefs play a key determining role in general acceptance and uptake of vaccines (11). More pertinently, research suggests that individuals' awareness and beliefs about HPV, HPV infection, HPV vaccination, and cervical cancer are determinants of HPV vaccination uptake (12,13). For example, belief that HPV vaccine is effective in cervical cancer prevention has been shown to have a positive influence on acceptance and receipt of the HPV vaccine (14,15). Therefore, assessing factors that predict beliefs surrounding key benefits of HPV vaccination, particularly its success in cervical cancer prevention, would provide critical insight for targeted efforts aimed at increasing HPV vaccination rates (16).

Health behavior theories have been employed to explain the influential role that sociodemographic factors have on health-related attitudes and beliefs (17,18). Although previous studies have assessed the predictors of knowledge and awareness of HPV, the HPV vaccine, and HPV-related diseases in the United States (19–21), little is known about the factors that predict beliefs in the success of HPV vaccine in preventing cervical cancer. Hence, this study examines the beliefs of US adult women about the success of the HPV vaccine in preventing cervical cancer.

Materials and Methods

HINTS Data and Study Population

We obtained data from the Health Information National Trends Survey (HINTS) 5, Cycle 1, administered by the National Cancer Institute. HINTS is a nationally representative, publicly available probability survey of adults aged 18 years or older in the civilian noninstitutionalized population of the United States. Cycle 5 data (response rate = 32.4%, n = 3285) were collected from January 25 through May 5, 2017. Details of survey development, design, and methodology have been published elsewhere and are available online (22). All questionnaire items in the HINTS have been tested to be reliable and valid before being administered. More information about the validation of the HINTS survey can be found at https://hints.cancer.gov/faq.aspx. All HINTS questionnaires, data, and reports are available at http://hints.cancer.gov/hints5.aspx.

This study focused on female respondents (n = 1914) of whom we excluded those with a personal history of cervical cancer (n = 37) and those with missing data for the outcome variable (n = 26).

Outcome Variable

Our study outcome was derived from the HINTS question: "In your opinion, how successful is HPV vaccine at preventing cervical cancer?" We categorized individuals who responded "very successful" or "pretty successful" as "successful"; "don't know" as "don't know"; and "a little successful" or "not at all successful" as "not successful."

Independent Variables

Independent variables were selected based on previous literature (23), including age, race and/or ethnicity, household income, education, health behavior, and access. They were categorized as follows: age (18–34, 35–49, 50–64, and 65 years or older); education (no greater than 12 years or completed high school, post–high school training or some college, and college graduate or higher); household income (< $35 000; $35 000–$49 999; $50 000–$74 999; and ≥ $75 000); health insurance (yes, no). Health behavior and access was assessed with the following questions: 1) "When was your last Pap screen?" (within the last 3 years, more than 3 years ago but less than 5 years ago, unknown or never), and 2) "In the last 12 months, has a doctor or health-care professional recommended that you or someone in your immediate family get an HPV shot or vaccine?" (yes, no, don't know). Race and ethnicity was categorized as Hispanic, non-Hispanic black (NHB), non-Hispanic white (NHW), Asian, and other.

Cigarette smokers were categorized as current, former, or never smokers. Personal cancer history was assessed with the question: "Have you ever been diagnosed as having cancer?" (yes, no). Family cancer history was assessed with the question: "Have any of your family members ever had cancer?" (yes, no, not sure). Mental health was assessed with the question: "Has a doctor or other health professional ever told you that you had any of the following medical conditions: depression or anxiety disorder?" (yes, no). Residence was classified along urban and rural categories using 2013 Rural Urban Continuum Codes (RUCCs) (24). RUCCs classify metropolitan areas at the county level by population size and nonmetropolitan areas by proximity to metropolitan areas and urbanization. Thus, RUCC 1–3 was classified as metropolitan (urban); RUCC 4–6 as median rural; and RUCC 7–9 as isolated rural.

Statistical Analysis

Analyses were performed using SAS (Version 9.4; SAS Institute Inc, Cary, NC) procedures, which incorporate survey sampling weights to account for the complex sampling design used in HINTS and to provide representative estimates of the US population. Weighted, unadjusted prevalence estimates (n, %) with their 95% confidence intervals (CI) were used to describe beliefs about the HPV vaccine's success and to compare potential predictors by HPV vaccine belief category. For covariates with missing data, a missing data category was created. We used weighted, multinomial logistic regression models (GLOGIT) to determine correlates of beliefs about the HPV vaccine's success in preventing cervical cancer among US adult women. To assess the noteworthiness of the strength of association between potential predictors of beliefs in the HPV vaccine and the outcome variable, we calculated a measure of the probability of false discovery called Bayesian false-discovery probabilities (BFDP) (25). In the multiple hypothesis-testing context, BFDP allows the false-discovery rate to be controlled by reducing the number of "discoveries" that are reported but not replicated in subsequent investigations (25). We calculated the BFDP value using a prior probability of 0.05 for an association. The standard recommended threshold of BFDP less than 0.8 was used to declare noteworthy associations. All variables included in this study were considered to be potential predictors of beliefs in the HPV vaccine and knowledge and thus were included in the final model even though some of these variables were correlated.

Results

Descriptive Characteristics

Overall, 29.8% of eligible respondents believed that the HPV vaccine is successful at preventing cervical cancer. Nearly two-thirds (63.6%) did not know if the HPV vaccine is successful at

preventing cervical cancer, and 6.6% believed that the HPV vaccine is not successful at preventing cervical cancer. Of the study respondents, 74.8% have had a Pap test within the last 3 years.

Characteristics of the study population by beliefs in the success of the HPV vaccine in preventing cervical cancer is reported in Table 1. Belief that the HPV vaccine is successful at preventing cervical cancer was higher among respondents who were aged 18–34 years (weighted percentage [Wt] = 40.8%, 95% CI = 30.0% to 51.7%), Hispanic (Wt = 33.3%, 95% CI = 23.3% to 43.3%), US born (Wt = 30.6%, 95% CI = 26.7% to 34.5%), college graduates or postgraduates (Wt = 41.1%, 95% CI = 36.1% to 46.1%), advised by a health-care provider to get an HPV shot (Wt = 47.5%, 95% CI = 37.3% to 57.8%), and with a household income no less than $75 000 (Wt = 42.8%, 95% CI = 36.4% to 49.3%). This belief was lower among uninsured (Wt = 22.6%, 95% CI = 4.3% to 40.9%), current smokers (Wt = 22.6%, 95% CI = 14.7% to 30.6%), and respondents who were unsure of a family history of cancer (Wt = 7.2%, 95% CI = 1.4% to 13.0%).

A higher proportion of women who did not know if the HPV vaccine is successful at preventing cervical cancer were aged 65 years and older (Wt = 77.2%, 95% CI = 73.1% to 81.3%), NHBs (Wt = 74.6%, 95% CI = 68.4% to 80.7%), in the lowest household income strata (<$35 000; Wt = 71.1%, 95% CI = 65.1% to 77.1%), current smokers (Wt = 74.2%, 95% CI = 66.3% to 82.1%), and had education levels no greater than 12 years of completed high school (Wt = 78.0%, 95% CI = 71.8% to 84.3%). This proportion was lower in women who have been recommended by a health-care provider to get an HPV shot within the last 12 months (Wt = 45.4%, 95% CI = 35.5% to 55.4%), in those with no personal cancer history (Wt = 62.7%, 95% CI = 59.2% to 66.2%), and in women with a family cancer history (Wt = 61.9%, 95% CI = 58.1% to 65.7%).

Higher proportions in the belief that the HPV vaccine is not successful at preventing cervical cancer were reported among women aged 18 to 34 years (Wt = 8.6%, 95% CI = 3.4% to 13.8%), Asians (Wt = 7.7%, 95% CI = 0.0% to 18.3%), uninsured (Wt = 10.2%, 95% CI = 2.4% to 18.0%), and those who have not been recommended by a health-care provider to get an HPV shot within the last 12 months (Wt = 9.1%, 95% CI = 5.0% to 13.2%). Lower proportions of this belief were found in women living in isolated rural areas (Wt = 5.0%, 95% CI = 0.0% to 10.4%), current smokers (Wt = 3.2%, 95% CI = 0.3% to 6.1%), and those unsure of a family cancer history (Wt = 1.3%, 95% CI = 0.0% to 3.6%) (Table 1).

Results of Multinomial Logistic Regression Analyses

Table 2 summarizes correlates of beliefs about the HPV vaccine's success in preventing cervical cancer in a multinomial logistic regression analysis. In this table, the first half of the columns (Do not know [vs Successful]) presents the associations of predictor variables with women who did not know if the HPV vaccine is successful at preventing cervical cancer compared with those who believed that the HPV vaccine is successful at preventing cervical cancer (reference category); whereas the second half of the columns (Not successful [vs Successful]) displays the associations between predictor variables with women who believed that the HPV vaccine is not successful at preventing cervical cancer compared with those who believed that the HPV vaccine is successful at preventing cervical cancer. After adjusting for covariates, NHBs vs NHWs (aOR = 1.80; $P = .010$; BFDP = 0.754), women with high school education or lower vs college and/or postgraduate education (aOR = 2.05; $P = .013$; BFDP = 0.785), and women who did not know if they received an HPV shot recommendation by a health-care provider vs those who were recommended by a health-care provider to get an HPV shot within the last 12 months (aOR = 4.19; $P = .012$; BFDP = 0.775) were more likely to not know if the HPV vaccine was successful at preventing cervical cancer. In addition, those not sure of a family history of cancer vs those who had no family cancer history (aOR = 5.17; $P = .012$; BFDP = 0.788) were more likely to not know if the HPV vaccine was successful at preventing cervical cancer.

Compared with women aged 65 years or older, women aged 50 to 64 years (aOR = 10.01; $P < .001$; BFDP = 0.187), those aged 35 to 49 years (aOR = 13.27; $P = .001$; BFDP = 0.454); and those aged 18 to 34 years (aOR = 12.68; $P = .005$; BFDP = 0.768) were more likely to believe that the HPV vaccine is not successful at preventing cervical cancer.

Discussion

In this study, we examined the beliefs of US adult women as to the success of the HPV vaccine in preventing cervical cancer. Using the HINTS data, we found that only 29.8% of women believed that the HPV vaccine is successful at preventing cervical cancer. Alarmingly, nearly two-thirds (63.6%) did not know if the HPV vaccine is successful. This remarkably high level of poor awareness of a key benefit of the HPV vaccine among US women could be a contributing factor to the low HPV vaccination rates in the United States. Only half of eligible teenagers completed their HPV vaccination series in 2017 (7), compared with the more than 80% coverage rate in other developed countries, including Australia, the United Kingdom, Belgium, Portugal, Spain, Sweden, and Iceland (26,27).

Several US studies have conducted population-level assessments on knowledge and awareness surrounding HPV, the HPV vaccine, and HPV-related diseases (19–21,28). However, US women's beliefs as to the success of the HPV vaccine preventing cervical cancer has not been previously examined. Therefore, this study goes a step further in characterizing individuals based not only on their knowledge of the virus or the vaccine but also what they stand to benefit from receiving the vaccine, which has a stronger predictive value on vaccination intention. In the same vein, although studies have shown HPV-related knowledge boosts vaccine acceptance and uptake (14,15), belief regarding the effectiveness of HPV vaccines against cervical cancer was found to be a stronger predictor of HPV vaccination intent (14).

One key finding of this study was that NHBs had increased odds of not knowing whether the HPV vaccine prevents cervical cancer. This corroborates with other studies that have reported relatively lower levels of knowledge and awareness on topics related to HPV or HPV vaccination among minorities in the United States, particularly among African Americans (20,26,29). Given that morbidity and mortality associated with cervical cancer is higher in NHBs compared with NHWs (30), this finding is indicative of a need to develop culturally appropriate and targeted interventions such as awareness campaigns aimed at boosting knowledge surrounding HPV vaccination and its benefits in this demographic. We also found that low levels of education (high school completion or lower) doubled the odds of not knowing about the success of the HPV vaccine in preventing cervical cancer, which may play a mediating role in the observed

Table 1. Characteristics of the study population by beliefs in the success of the HPV vaccine in preventing cervical cancer, Health Information National Trends, 2018

Characteristics	No.	In your opinion, how successful is the HPV vaccine at preventing cervical cancer?		
		Successful Wt % (95% CI)	Do not know Wt % (95% CI)	Not successful Wt % (95% CI)
Age, y				
18–34	245	40.8 (30.0 to 51.7)	50.6 (40.9 to 60.2)	8.6 (3.4 to 13.8)
35–49	384	28.7 (22.8 to 34.5)	64.2 (58.8 to 69.6)	7.1 (4.6 to 9.7)
50–64	586	29.7 (23.6 to 35.7)	63.0 (56.5 to 69.5)	7.3 (4.0 to 10.7)
≥65	569	21.5 (17.2 to 25.7)	77.2 (73.1 to 81.3)	1.3 (0.3 to 2.3)
Missing	67	6.4 (0.0 to 12.9)	78.7 (64.6 to 92.9)	14.9 (1.1 to 28.6)
Race/ethnicity				
White, non-Hispanic	1029	32.4 (27.6 to 37.1)	60.9 (56.5 to 65.4)	6.7 (3.9 to 9.5)
Black, non-Hispanic	274	19.1 (13.1 to 25.1)	74.6 (68.4 to 80.7)	6.3 (2.4 to 10.3)
Hispanic	238	33.3 (23.3 to 43.3)	62.5 (52.3 to 72.7)	4.1 (0.9 to 7.4)
Asian	69	33.1 (16.0 to 50.3)	59.2 (37.3 to 81.1)	7.7 (0.0 to 18.3)
Others	67	31.7 (13.5 to 50.0)	64.9 (45.8 to 84.0)	3.4 (0.0 to 8.2)
Missing	174	13.1 (7.2 to 18.9)	75.0 (66.3 to 83.7)	11.9 (5.4 to 18.4)
Education				
≤12 years/completed high school	497	19.2 (12.9 to 25.5)	78.0 (71.8 to 84.3)	2.8 (1.0 to 4.5)
Post–high school/some college	525	27.8 (20.8 to 34.8)	62.3 (55.4 to 69.2)	9.8 (4.8 to 14.8)
College graduate/postgraduate	783	41.1 (36.1 to 46.1)	52.2 (47.5 to 56.9)	6.7 (4.2 to 9.2))
Missing	46	13.2 (0.0 to 28.2)	71.5 (53.3 to 89.7	15.3 (0.7 to 30.0)
Household income				
<$35 000	626	22.3 (17.1 to 27.5)	71.1 (65.1 to 77.1)	6.6 (2.3 to 10.9)
$35 000–<$50 000	218	24.3 (15.0 to 33.6)	70.8 (61.3 to 80.3)	4.9 (1.5 to 8.3)
$50 000–<$75 000	286	28.6 (21.9 to 35.3)	62.4 (55.0 to 69.7)	9.1 (4.4 to 13.8)
≥$75 000	530	42.8 (36.4 to 49.3)	50.8 (44.3 to 57.3)	6.4 (3.5 to 9.3)
Missing	191	20.3 (7.5 to 33.0)	74.3 (61.4 to 87.2)	5.4 (1.1 to 9.7)
Last Pap test				
Within the last 3 years	1367	31.4 (27.4 to 35.3	61.6 (57.7 to 65.5	7.0 (4.9 to 9.2)
3–5 years	410	20.9 (14.7 to 27.0)	73.1 (66.7 to 79.5)	6.0 (2.2 to 9.8)
Never	47	38.3 (10.3 to 66.3)	57.7 (29.8 to 85.7)	3.9 (0.0 to 9.7)
Missing	27	18.6 (0.3 to 36.9)	78.3 (59.4 to 97.2)	3.1 (0.0 to 9.7)
Smoking status				
Current smoker	228	22.6 (14.7 to 30.6)	74.2 (66.3 to 82.1)	3.2 (0.3 to 6.1)
Former smoker	436	30.7 (24.2 to 37.1)	61.0 (53.8 to 68.2)	8.3 (2.3 to 14.3)
Never smoker	1182	31.1 (26.6 to 35.6)	62.1 (58.1 to 66.2)	6.8 (4.9 to 8.8)
Missing	5	34.9 (0.0 to 100.0)	65.1 (0.0 to 100.0)	—
Personal cancer history				
Yes	261	21.2 (13.6 to 28.8)	73.2 (65.2 to 81.2)	5.6 (1.8 to 9.4)
No	1586	30.6 (26.8 to 34.4)	62.7 (59.2 to 66.1)	6.7 (4.8 to 8.6)
Family cancer history				
Yes	1334	31.6 (27.7 to 35.6)	61.9 (58.1 to 65.7)	6.5 (4.1 to 8.8)
No	386	29.9 (22.4 to 37.4)	62.8 (55.0 to 70.6)	7.2 (3.2 to 11.2)
Not sure	80	7.2 (1.4 to 13.0)	91.5 (85.2 to 97.9)	1.3 (0.0 to 3.6)
Health care professional recommended HPV shot?				
Yes	190	47.5 (37.3 to 57.8)	45.4 (35.5 to 55.4)	7.1 (2.1 to 12.0)
No	388	33.3 (26.0 to 40.6)	57.6 (50.5 to 64.6)	9.1 (5.0 to 13.2)
Don't know	132	15.9 (5.4 to 26.5)	82.6 (71.5 to 93.8)	1.4 (0.0 to 3.2)
Inapplicable*	940	26.6 (23.0 to 30.1)	67.4 (63.2 to 71.6)	6.0 (3.0 to 9.0)
Missing	201	17.5 (10.8 to 24.3)	77.3 (69.7 to 85.0)	5.1 (1.1 to 9.2)
Born in United States				
Yes	1575	30.6 (26.7 to 34.5)	63.1 (59.4 to 66.8)	6.3 (4.3 to 8.3)
No	240	26.9 (19.7 to 34.2)	65.5 (56.2 to 74.7)	7.6 (2.3 to 12.9)
Depression				
Yes	485	32.1 (25.6 to 38.6)	61.8 (55.3 to 68.3)	6.1 (2.2 to 10.1)
No	1337	29.2 (25.2 to 33.2)	64.1 (60.4 to 67.7)	6.7 (4.8 to 8.5)
Residence				
Urban	1600	29.9 (26.3 to 33.6)	63.5 (60.2 to 66.8)	6.6 (4.5 to 8.7)
Median rural	178	31.4 (18.1 to 44.6)	60.9 (48.2 to 73.6)	7.7 (1.4 to 14.1)
Isolated rural	73	23.1 (11.8 to 34.5)	71.9 (60.8 to 83.0)	5.0 (0.0 to 10.4)

(continued)

Table 1. (continued)

Characteristics	No.	In your opinion, how successful is the HPV vaccine at preventing cervical cancer? Successful Wt % (95% CI)	Do not know Wt % (95% CI)	Not successful Wt % (95% CI)
Health insurance				
Yes	1747	30.6 (27.1 to 34.0)	63.1 (60.2 to 66.1)	6.3 (4.4 to 8.2)
No	92	22.6 (4.3 to 40.9)	67.1 (44.2 to 90.1)	10.2 (2.4 to 18.0)

*The category "inapplicable" refers to respondents to the Health Information National Trends Survey 5, Cycle 1 survey who responded "no" to the question, "Including yourself, is anyone in your immediate family between the ages of 9 and 27 years old?" and thus were not eligible to respond to the question, "In the last 12 months, has a doctor or health-care professional recommended that you or someone in your immediate family get an HPV shot or vaccine?" CI = confidence interval; HPV = human papillomavirus; Wt = weighted percentage.

Table 2. Association between beliefs on the success of HPV vaccine in preventing cervical cancer and characteristics of US female adults, Health Information National Trends, 2018*

Characteristics	Do not know (vs successful) aOR (95% CI)	*P*	BFDP	Not successful (vs successful) aOR (95% CI)	*P*	BFDP
Age, y						
≥65	(Referent)			(Referent)		
18–34	0.61 (0.35 to 1.06)	.080	0.941	12.68 (2.23 to 72.20)	.005	0.768
35–49	1.22 (0.74 to 2.02)	.432	0.982	13.27 (3.07 to 57.46)	.001	0.454
50–64	0.91 (0.59 to 1.40)	.650	0.987	10.01 (3.05 to 32.89)	<.001	0.187
Race/ethnicity						
White, non-Hispanic	(Referent)			(Referent)		
Black, non-Hispanic	1.80 (1.16 to 2.79)	.010	0.754	1.23 (0.45 to 3.37)	.682	0.973
Hispanic	0.93 (0.49 to 1.75)	.807	0.982	0.59 (0.18 to 1.88)	.361	0.963
Asian	0.97 (0.28 to 3.31)	.953	0.971	1.12 (0.11 to 11.29)	.923	0.960
Others	1.24 (0.54 to 2.87)	.607	0.976	0.68 (0.06 to 7.86)	.750	0.959
Born in United States						
Yes	(Referent)			(Referent)		
No	1.44 (0.67 to 3.09)	.347	0.971	1.51 (0.51 to 4.44)	.446	0.968
Education						
College graduate/postgraduate	(Referent)			(Referent)		
≤12 years/completed high school	2.05 (1.17 to 3.60)	.013	0.785	0.78 (0.26 to 2.34)	.653	0.971
Post–high school or some college	1.50 (0.96 to 2.35)	.076	0.947	2.02 (0.78 to 5.22)	.145	0.947
Household income						
<$35 000	(Referent)			(Referent)		
$35 000–$49 999	1.28 (0.65 to 2.56)	.468	0.977	0.60 (0.19 to 1.90)	.380	0.964
$50 000–$74 999	0.81 (0.48 to 1.37)	.423	0.981	1.13 (0.35 to 3.63)	.839	0.972
≥ $75 000	0.59 (0.37 to 0.93)	.024	0.873	0.52 (0.17 to 1.62)	.257	0.958
Residence						
Urban	(Referent)			(Referent)		
Median rural	0.80 (0.42 to 1.53)	.488	0.978	0.84 (0.24 to 2.96)	.779	0.970
Isolated rural	1.01 (0.44 to 2.35)	.977	0.978	0.95 (0.15 to 5.90)	.958	0.964
Health insurance						
No	(Referent)			(Referent)		
Yes	0.74 (0.23 to 2.40)	.612	0.970	0.40 (0.12 to 1.32)	.129	0.940
Health-care professional recommended HPV shot?						
Yes	(Referent)			(Referent)		
No	1.82 (1.08 to 3.06)	.025	0.866	1.49 (0.40 to 5.50)	.545	0.966
Don't know	4.19 (1.39 to 12.60)	.012	0.775	0.77 (0.10 to 5.74)	.798	0.962
Smoking status						
Never smokers	(Referent)			(Referent)		
Former smokers	0.95 (0.65 to 1.37)	.760	0.989	1.49 (0.58 to 3.85)	.402	0.969
Current smokers	1.42 (0.82 to 2.48)	.209	0.969	0.49 (0.14 to 1.66)	.244	0.955
Last Pap test						
Within the last 3 years	(Referent)			(Referent)		
3–5 years	1.09 (0.68 to 1.73)	.727	0.986	1.49 (0.62 to 3.59)	.369	0.969
Unknown or never	0.82 (0.16 to 4.25)	.806	0.965	0.35 (0.03 to 4.39)	.412	0.954

(continued)

Table 2. (continued)

Characteristics	Do not know (vs successful)			Not successful (vs successful)		
	aOR (95% CI)	P	BFDP	aOR (95% CI)	P	BFDP
Depression						
No	(Referent)			(Referent)		
Yes	0.83 (0.56 to 1.23)	.347	0.983	0.79 (0.38 to 1.66)	.531	0.977
Personal cancer history						
No	(Referent)			(Referent)		
Yes	1.18 (0.72 to 1.94)	.510	0.983	1.48 (0.55 to 3.95)	.427	0.969
Family cancer history						
No	(Referent)			(Referent)		
Yes	0.99 (0.63 to 1.54)	.957	0.987	0.89 (0.39 to 2.05)	.778	0.978
Not sure	5.17 (1.48 to 18.21)	.012	0.788	0.48 (0.01 to 269.37)	.817	0.952

*In the regression analysis, a "missing data" category for variables with missing data was included in the model. For reader's convenience, the results of this "missing data" category are not displayed in this table. The following factors were adjusted for in the multinomial logistic regression analysis: age, race and/or ethnicity, place of birth, education, household income, residence, health insurance, health-care professional recommended HPV shot, smoking status, last Pap test, depression, personal cancer history, family cancer history. aOR = adjusted odds ratio; BFDP = Bayesian false-discovery probability; CI = confidence interval; HPV= human papillomavirus.

association between levels of education and HPV vaccination uptake (31,32).

Women who were unaware of prior HPV vaccination recommendation by a health-care provider were found to have an increased likelihood of not knowing about the HPV vaccine's success in preventing cervical cancer. This finding may provide some explanation to studies that document health-care provider recommendation as a strong predictor of HPV vaccination (33,34). This underlines the major influence providers have on HPV vaccination and the potential role they can play in boosting uptake. Therefore, this potential can be harnessed through educational programs aimed at boosting physician self-efficacy in promoting HPV vaccination of eligible patients and managing difficult situations such as vaccine hesitancy. A study that employed an innovative approach to increase provider participation in administering effective recommendations for HPV vaccination noted improvements in the rate of HPV vaccination recommendations among clinicians, as well as uptake of the vaccine (35).

We found that women younger than 65 years were more likely to believe that HPV vaccine is not successful at preventing cervical cancer. Two distinct populations are implicated in the interpretation of this finding. The first population is women in the older age categories who are parents or grandparents and have assent and decision-making responsibility over HPV vaccination of the children in their care. The influence of parental decision on child and adolescent HPV vaccination is well documented (36). The second population is young adults in the youngest age group, who have autonomy and are largely responsible for their own HPV vaccination. This population largely includes those participating in HPV vaccination during the later stages of the catch-up phase (ages 18–26 years) and beyond. In fact, in line with the recent Food and Drug Administration extended approval of the HPV vaccine to early mid-age, the Advisory Committee on Immunization Practices took a stand in favor of an expansion of the upper age limit for catch-up HPV vaccination to 45 years. With advancing age, the odds of believing that the HPV vaccine is not successful at preventing cervical cancer goes down. A possible explanation for this trend is that older women tend to use health-care services more frequently than younger women, and the resulting contact with health-care providers may expose them to more accurate information about the HPV vaccine. Although we acknowledge that women older than 65 years are generally not recommended to receive cervical cancer screening, they may still have an influence on the health-related beliefs and practices of their grandchildren, at least in some communities. In African American families, for instance, the social structure includes the commonality of intergenerational guardianship of children (37). In 2011, about 22% of African American grandparents acted as caregivers of their grandchildren, a trend that increases during periods of economic recession (38).

Because the economic, sociocultural, and physical environment tend to vary between urban and rural areas (39), we anticipated that women's beliefs toward the HPV vaccine may differ among residents in urban and rural areas. However, rurality did not affect beliefs about the HPV vaccine in our study. This is consistent with the study by Degarege et al. (40), in which no statistically significant difference was found among parents residing in urban and rural areas in their beliefs about the ability of the HPV vaccine to protect against cervical cancer. Therefore, the difference observed in HPV vaccine uptake and cervical cancer incidence rates between rural and urban dwellers in the United States may be explained by factors other than people's beliefs about the HPV vaccine.

With a background of suboptimal HPV vaccination coverage in the United States (7) compared with other developed nations (27), our study findings are indicative of substantial knowledge gaps of a key benefit of HPV vaccination (cervical cancer prevention) among adult women in the United States. Knowledge of rewards and benefits is a well-documented promoter of health behaviors. Hence, it is plausible to state that embarking on population-level initiatives aimed at boosting knowledge of HPV vaccination benefits (prevention of cervical cancer in this case) has the potential to enhance HPV vaccination uptake in the United States.

This study assesses predictors of beliefs about the success of the HPV vaccine in preventing cervical cancer in a nationally representative sample of adult women. Limitations of the present study include the following. First, HINTS cycles do not assess current health-care provider awareness, knowledge, and practices regarding HPV, as well as actual vaccination patterns. These missing variables could explain some of the differences seen in our study. Second, our data could be affected by a variety of biases, including low-response bias and social desirability bias. However, considerable efforts were made to reduce potential for bias through modality coverage and sampling (41). Low-response rates in HINTS data could lead to low-response bias

and, as such, could lead to an underestimation of the association between potential predictors of HPV vaccine beliefs and the outcome variable. However, the HINTS investigators conducted a nonresponse bias analysis of these data to characterize the potential impact of nonresponse (42). Findings from their study revealed that many of the demographic influences on nonresponse can be compensated for through application of standard weighting procedures, which was employed in the present study. Concerning the social desirability bias, the strategy commonly used to prevent this bias is to validate the self-reporting instrument before implementing it for data collection. For each cycle of the HINTS survey for which data about the American public's use of cancer-related information is routinely collected, all questionnaires are tested to be reliable and valid before being administered. Other limitations are related to the cross-sectional nature of the HINTS data. Because the presence of risk factors and outcomes are measured simultaneously, it is difficult to confidently infer causal association.

This study reveals severe knowledge gaps and inaccurate beliefs surrounding a key benefit of the HPV vaccination among US women. Interventions aimed at increasing population-level knowledge about the benefits of the HPV vaccine have the potential to enhance HPV vaccination uptake in the United States. To boost HPV vaccination coverage, as well as tackle disparities in cervical cancer burden in the United States, future interventions should target young adults, NHBs, and women with a lower level of education. Finally, strategies must be developed to increase health-care providers' participation in promotion of patient education about HPV vaccination.

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Notes

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