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Association of provider HPV vaccination training with provider assessment of HPV vaccination status and recommendation of HPV vaccination

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ABSTRACT

The delivery of strong HPV vaccine recommendations hinges on the expertise of healthcare providers (HCPs) in assessing patients' status and recommending HPV vaccination. We conducted a population-based cross-sectional study of HCPs practicing in Texas to examine the relationship between HPV vaccination training of HCPs and HPV vaccination status assessment and recommendation. Logistic regression analyses were used to assess the association between HCPs' formal training and recency of training in HPV vaccination promotion or counseling with HPV vaccination status assessment and recommendation. Of the 1,283 HCPs who completed the online survey, 43% had received training in HPV vaccination promotion or counseling, 47% often/always assess HPV vaccination status, and 59% often/always recommend HPV vaccination. Compared with HCPs who received no training, those who received training had over four times higher odds (adjusted odds ratio [AOR]: 4.32; 95% CI: 3.06–6.10) of often/always assessing HPV vaccination status and over three and half times higher odds (AOR: 3.66; 95% CI: 2.73–4.90) of often/always recommending HPV vaccination. Furthermore, HCPs who recently received HPV vaccination training had higher odds of HPV vaccination status assessment and recommendations than those without training. Hispanic HCPs had higher odds of often/always assessing HPV vaccination status and recommending vaccination than did non-Hispanic White HCPs. Also, nurses and physician assistants had lower odds of often/always assessing HPV vaccination status and recommending HPV vaccination than did physicians. Targeted and continuous training of HCPs in HPV vaccination promotion or counseling is needed to increase HPV vaccination status assessment, recommendation, and uptake rates.

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Introduction

HPV is highly prevalent, with more than 80% of individuals likely to acquire an infection at some point in their lifetime.[1–3] HPV is associated with several cancers, including cancers of the cervix, anus, and oropharynx, and accounts for about 7% of cancers in the United States (US).[4] Additionally, HPV-related cancers impose an enormous economic burden on individuals, families, and governments at the national and state levels.[3,5] It is estimated that the US spends about $8 billion annually on direct medical costs to prevent and treat HPV-related cancers.[3]

HPV vaccination is an essential public health tool that can prevent more than 90% of HPV-associated cancers from developing.[6] The US Centers for Disease Control and Prevention (CDC) recommends that healthcare providers (HCPs) assess patients' vaccination status and strongly recommend needed vaccines at every clinical encounter.[7] According to the CDC Advisory Committee on Immunization Practices, HPV vaccines should be routinely recommended from ages 11 to 12 years but could be started as early as 9 years.[8] In addition, catch-up vaccination is recommended from ages 13 to 26 years in persons not adequately vaccinated.[8] However, in 2020, the HPV vaccination completion rate for teenagers in Texas was 55%, lagging behind the national HPV vaccination rate of 59%, and the national HPV vaccination goal of 80% by 2030.[9–11]

Provider recommendations of HPV vaccination is a key determinant of HPV vaccination uptake.[12–14] A recent systematic review and meta-analysis found that provider recommendation increased HPV vaccine initiation and completion rates.[13] Furthermore, the delivery of strong HPV vaccine recommendations is crucial for uptake, and it is contingent on the expertise and comfort of HCPs in discussing and counseling patients about HPV and HPV vaccines.[14–16] Poor knowledge of HPV-related disease among HCPs has been identified as a barrier to HPV vaccination.[17] Also, a multimodal intervention including assessment and documentation of vaccination status at every clinic visit increased HPV vaccine initiation and completion rates.[18] Consequently, increasing HCPs' knowledge in HPV vaccination status assessments and

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recommendations through training could provide an opportunity to increase HPV vaccination rates in Texas.

However, even though some studies[12–14] examined the importance of HPV vaccine recommendation by HCPs on vaccine uptake, no study has investigated how training and recency of training received by HCPs in Texas impact HPV vaccination status assessments and recommendations. Amid documented knowledge gaps among HCPs on the indications for vaccination and effective ways of counseling patients,[19,20] this study aimed to determine the impact of formal HCP training and recency of training in HPV vaccination promotion or counseling on HPV vaccination status assessments and recommendations to eligible patients in Texas.

Methods

Study design, data source, and population

This was a cross-sectional study using data from a statewide survey conducted between January and April 2021 by The University of Texas MD Anderson Cancer Center. HCPs were defined as physicians in internal medicine, family medicine, obstetrics/gynecology, and pediatrics, as well as physician assistants and nurse practitioners. Inclusion criteria were HCPs who are currently practicing in Texas, have an MD or equivalent or are physician assistants or nurse practitioners, and have a current e-mail address for delivery of the online survey link. E-mail addresses for HCPs practicing in Texas were obtained from LexisNexis Master Provider Referential Database.[21] All eligible HCPs then received an e-mail invitation to participate in the survey along with a brief description of the study's goals and a link to the survey. The survey was distributed between January and April 2021. Up to three follow-up e-mails were sent to participants. Each participant was offered a $10 gift card as compensation for the time and effort in completing the survey. The survey took about 10 minutes to complete. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[22] The study was approved by The University of Texas MD Anderson Cancer Center Ethical Review Board.

Measures

Dependent variables

This study had two dependent variables, namely HCPs' HPV vaccination status assessment and recommendation. The HCPs were asked two separate questions: 1) "At every patient encounter, do you assess HPV vaccination status?" 2) "For the unvaccinated or incompletely vaccinated for HPV, do you recommend HPV vaccination?" Possible responses to these questions were "never," "sometimes," or "often/always," and the responses were recategorized as a binary variable, 0 = "never/sometimes" and 1 = "often/always." The reference category was "never/sometimes."

Independent variables

Training of HCPs. To assess the training of HCPs, participants were asked, "Have you received formal training in HPV vaccination promotion or counseling (e.g., continuing medical education, workshops, and certified training seminars)?" Possible responses were 0 = "no" or 1= "yes," and the reference category was "no." Furthermore, to assess the recency of training, all HCPs who reported that they had received formal training were asked, "How long ago did you attend a formal training session on HPV vaccination?." Responses were categorized as <2 years ago, 2 to 5 years ago, and >5 years ago. The reference category for recency of training was no training.

HCP socio-demographic and practice-related factors. HCP-related factors assessed were age (<35 years, 35 to 54 years, and ≥55 years), sex (male and female), race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Other, and Hispanic), and region of practice (rural and urban). The 2013 Rural-Urban Continuum Codes (RUCC) were used to determine HCPs' region of practice based on the zip codes reported.[23] Other factors assessed were the number of years in practice (≤10 years, 11–20 years, and >20 years), the number of patients seen per week (0–50, 51–100, and >100), practice role (physician, nurse, physician assistant, and other), and facility type (solo practice, group practice, university or teaching hospital, federally qualified health center (FQHC)/public facility, and other).

Data analysis

By each dependent variable (HPV vaccination status assessment and Descriptive statistics were presented for the independent variables stratified recommendation) using proportions and Pearson's chi-square test. We had two separate models for each of our study outcomes. A *priori*, variables considered relevant to our study based on the literature were included in our analyses. Thus, no variable selection was conducted. Bivariable and multivariable logistic regression analyses were used to estimate the odds of HPV vaccination status assessment and recommendation among HCPs who received HPV vaccination training compared with those who received no training. Also, we assessed the association between the recency of training and HPV vaccination status assessment and recommendation. Each multivariable logistic regression model was adjusted for HCPs' age, sex, race/ethnicity, region of practice, number of years in practice, number of patients seen per week, role in practice, and facility type. Our study allowed us to conduct subset analyses for recommendation but not for assessment of HPV vaccination status. These sub-analyses were performed to estimate the odds of HPV vaccination recommendation to patients aged 9 to 12 years, 13 to 18 years, and 18 to 26 years, stratified by patient gender. All analyses were conducted using Stata/IC Version 15.1.[24] Statistical significance was defined as a two-sided p-value <.05.

Results

A total of 1,283 HCPs were included in this study, a response rate of 7%. Of the participants, 43% had received training while 57% had received no training in HPV vaccination promotion or counseling (Table 1). Participants were predominantly 35 to 54 years (62%), female (77%), non-Hispanic White (53%),

Table 1. Distribution of training, demographics, and practice-related factors for healthcare providers by strata of HPV vaccination status assessment and recommendation.

		Assessment of HPV vaccination status (n = 1019)			Recommendation of HPV vaccination (n = 1283)		
Characteristics	Overall (n = 1283)	Often/Always (n = 482)	Never/Sometimes (n = 537)	*p*-value	Often/Always (n = 756)	Never/Sometimes (n = 527)	*p*-value
Training, n (%)				<0.001			<0.001
No	730 (57.3)	187 (31.2)	413 (68.8)		324 (44.4)	406 (55.6)	
Yes	545 (42.8)	294 (71.0)	120 (29.0)		429 (78.7)	116 (21.3)	
Recency of training, years, n (%)				<0.001			<0.001
No Training	730 (57.3)	187 (31.2)	413 (68.8)		324 (44.4)	406 (55.6)	
Training received >5 years ago	168 (13.2)	81 (65.9)	42 (34.2)		132 (78.6)	36 (21.4)	
Training received 2–5 years ago	211 (16.6)	101 (66.9)	50 (33.1)		160 (75.8)	51 (24.2)	
Training received <2 years ago	164 (12.9)	110 (79.7)	28 (20.3)		135 (82.3)	29 (17.7)	
Provider age, years, n (%)				<0.001			0.006
< 35	160 (12.7)	42 (33.1)	85 (66.9)		80 (50.0)	80 (50.0)	
35-54	783 (62.2)	278 (46.3)	323 (53.7)		463 (59.1)	320 (40.9)	
≥ 55	316 (25.1)	156 (58.2)	112 (41.8)		206 (65.2)	110 (34.8)	
Provider sex, n (%)				0.841			0.923
Female	966 (76.5)	362 (47.1)	406 (52.9)		569 (58.9)	397 (41.1)	
Male	297 (23.5)	113 (47.9)	123 (52.1)		174 (58.6)	123 (41.4)	
Race/ethnicity, n (%)				0.001			0.031
Non-Hispanic White	668 (53.3)	230 (44.2)	291 (55.9)		380 (56.9)	288 (43.1)	
Non-Hispanic Black	116 (9.3)	44 (46.8)	50 (53.2)		67 (57.8)	49 (42.2)	
Hispanic	164 (13.1)	84 (63.6)	48 (36.4)		114 (69.5)	50 (30.5)	
Non-Hispanic other	306 (24.4)	111 (45.1)	135 (54.9)		178 (58.2)	128 (41.8)	
Practice location, n (%)				0.072			0.080
Rural	54 (4.2)	25 (61.0)	16 (39.0)		38 (70.4)	16 (29.6)	
Urban	1228 (95.8)	456 (46.7)	521 (53.3)		717 (58.4)	511 (41.6)	
Provider type, n (%)				<0.001			<0.001
Physician	501 (39.1)	291 (74.6)	99 (25.4)		403 (80.4)	98 (19.6)	
Nurse	407 (31.7)	129 (40.4)	190 (59.6)		214 (52.6)	193 (47.4)	
Physician assistant	273 (21.3)	45 (20.2)	178 (79.8)		110 (40.3)	163 (59.7)	
Other	102 (8.0)	17 (19.5)	70 (80.5)		29 (28.4)	73 (71.6)	
Type of practice, n (%)				<0.001			<0.001
University/teaching hospital	398 (31.0)	96 (29.7)	227 (70.3)		182 (45.7)	216 (54.3)	
Solo practice	144 (11.2)	62 (54.4)	52 (45.6)		92 (63.9)	52 (36.1)	
Group practice	407 (31.7)	187 (59.2)	129 (40.8)		277 (68.1)	130 (31.9)	
FQHC/public facility	132 (10.3)	66 (62.9)	39 (37.1)		93 (70.5)	39 (29.6)	
Other	202 (15.7)	71 (44.1)	90 (55.9)		112 (55.5)	90 (44.6)	
Years in practice, n (%)				<0.001			<0.001
≤ 10 years	492 (38.7)	157 (41.3)	223 (58.7)		268 (54.5)	224 (45.5)	
11–20 years	434 (34.2)	151 (44.2)	191 (55.9)		248 (57.1)	186 (42.9)	
> 20 years	344 (27.1)	170 (59.7)	115 (40.4)		235 (68.3)	109 (31.7)	
No of patients seen (per week), n (%)				<0.001			<0.001
≤ 50	608 (48.8)	149 (29.9)	349 (70.1)		274 (45.1)	334 (54.9)	
51-100	486 (39.0)	246 (65.6)	129 (34.4)		356 (73.3)	130 (26.8)	
> 100	153 (12.3)	73 (64.6)	40 (35.4)		109 (71.2)	44 (28.8)	

8 observations missing for training, 10 observations missing for recency of training, 24 observations missing for age, 20 observations missing for sex, 1 observation missing for practice location, 29 observations missing for race/ethnicity, 13 observations missing for years in practice, and 36 observations missing for the number of patients seen per week.

worked in US urban regions (96%), and physicians (39%). Also, 32% worked in a group practice, 39% had ≤10 years of practice, and 49% saw ≤50 patients per week.

Assessment of HPV vaccination status

A total of 1,019 HCPs responded to the question about assessment of HPV vaccination status. Of these, 482 (47%) reported that they often/always assess patients' HPV vaccination status while 537 (53%) never/sometimes assess patients' HPV vaccination status (Table 1). HCPs who received training in HPV vaccination promotion or counseling were significantly more likely to often/always assess HPV vaccination status than those who received no training (71% vs. 31%). HCPs ≥55 years old (58%) were more likely to often/always assess HPV vaccination status than were those <35 years old (33%) and those 35 to 54 years old (46%). Also, HCPs who were Hispanics (64%) were more likely to often/always assess HPV vaccination status than were those who were non-Hispanic Whites (44%), non-Hispanic Blacks (47%), and non-Hispanic other (45%). Additionally, physicians (75%) were more likely to often/always assess HPV vaccination status than were nurses (40%) or physician assistants (20%). Furthermore, HCPs who replied that they often/always assess HPV vaccination status were more likely to work in FQHCs/Public facilities (63%), have >20 years of experience (60%), and see on average 51–100 patients per week (66%).

As seen in Table 2, the multivariable logistic regression analysis showed that, compared with HCPs who received no training in HPV vaccination promotion or counseling, those who received such training had more than four times higher odds (adjusted odds ratio [AOR]: 4.32; 95% CI: 3.06–6.10) of assessing HPV vaccination status (Table 2). Also, male HCPs had 38% lower odds (AOR: 0.62; 95% CI: 0.41–0.95) of often/

Table 2. Bivariable and multivariable logistic regression analyses of the association between training and provider assessment of HPV vaccination status and recommendation of HPV vaccines – overall population.

	Assessment of HPV vaccination status				Recommendation of HPV vaccination			
Characteristics	Crude OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value	Crude OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Training								
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	5.41 (4.12–7.11)	<0.001	4.32 (3.06–6.10)	<0.001	4.63 (3.60–5.96)	<0.001	3.66 (2.73–4.90)	<0.001
Provider age, years								
< 35	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
35-54	1.74 (1.16–2.60)	0.007	1.41 (0.78–2.55)	0.260	1.45 (1.03–2.03)	0.034	1.20 (0.76–1.91)	0.436
≥ 55	2.82 (1.81–4.39)	<0.001	2.07 (0.93–4.60)	0.073	1.87 (1.27–2.76)	0.001	1.19 (0.63–2.26)	0.588
Provider sex								
Female	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Male	1.03 (0.77–1.38)	0.841	0.62 (0.41–0.95)	0.029	0.99 (0.76–1.29)	0.923	0.70 (0.50–1.00)	0.047
Race/ethnicity								
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	1.11 (0.72–1.73)	0.633	1.35 (0.75–2.44)	0.323	1.04 (0.70–1.54)	0.861	1.07 (0.65–1.75)	0.792
Hispanic	2.21 (1.49–3.29)	<0.001	2.55 (1.52–4.29)	<0.001	1.73 (1.20–2.49)	0.003	1.87 (1.21–2.89)	0.005
Non-Hispanic other	1.04 (0.77–1.41)	0.800	0.99 (0.64–1.52)	0.959	1.05 (0.80–1.39)	0.707	1.06 (0.75–1.49)	0.752
Practice location								
Rural	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Urban	0.56 (0.30–1.06)	0.076	0.54 (0.24–1.24)	0.146	0.59 (0.33–1.07)	0.083	0.59 (0.29–1.19)	0.138
Provider type								
Physician	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Nurse	0.23 (0.17–0.32)	<0.001	0.23 (0.16–0.35)	<0.001	0.27 (0.20–0.36)	<0.001	0.29 (0.20–0.41)	<0.001
Physician assistant	0.09 (0.06–0.13)	<0.001	0.08 (0.05–0.13)	<0.001	0.16 (0.12–0.23)	<0.001	0.18 (0.12–0.26)	<0.001
Other	0.08 (0.05–0.15)	<0.001	0.11 (0.06–0.23)	<0.001	0.10 (0.06–0.16)	<0.001	0.14 (0.08–0.24)	<0.001
Type of practice								
University/teaching hospital	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Solo practice	2.82 (1.82–4.37)	<0.001	2.13 (1.20–3.77)	0.010	2.10 (1.42–3.11)	<0.001	1.43 (0.89–2.31)	0.139
Group practice	3.43 (2.47–4.76)	<0.001	1.69 (1.08–2.65)	0.021	2.53 (1.90–3.37)	<0.001	1.38 (0.96–1.99)	0.082
FQHC/public facility	4.00 (2.52–6.35)	<0.001	2.14 (1.14–4.00)	0.018	2.83 (1.85–4.32)	<0.001	1.78 (1.04–3.03)	0.035
Other	1.87 (1.26–2.76)	0.002	1.03 (0.61–1.73)	0.918	1.48 (1.05–2.08)	0.025	0.94 (0.62–1.45)	0.792
Years in practice								
≤ 10 years	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
11–20 years	1.12 (0.84–1.51)	0.442	0.73 (0.47–1.13)	0.160	1.11 (0.86–1.45)	0.414	0.75 (0.53–1.07)	0.113
> 20 years	2.10 (1.54–2.87)	<0.001	1.04 (0.56–1.93)	0.893	1.80 (1.35–2.40)	<0.001	1.19 (0.73–1.95)	0.484
No of patients seen (per week)								
≤ 50	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
51-100	4.47 (3.35–5.95)	<0.001	4.06 (2.80–5.89)	<0.001	3.34 (2.58–4.31)	<0.001	2.79 (2.05–3.80)	<0.001
> 100	4.27 (2.78–6.58)	<0.001	3.80 (2.13–6.78)	<0.001	3.02 (2.06–4.44)	<0.001	2.55 (1.58–4.11)	<0.001

OR: Odds Ratio; CI: Confidence Interval.

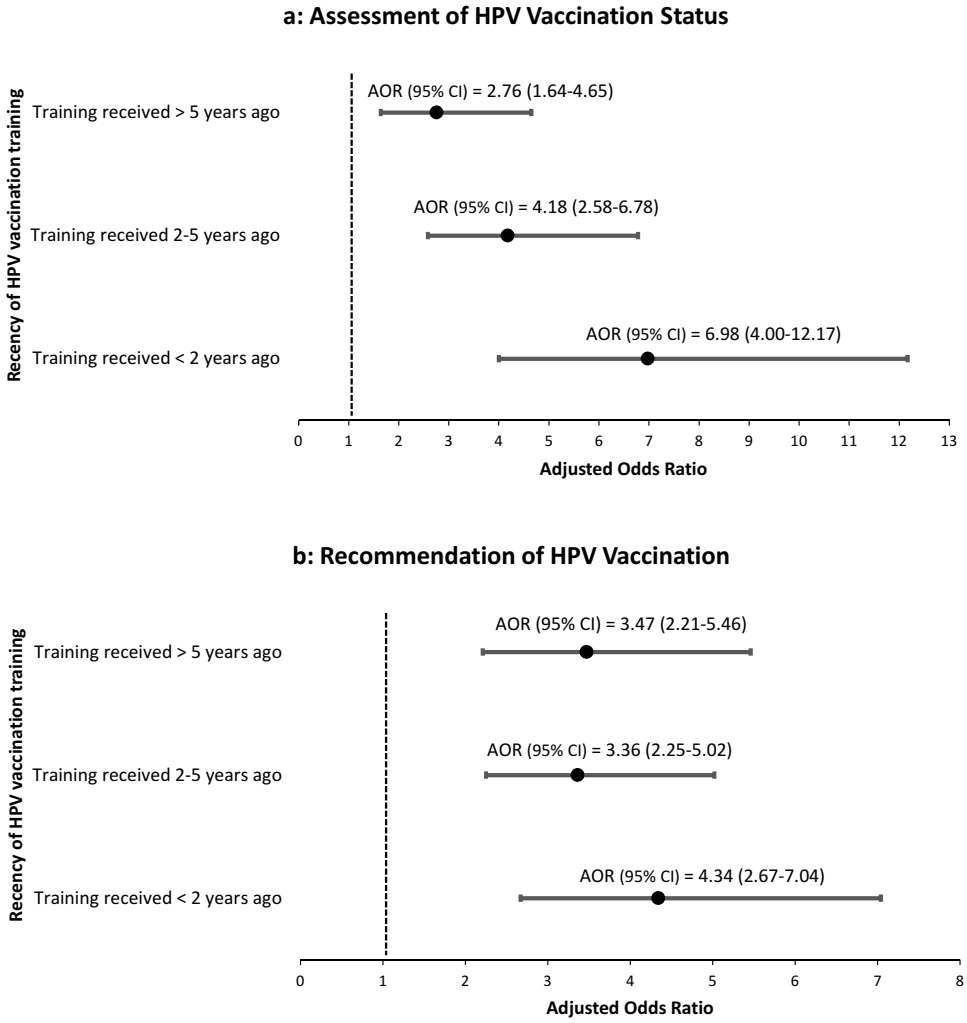
always assessing HPV vaccination status compared with female HCPs. The odds of often/always assessing HPV vaccination status were two and a half times higher (AOR: 2.55; 95% CI: 1.52–4.29) among Hispanic HCPs compared with non-Hispanic White HCPs. Also, nurses and physician assistants had 77% (AOR: 0.23; 95% CI: 0.16–0.35) and 92% (AOR: 0.08; 95% CI: 0.05–0.13) lower odds, respectively, of often/always assessing HPV vaccination status compared with physicians. Furthermore, the odds of often/always assessing HPV vaccination status were higher among HCPs working in solo practices, group practices, or FQHCs/public facilities compared with those in university/teaching hospitals. HCPs who saw 51–100 patients per week and those who saw >100 patients per week had 4.06 (AOR: 4.06; 95% CI: 2.80–5.89) and 3.80 (AOR: 3.80; 95% CI: 2.13–6.78) times higher odds, respectively, of often/always assessing HPV vaccination status compared with those who saw ≤50 patients per week.

On further analysis, we found recency of training was significantly associated with HPV vaccination status assessment. HCPs who received formal training in HPV vaccination <2 years ago, 2 to 5 years ago, and >5 years ago had 6.98 times, 4.18 times, and 2.76 times higher odds, respectively, of assessing HPV vaccination status often/always compared with HCPs with no training (Figure 1a).

Recommendation of HPV vaccination

Of the 1,283 HCPs who responded to the question on the recommendation of HPV vaccination, 756 (59%) HCPs reported that they often/always recommended HPV vaccines, while 527 (41%) reported that they never/sometimes recommended HPV vaccination (Table 1). HCPs trained in HPV vaccination promotion or counseling were significantly more likely to often/always recommend HPV vaccination than those who received no training (79% vs. 44%). HCPs ≥55 years old (65%) were more likely to often/always recommend HPV vaccination compared with those <35 years old (50%) and those 35 to 54 years old (59%). Also, HCPs who were Hispanic (70%) were more likely to often/always recommend HPV vaccination compared with those who were non-Hispanic Whites (57%), non-Hispanic Blacks (58%), and non-Hispanic other (58%). Also, physicians (80%) were more likely to often/always recommend HPV vaccination compared with nurses (53%) and physician assistants (40%). Furthermore, HCPs who

Figure 1. Multivariable logistic regression analyses of the association of recency of HPV vaccination training of HCPs with HPV vaccination status assessment and recommendation in the overall population of HCPs in Texas.



Reference category for recency of HPV vaccination training was "No training received". AOR = Adjusted Odds Ratio. Odds ratio from logistic regression models were adjusted for HCP's age, sex, race/ethnicity, location of practice, provider type, practice type, number of years in practice, and number of patients seen.

often/always recommended HPV vaccination were more likely to work in FQHCs/public facilities (71%), have >20 years of experience (68%), and see on average 51–100 patients per week (73%).

On multivariable logistic regression analysis, we found that, compared with HCPs who received no training in HPV vaccination promotion or counseling, those who received training had more than three and half times higher odds (AOR: 3.66; 95% CI: 2.73–4.90) of often/always recommending HPV vaccination. The odds of often/always recommending HPV vaccination were 30% lower (AOR: 0.70; 95% CI: 0.50–1.00) among male HCPs compared with female HCPs. Additionally, the odds of often/always recommending HPV vaccination were 87% higher (AOR: 1.87; 95% CI: 1.21–2.89) among Hispanic HCPs compared with non-Hispanic White HCPs. Also, nurses and physician assistants had 71% (AOR: 0.29; 95% CI: 0.20–0.41) and 82% (AOR: 0.18; 95% CI: 0.12–0.26) lower odds, respectively, of often/always recommending HPV vaccination compared with physicians. Furthermore, the odds of often/always recommending HPV vaccination were 78% higher (AOR: 1.78; 95% CI: 1.04–3.03) among HCPs working in FQHCs/public facilities than those in university/teaching hospitals. Also, compared with HCPs who saw ≤50 patients a week, HCPs who saw 51–100 patients per week and those who saw >100 patients per week had 2.79 (AOR: 2.79; 95% CI: 2.05–3.80) and 2.55 (AOR: 2.55; 95% CI: 1.58–4.11) times higher odds, respectively, of often/always recommending HPV vaccine.

Similarly, recency of training was associated with HPV vaccination recommendation. HCPs who received formal training in HPV vaccination <2 years ago, 2 to 5 years ago, and >5 years ago had 4.34 times, 3.36 times, and 3.47 times higher odds, respectively, of often/always recommending HPV vaccination compared with those with no training (Figure 1b).

We further conducted subset analyses of HPV vaccination recommendations by the age and gender of patients. Training of HCPs was significantly associated with higher odds of often/always recommending HPV vaccination across different age

and gender groups (Supplemental Tables 1 and 2). Of note, compared with female HCPs, male HCPs were 48% and 44% significantly less likely to often/always recommend HPV vaccination to boys and girls, respectively, during the routine recommended age range (9 to 12 years). Similarly, compared with non-Hispanic White HCPs, Hispanic HCPs were twice as likely to often/always recommend HPV vaccination to boys and girls during the routine recommended age range (9 to 12 years). Also, HCPs working in FQHCs/public facilities were more likely to often/always recommend HPV vaccination to boys and girls during the recommended age range.

Discussion

Our findings demonstrate the importance of training HCPs in HPV vaccination promotion or counseling to increase HPV vaccination coverage. Overall, our findings indicate that more than half the HCPs in Texas have not received formal HPV vaccination training. This finding highlights inadequate training of HCPs in HPV vaccination promotion or counseling and supports prior studies that found knowledge gaps among HCPs on the indications for HPV vaccination and effective counseling of patients, with corresponding low vaccination rates.[19,20] This knowledge gap may not be related to a lack of educational resources on HPV and HPV vaccines, given the availability of guidelines and educational materials on HPV from the CDC and other organizations.[19,25] Also, in centers where HPV vaccination training exists, variations in the structure and standards of HPV vaccination training for HCPs within and between academic programs have been noted.[26] Thus, even when HCPs have access to education resources, well-structured formal training programs are crucial in increasing HPV vaccination recommendation and uptake.[16,27]

Our study confirms the positive impact of training on HPV vaccination status assessment and recommendation. According to the CDC guidelines, HCPs should assess the HPV vaccination status of patients at every clinic visit as a first step in minimizing missed opportunities to educate, counsel, and recommend HPV vaccination to patients and parents.[7,28] Rand et al. found that patients were more likely to receive the HPV vaccine when their providers received training to strengthen their communication about the vaccine.[29] In another study by Vu et al., providers' knowledge of HPV vaccine or recommendation guidelines were reported as critical influences that determined the promotion and uptake of HPV vaccines.[28] Thus, HCPs would benefit from training on HPV vaccination promotion or counseling to enhance the assessment of HPV vaccination status and recommendation of HPV vaccination to eligible patients at every encounter. Our study emphasized the positive impact of recency of formal training on HPV vaccination status assessment and recommendation and highlights the need for more frequent HPV vaccination-focused continuing medical education programs for HCPs across settings and practices.

Overall, we found that female HCPs were more likely to recommend HPV vaccination than were male HCPs. However, in our sub-analysis, this association held true only for adolescents aged 9 to 12 years old, regardless of adolescent gender. Several inter-related factors may explain this. First, mothers who typically accompany their young adolescents to the clinic are frequently the sole decision-makers in their adolescent's HPV vaccine initiation and completion.[30] Given that HPV is mainly sexually transmitted, recommendation of HPV vaccine is often accompanied by discussions to address parent's sex-related concerns about their adolescents. For example, when discussing sex-related matters, women tend to be more proactive than men in engaging their HCPs and are more likely to be engaged by female HCPs than male HCPs.[31,32] Therefore, our study highlights the need for educational interventions focusing on male HCPs to increase their confidence in providing cancer prevention messages and in discussing and addressing parents' HPV vaccination concerns, particularly while communicating with parents of children aged 9 to 12 years. Our study also identified the critical role of provider experience in discussing and promoting HPV vaccination as we found that HCPs who see more patients assessed vaccination status and recommended HPV vaccination more often. This is consistent with a study that found higher vaccine recommendations among HCPs with more experience and those who see more patients.[33]

We found that Hispanic HCPs in Texas were more likely than their non-Hispanic White counterparts to assess vaccination status and recommend HPV vaccination. El Paso County in Texas, predominantly Hispanic, has the highest HPV vaccination rates in Texas,[34] and HCP recommendations may have contributed to this success. The high vaccination rate in this region has been linked to the successful implementation of a cultural-based educational intervention targeting psychosocial barriers to vaccination.[35] Nationally, it has also been noted that Hispanic adolescents are more likely to receive HPV vaccines.[9,36] Consequently, Hispanic HCPs who are more likely to see Hispanic patients/parents may often assess HPV vaccination status and recommend vaccination based on their Hispanic patients' general willingness to receive the vaccine.[9,35,36] Also, we found that nurses and physician assistants were less likely than physicians to assess vaccination status and recommend the HPV vaccination. Our finding provides a justification to include nurses and physician assistants in HPV vaccination training programs.

In our study, HCPs practicing at FQHCs were more likely to assess vaccination status and recommend HPV vaccination than those at university/teaching hospitals. This is not surprising given the socio-demographic characteristics of patients attending FQHCs and the prioritization of preventive and primary health services at these centers. Most patients at FQHCs are uninsured (41%), with a third earning income at or below the federal poverty level.[37] Also, studies have shown that patients from low-income families are more likely to initiate and complete the HPV vaccines.[9,36] More so, our data show that HCPs in FQHCs see more patients than those in teaching hospitals and that seeing a high number of patients positively correlates with HPV vaccination status assessments and recommendations. Overall, our study highlights important opportunities for HCPs to be adequately prepared and equipped with tools to address patient concerns and counsel, promote, and recommend HPV vaccination at every visit.

Specifically, HCPs who were female, were Hispanic, and practiced in FQHCs were more likely to recommend the

HPV vaccination to boys and girls within the recommended HPV vaccination age range (9 to 12 years). A recent study of HPV vaccination in ages 9–12 years revealed that although HPV vaccination rates in this age range have increased, rates have remained suboptimal and behind target.[38] Our study highlights the need for HCPs across different sociodemographic and practice settings to continue recommending HPV vaccination to boys and girls aged 9 to 12 years. Additionally, our study provides a window to train HCPs to routinely recommend HPV vaccination to all eligible patients, including boys and girls in the catch-up age group (13 to 26 years).

Our study has some limitations. It is cross-sectional in nature, and thus we may not be able to infer causality. Also, the study is prone to potential recall bias if the recollection of practice experiences differs among HCPs who often/always compared with those who never/sometimes assess HPV vaccination status and recommend HPV vaccination. Furthermore, our study was nonspecific on the nature of HPV vaccination training received by HCPs in terms of the length, type, or topics covered. Also, HPV vaccination status assessment was measured in the survey at every patient encounter and not by visit type; therefore, we were unable to account for or adjust for these potential variations in our analyses. Thus, our study may be prone to residual (unmeasured) confounding. Our study does not directly evaluate the effect of HCP training on HPV vaccination uptake (patient-level factors); however, it focuses on modifiable HCP-level factors including HPV vaccination status assessment and recommendations, key predictors of vaccine uptake. Also, our study uses data from a statewide survey of frontline HCPs in Texas, which could increase the generalizability of our findings to other states with similar characteristics of HCPs. In addition, we considered the response rate for this study reasonable, given that the study targeted frontline HCPs, most of whom are very busy and in non-academic settings. Also, there was no significant difference between respondents and non-respondents with respect to provider type (e.g., family physician, pediatrician, internal medicine, nurse practitioner) and sex of HCPs, the only two characteristics for which data were available for non-respondents. Thus, we considered the survey representative, at least with respect to these two variables.

In conclusion, our data indicate that most HCPs in Texas have not received formal training in HPV vaccination promotion or counseling. Also, HCP training and the recency of training were associated with increased frequency of HPV vaccination status assessments and recommendations. HCPs in Texas across different practice settings and backgrounds will benefit from frequent training on HPV vaccination promotion or counseling to increase HPV vaccine uptake. Moreover, our study provides a chance to enhance the recommendation of HPV vaccination to patients and parents through formal training and ultimately increase the HPV vaccination coverage rate. Novel strategies are also needed to enhance HCPs' participation in future surveys and population health research, given their role as frontline professionals and stakeholders in patients' health decisions. Furthermore, to better understand role of HPV vaccination training, future studies should be more specific in assessing the length, type, and content of training received by HCPs. Finally, future longitudinal studies should evaluate the effectiveness of HPV vaccination training interventions for HCPs in Texas on HPV vaccination status assessment, recommendation, and uptake.

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