



Clinician offering is a key factor associated with HPV vaccine uptake among Mexican mothers in the USA and Mexico: a cross-sectional study

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Abstract

Objective To compare the knowledge, beliefs, and practices regarding HPV vaccination among mothers of vaccine-eligible girls in Mexico and the USA.

Methods Similar samples of Mexican mothers with vaccine-eligible daughters were surveyed at two clinics in Cuernavaca, Morelos, from July to October 2012 ($n = 200$) and at two clinics in Oxnard, California, from August to November 2013 ($n = 200$).

Results Although mothers in the USA had less knowledge and more negative attitudes toward the vaccine than their counterparts in Mexico, vaccine uptake rates were higher in the USA (49% vs. 40%). US mothers were more likely to have discussed and been offered the HPV vaccine by a clinician than mothers in Mexico. In multivariate analyses, having been offered the HPV vaccine was the most important predictor of vaccine uptake.

Conclusions Our results suggest that healthcare access or other system, clinic, or provider factors are the main drivers of vaccine receipt in this binational sample of Mexican mothers. Interventions and programs that encourage clinicians to offer the HPV vaccine should be developed to increase vaccine uptake in both countries.

Keywords Human papillomavirus · Vaccination · Cervical cancer prevention · Health disparities · Mexico · Latinos

Introduction

Worldwide, cervical cancer is the fourth most common cancer and the third in terms of cancer-related deaths among women in developing regions (Ferlay et al. 2015). However, this disease continues to be a significant public health problem in more developed countries such as the USA and Mexico. In 2018, the American Cancer Society estimates that there will be 13,240 new cases of cervical cancer and 4170 deaths in the USA, and Latinas have the highest incidence rate and the second highest mortality rate after black women (ACS 2018; Centers for Disease Control and Prevention 2018). In California, Latinas are more likely to develop and die from cervical cancer than any other racial/ethnic group (ACS 2017). The cervical cancer incidence rate for Latinas in Los Angeles County is still much higher than among non-Latina whites, African Americans, and certain Asian groups (Liu et al. 2016). In

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Mexico, cervical cancer is the second most common cancer among women, and the first among those aged 15–44 years (Bruni et al. 2017). In 2012, there were 13,960 new cervical cancer cases and 4769 deaths (Bruni et al. 2017). Although there has been a national cervical cancer screening program in Mexico since 1974 (Lazcano-Ponce et al. 1999) and the Pap test is widely used in the USA since the early 1960s, this preventable disease remains an important cause of mortality in both countries.

The recognition of human papillomavirus (HPV) infection as a necessary cause of cervical cancer and the subsequent development of the HPV vaccine have brought about significant changes to prevention efforts. In the USA, HPV vaccination is recommended for girls who are 9 or older with a catch-up vaccine for girls aged 13–26 who were not previously vaccinated (Markowitz et al. 2007, 2014; Petrosky et al. 2015). Under the Vaccines for Children Program, girls who are 18 years or younger that qualify for Medicaid, are uninsured, or have insurance that does not cover HPV vaccination, can receive the vaccine for free (Centers for Disease Control and Prevention 2014). In the USA, the HPV vaccine is mainly administered through pediatric and primary-care providers. In Mexico, the first pilot HPV vaccination program took place in 2008 and a school-based HPV vaccine program for girls aged 9–10 began in 2011 (Centers for Disease Control and Prevention 2011). Over one million doses are applied each year through school-based vaccination programs that exclusively target girls in fifth grade. Eligible girls are vaccinated for free at schools or health centers during the National Vaccination Weeks.

The availability of HPV vaccines represents a landmark breakthrough in the primary prevention of HPV-associated disease, and they show high efficacy in preventing persistent infection with high-risk types that cause over 70% of cervical cancer cases. Despite the widespread availability and free access, HPV vaccination rates in both the USA and Mexico are suboptimal. In 2016, 60% of girls aged 13–17 years received ≥ 1 dose of the HPV vaccine and 49.5% received the complete vaccination series, with higher rates of 71.8% and 55.3%, respectively, observed among Latina girls in the USA (Walker et al. 2017). Factors influencing HPV vaccine uptake in the USA include availability of culturally appropriate information to improve awareness, access to free or low-cost vaccinations, child's age, and healthcare providers' recommendation of the vaccine (Glenn et al. 2015; Berenson 2015; Gerend et al. 2013; Tsui et al. 2013; Ylitalo et al. 2013). Other studies have examined how provider discomfort discussing the sexual transmission of HPV and the lack of adherence to practice guidelines are barriers that contribute to missed opportunities to recommend and offer the HPV vaccine (Bynum et al. 2014; Javanbakht et al. 2012; Perkins et al.

2013; Berenson 2015; Sussman et al. 2015). In Mexico, the HPV vaccine coverage is estimated to be 67% (Bruni et al. 2016). However, few published studies have investigated clinician offering and patient uptake of the HPV vaccine programs in Mexico (Ramírez-Rios and Bonnez 2013; Sánchez Anguiano et al. 2013).

Although Latinas have the highest risk of developing cervical cancer in California and cervical cancer is the second leading cause of death due to cancer for women in Mexico, there is scarce information about the knowledge and preventive practices regarding HPV vaccination in these populations. Thus, the purpose of this study was to compare the knowledge, beliefs, and practices regarding HPV vaccination among Mexican mothers/caregivers (henceforth, mothers) of vaccine-eligible girls at health-care clinics in Cuernavaca, Morelos, and in Oxnard, California. To our knowledge, this is the first study to examine HPV vaccination knowledge, beliefs, and practices among Mexican mothers in the USA and Mexico. A greater understanding of the barriers and facilitators of HPV vaccination in these high-risk groups could help guide the development of more appropriate and effective vaccine promotion strategies and programs in both countries.

Methods

Study sites

The US surveys were conducted at two *Clinicas del Camino Real* clinics: (1) the Oxnard Clinic and (2) the *Maravilla* Clinic, which offer the HPV vaccine to low-income girls and adolescents in Oxnard County. *Clinicas del Camino Real, Inc.*, is a Federally Qualified Health Center (FQHC) and a 501(c)(3) nonprofit organization that delivers a fully integrated system of healthcare services, at 13 locations. *Clinicas'* bilingual and bicultural staff reaches out to members of the community who are traditionally underserved due to limited income, resources, cultural, and language barriers. These clinics were selected because their patient population is mostly Latino and the majority are of Mexican origin.

In Mexico, participants were enrolled and interviewed at two Mexican Institute of Social Security (IMSS) clinics in Cuernavaca. IMSS is the main social security institution in Mexico, offering health insurance coverage to current or formerly employed workers and their dependents, providing care to an estimated 44% of the Mexican population (INEGI 2013). In both countries, recruitment and surveys were conducted at clinical sites with vaccination services, so all respondents had free or low-cost access to the HPV vaccine for their daughters. Additionally, these clinics were

chosen because of a preexisting working relationship between the study researchers and the clinic administrators. The two IMSS clinics in Cuernavaca, Mexico, and the two *Clinicas del Camino Real* clinics in Oxnard, USA, are within close proximity to each other in an urban environment (approximately 4 km apart).

Identification of participants and study procedures

A sample of 200 Mexican women 18–65 years of age who are the mothers or medical decision-makers for at least one girl who is eligible to receive the HPV vaccine (9–12 years) were surveyed at two IMSS clinics in Cuernavaca from July to October 2012. A similar sample of 200 Mexico-born, Spanish-speaking mothers with a daughter(s) of vaccinating age (9–18 years) were surveyed at two clinics in Oxnard from August to November 2013. Our study population was restricted to women who were born in Mexico, whose primary language is Spanish, and who have access to free or low-cost medical services, in order to minimize the differences between the two groups.

Trained interviewers enrolled eligible participants in the waiting room areas of the clinics in Oxnard and Cuernavaca, using the same identification and recruitment procedures. Women who met the inclusion criteria were invited to participate and were provided with a detailed explanation of the study while emphasizing the voluntary and confidential nature of the survey. All subjects provided informed consent before participating in the survey, which took place in a separate room or private area of the waiting room to ensure confidentiality. The response rate among women who were eligible to participate in the study was over 80%. Participants in the USA were paid \$10 dollars after completing the survey, but the women in Mexico were not compensated because subjects cannot be paid to participate in research studies. Approval for this study was obtained from the UCLA and IMSS Internal Review Boards prior to beginning any data collection activities.

Survey instruments and conceptual framework

The theoretical perspective of the Multi-Level Health Outcomes Framework, formerly known as the Health Behavior Framework, developed by Dr. Roshan Bastani and colleagues (Bastani et al. 2010), was used to develop the study questionnaires and guide the data analyses. Survey items were drawn from prior studies of the research team, as described previously (Glenn et al. 2015; Bastani et al. 2011). Since the focus of this study was on the mothers of HPV vaccine-eligible girls, a greater emphasis was placed on individual-level variables from the model such as mothers' knowledge regarding HPV, perceived

susceptibility to disease, and the socio-demographics of the mother and daughter. We also examined perceived barriers to preventive services and medical care, vaccine-related attitudes and beliefs, as well as communication between mother and clinician. A subsample of 15 mothers in Mexico and 20 in the USA participated in in-depth semi-structured interviews eliciting participants' narratives regarding their HPV and other vaccine-related decision-making and values. These qualitative results are reported in a separate manuscript (Wentzell et al. 2016).

Measures

The main study outcome was adolescent HPV vaccine receipt as reported by the mother, through the question: "Has your daughter received any doses of the HPV vaccine?" If applicable, the participants were asked to indicate how they heard about the HPV vaccine, and if they had been offered the HPV vaccine by a doctor or nurse. The mothers were also asked "Have you ever heard of HPV? HPV stands for Human Papilloma virus". (yes/no), and among mothers who were aware of HPV, various follow-up questions assessed if they knew about the association between HPV and cervical cancer, the mechanism of HPV transmission, and whether infections normally clear on their own. Demographic data obtained included: age, education level, household income, marital status, health insurance status, and usual source of medical care.

Statistical analysis

The results reported by Mexican mothers in the USA and Mexico were compared using Chi-square tests for categorical variables (health insurance status, income, and level of education) and T-tests for continuous variables. Chi-square analyses were also used to compare knowledge, access, and vaccine receipt variables, as well as the potential barriers to vaccination uptake among unvaccinated girls, and differences in beliefs between the mothers of vaccinated and unvaccinated girls in both countries. Multivariate logistic regression analyses were performed to identify independent correlates of HPV vaccine uptake, after adjusting for other factors. The variables included in the final multivariate model were selected based on their statistical significance in the bivariate model ($P < 0.05$), tests of multicollinearity, and the conceptual importance of predictor covariates. Unadjusted and adjusted odds ratios (OR) with 95% confidence intervals (95% CI) are reported, and for all analyses, a two-sided P value < 0.05 was considered statistically significant. Data were analyzed using SAS, version 9.3 (SAS Institute, 2011).

Results

The demographic characteristics of the study participants at two Mexican Institute of Social Security (IMSS) clinics in Mexico (Hospital and Clinic) and two clinics in the USA (Oxnard and *Maravilla*) are presented in Table 1. The mean age of participants in Mexico (36.8 years) is younger than in the USA (39.6 years). Mothers in Mexico are more likely to have health insurance (94% vs. 28%, respectively) and are more educated (10.1 vs. 7.4 average years of education, respectively) than participants in the USA. Most mothers in both countries report a household income under \$25,000 USD per year (85% in Mexico and 91% in USA). The mean age of girls in Mexico (10.6 years) is younger than in the USA (13.1 years).

The HPV knowledge, access, and HPV vaccine uptake rates reported by the respondents at two IMSS clinics in Mexico and two clinics in the USA are compared in Table 2. Most of the participants in Mexico have heard of HPV (97% vs. 65% in the USA) and know that HPV causes cervical cancer (94% vs. 87% in the USA). Mothers in Mexico are also more likely to have heard of the HPV vaccine (90% vs. 72% in the USA) and that the vaccine is most effective if administered before sexual debut (99% vs. 89% in the USA). A higher proportion of mothers in the USA indicated that they have discussed the HPV vaccine with their daughter's clinician (69% vs. 44%), their daughter has been offered the HPV vaccine by a clinician (77% vs. 55%), and their daughter has received at least one dose of the HPV vaccine (49% vs. 40%), than those in Mexico. Only 19% of the mothers in the USA and 16% in

Mexico report that their daughters received all the required HPV vaccine doses.

Figure 1 shows the comparison of some decision factors reported by the mothers who did not vaccinate their daughters in Mexico and the USA. Mexican mothers in the USA are more likely to believe their daughters will think it is alright to have sex if they get the HPV vaccine (15% vs. 3% in Mexico), and they also believe that the HPV vaccine might cause problems getting pregnant (21% vs. 1% in Mexico) or other future health problems (20% vs. 2% in Mexico). A larger proportion of Mexican mothers in the USA said they do not have enough information about the HPV vaccine to make a decision (66% vs. 49% in Mexico) and that they are very worried about the vaccine's side effects (63% vs. 31% in Mexico). Mothers with unvaccinated daughters in both countries reported that they would have their daughter vaccinated if their doctor recommends it (100% in Mexico vs. 93% in the USA) and that getting the HPV vaccine for their daughter would be a good idea (100% in Mexico vs. 84% in the USA) (data not shown).

Table 3 contrasts the difference in beliefs between mothers of vaccinated and unvaccinated girls in the USA and Mexico. In the USA, a greater proportion of mothers with vaccinated daughters agree that the HPV vaccine is effective/very effective than mothers of unvaccinated girls (93% vs. 79%). A few respondents in Mexico (2%) and the USA (10%) believe that vaccines cause more harm than good, with significant differences observed between the mothers of vaccinated and unvaccinated girls in the USA (5% vs. 14%, respectively). Mexican mothers in the USA

Table 1 Demographic characteristics of study participants at two sites in Mexico (Hospital and Clinic) and two sites in the USA (Oxnard and *Maravilla*) ($n = 400$)

	Hospital $n = 100$	Clinic $n = 100$	Mexico total ^a $n = 200$	Oxnard clinic $n = 100$	Maravilla Clinic $n = 100$	US total ^a $n = 200$
<i>Mothers/caregivers</i>						
Age (years, mean)	37.5	36.0	36.8	39.9	39.3	39.6**
Uninsured (%)	7%	4%	6%	68%	75%	72%**
Household Income (< \$25,000 US dollars/year)	85%	85%	85%	86%	97%	91%*
Education (years, mean)	9.9	10.4	10.1	7.9	6.9	7.4**
< High school (%)	52%	49%	51%	77%	86%	82%**
Complete high school (%)	35%	32%	33%	15%	6%	11%**
> High school (%)	13%	19%	16%	8%	8%	8%**
<i>Girls/adolescents</i>						
Age (years, mean)	10.4	10.8	10.6	12.9	13.3	13.1**

Cuernavaca, Mexico and Oxnard, USA, 2012–2013

* $P < 0.05$; ** $P < 0.01$

^aDifferences between proportions in total Mexico sample versus total US sample were obtained using Chi-square tests of homogeneity; differences between means were obtained using t test

Table 2 Differences in HPV knowledge, access, and vaccine uptake reported by the participants at two sites in Mexico (hospital and clinic) and two sites in the USA (Oxnard and Maravilla)

	Hospital <i>n</i> (%)	Clinic <i>n</i> (%)	Mexico total ^a <i>n</i> (%)	Oxnard clinic <i>n</i> (%)	Maravilla Clinic <i>n</i> (%)	US total ^a <i>n</i> (%)
<i>Awareness</i> Has heard of HPV (yes)	96 (96)	98 (98)	194 (97)	64 (64)	66 (66)	130 (65)**
<i>Knowledge</i> HPV is transmitted sexually (yes, among aware of HPV)	87 (91)	96 (98)	183 (94)	57 (89)	56 (85)	113 (87)*
<i>Knowledge</i> HPV causes cervical cancer (yes, among aware of HPV)	86 (90)	93 (95)	179 (92)	59 (92)	62 (94)	121 (93)
<i>Awareness</i> Has heard of HPV vaccine (yes)	83 (83)	97 (97)	180 (90)	70 (70)	74 (74)	144 (72)**
<i>Knowledge</i> HPV vaccine is most effective if administered prior to sexual debut (yes, among aware of HPV vaccine)	82 (99)	96 (100)	179 (99)	65 (94)	62 (84)	127 (89)**
<i>Access</i> Has discussed HPV vaccine with daughter's doctor (yes, among aware of HPV vaccine)	33 (40)	45 (47)	78 (44)	42 (60)	58 (78)	100 (69)**
<i>Access</i> Daughter has been offered the HPV vaccine by a doctor or nurse (yes, among aware of HPV vaccine)	47 (57)	52 (54)	99 (55)	54 (78)	56 (76)	110 (77)**
<i>Receipt</i> Initiated HPV vaccine (received ≥ 1 dose)	40 (40)	40 (40)	80 (40)	45 (45)	52 (52)	97 (49)
<i>Receipt</i> Daughter completed HPV vaccination	13 (13)	19 (19)	32 (16)	15 (15)	22 (22)	37 (19)

Cuernavaca, Mexico and Oxnard, USA, 2012–2013

P* < 0.05; *P* < 0.01

^aDifferences between proportions in total Mexico sample versus total US sample were obtained using Chi-square tests of homogeneity. Total sample at each clinic in Mexico is 100, and the total sample at each clinic in the USA is 100

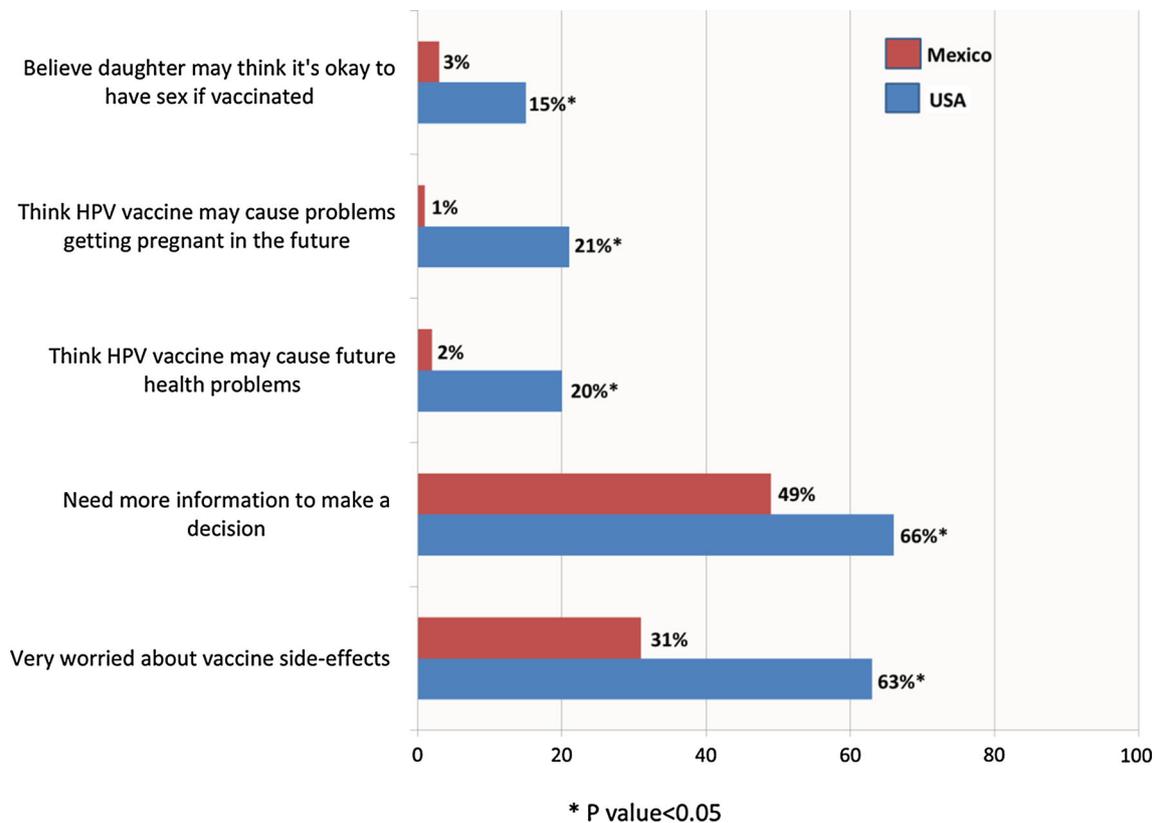


Fig. 1 Percentage of participants with unvaccinated daughters who reported potential barriers to vaccine uptake in Mexico compared to the USA (*n* = 223). [‡]Differences between proportions in total Mexico

sample versus total US sample were obtained using Chi-square tests of homogeneity. Cuernavaca, Mexico and Oxnard, USA, 2012–2013

Table 3 Proportion of mothers with vaccinated or unvaccinated daughters who report specific beliefs regarding the HPV vaccine in Mexico and the USA

	Mexico			USA		
	Not vaccinated <i>n</i> = 120 (%)	Vaccinated <i>n</i> = 80 (%)	Total <i>n</i> = 200 (%)	Not vaccinated <i>n</i> = 103 (%)	Vaccinated <i>n</i> = 97 (%)	Total <i>n</i> = 200 (%)
Agree HPV vaccine is effective/very effective ^e	95 ^d	88	92	79 ^{b,d}	93 ^b	88
Agree vaccination to prevent disease is good	100	100	100	96	100	99
Agree vaccines cause more harm than good	0 ^{a,d}	4 ^a	2	14 ^{b,d}	5 ^b	10
Agree vaccination to prevent serious diseases should be required by law	71 ^d	67 ^c	69	83 ^d	90 ^c	86
Agree with school mandate for HPV vaccine	30 ^d	27 ^c	29	56 ^{b,d}	75 ^{b, c}	66

Cuernavaca, Mexico and Oxnard, USA, 2012–2013

^a*P* < 0.05 for differences between vaccinated versus not vaccinated in Mexico^b*P* < 0.05 for differences between vaccinated versus not vaccinated in the USA^c*P* < 0.05 for differences between vaccinated in Mexico versus vaccinated in the USA^d*P* < 0.05 for differences between not vaccinated in Mexico versus not vaccinated in the USA^eOnly applied to participants who had heard HPV vaccine

are more likely to agree that vaccination to prevent serious diseases should be required by law, than mothers in Mexico, regardless of whether they vaccinated their daughters or not. US mothers are also more likely to agree with a school mandate for the HPV vaccine than mothers in Mexico, whether they vaccinated their daughters or not.

The bivariate and multivariate correlates of vaccine initiation are presented in Table 4. In the bivariate logistic regression analyses, the following factors predict a higher likelihood of receiving ≥ 1 dose of the HPV vaccine: daughter's age, heard of HPV, heard about the HPV vaccine from a clinician, discussed the HPV vaccine with a doctor, were offered the HPV vaccine by a clinician, think daughter has a lower risk of HPV than other girls, agree with school mandate for HPV vaccine, and report a younger acceptable age for HPV vaccination ($P < 0.05$). These variables as well as the mother's age and study site were included in the multivariate logistic regression analyses. Model 1 excluded the variable "has discussed the HPV vaccine with a doctor," while Model 2 excluded "daughter has been offered the HPV vaccine by a clinician." Six factors are associated with a greater likelihood of HPV vaccine uptake: mother's age, daughter's age, discussed the HPV vaccine with a doctor, offered the HPV vaccine by a clinician, think daughter has a lower risk of HPV, and reporting a younger acceptable age for HPV vaccination ($P < 0.05$). The two variables with the strongest association with vaccine initiation are "having discussed the HPV vaccine with a doctor" (OR 8.33, 95% CI 4.37, 15.91) and "having been offered the HPV vaccine by a clinician" (OR 12.37, 95% CI 6.21, 24.63) ($P < 0.001$) (Table 4).

Discussion

This is the first study to assess the knowledge, beliefs, and preventive practices regarding HPV vaccination in a binational sample of Mexican mothers in the USA and Mexico. Our findings indicate that even though Mexican mothers in the USA are less knowledgeable and have more negative attitudes toward the HPV vaccine compared to their counterparts in Mexico, the uptake rates reported by the study participants in Oxnard are higher than those in Cuernavaca. Other studies in the USA have reported low levels of knowledge regarding HPV and the HPV vaccine among Latinos in the USA (Fernandez et al. 2009; Kepka et al. 2012, 2015; Vanslyke et al. 2008). An explanation for the higher vaccine uptake rates in the USA may be that while most participants at the Oxnard clinics had lower levels of knowledge and were also uninsured, they were able to obtain the HPV vaccine for their daughters at low or no cost through programs such as the Vaccines for Children Program and Medi-Cal. Nonetheless, the HPV vaccination rate we observed among our sample of Mexican-American mothers in Oxnard is lower than the national rate reported among Latinas in 2013 (67.5%) (Elam-Evans et al. 2014). We also expected to find a higher vaccine uptake rate in this low-income population, since HPV vaccination coverage is higher among adolescents living below the federal poverty level than among those at or above the poverty level (Walker et al. 2017).

The higher levels of knowledge regarding the association between HPV and cervical cancer, as well as the greater awareness about the HPV vaccine reported among the mothers in Mexico, are expected among a group that is

Table 4 Bivariate and multivariate correlates of vaccine initiation (received ≥ 1 dose of HPV vaccine), odds ratios (OR), and 95% confidence intervals (95% CI)

	Bivariate analysis OR (95% CI)	Multivariate model 1 ^a OR (95% CI)	Multivariate model 2 ^b OR (95% CI)
<i>Caregiver characteristics</i>			
Age (continuous)	1.02 (0.99, 1.05)	0.96 (0.912, 1.00)	0.95 (0.91, 0.99)*
Study sites			
Cuernavaca, Mexico (reference)		1.22 (0.56, 2.69)	0.97 (0.45, 2.09)
Oxnard, the USA	1.41 (0.95, 2.10)		
Income (reference: at or below poverty level or unemployed)			
Above poverty level	1.14 (0.76, 1.71)	–	–
Education (reference: < high school diploma)			
High school diploma or more	1.09 (0.72, 1.65)	–	–
Marital status (reference: not married)			
Married	0.89 (0.52, 1.51)	–	–
<i>Daughter's characteristics</i>			
Daughter's age (continuous)	1.23 (1.14, 1.34)**	1.46 (1.23, 1.72)**	1.51 (1.28, 1.77)**
Insurance status of daughter (reference: uninsured)			
Insured	1.67 (0.95, 2.95)	–	–
<i>HPV and HPV vaccine-related factors</i>			
Heard of HPV (reference: no)			
Yes	1.80 (1.07, 3.05)*	2.01 (0.80, 5.02)	2.25 (0.92, 5.49)
Heard about HPV vaccine from a clinician (reference: no)			
Yes = 244	6.75 (4.19, 10.89)**	–	–
Has discussed HPV vaccine with a doctor (reference: no/don't know)			
Yes	8.69 (5.52, 13.69)**	–	8.33 (4.37, 15.91)**
Daughter offered HPV vaccine by clinician (reference: no/don't know)			
Yes	13.08 (7.98, 21.4)**	12.37 (6.21, 24.63)**	–
Perceived severity of HPV infection (reference: not serious)			
Serious	1.12 (0.64, 1.96)	–	–
Perceived risk of HPV infection (reference: same/more risk)			
Daughter has less risk than other girls	2.84 (1.87, 4.32)**	3.47 (1.78, 6.77)**	4.65 (2.37, 9.13)**
Immunization should be required by law (reference: disagree/neither agree nor disagree/don't know)			
Agree	1.18 (0.73, 1.91)	–	–
School mandate for HPV vaccine (reference: no/don't know)			
Yes	1.57 (1.06, 2.34)*	1.56 (0.80, 3.03)	1.70 (0.88, 3.28)
Acceptable age for HPV vaccination (continuous, older to younger)	1.21 (1.11, 1.33)**	1.33 (1.16, 1.54)**	1.35 (1.17, 1.55)**

Significant results are shown in bold text

Cuernavaca, Mexico and Oxnard, USA, 2012–2013

* $P < 0.05$; ** $P < 0.001$ using logistic regression analysis

^aModel 1 included the following variables: mother's age, study site, daughter's age, heard of HPV, offered HPV vaccine by a clinician, perceived risk of HPV infection, school mandate for HPV vaccine, and acceptable age at vaccination

^bModel 2 included the following variables: mother's age, study site, daughter's age, heard of HPV, discussed HPV vaccine with a clinician, perceived risk of HPV infection, school mandate for HPV vaccine, and acceptable age at vaccination

more educated. Nearly half of the participants in Mexico have a high school degree or greater, as compared to 19% among the US respondents. However, this greater knowledge about HPV and the HPV vaccine among the mothers in Mexico is not as strongly correlated to increased HPV

vaccination uptake rates as other factors. The Mexican mothers in the US sample were significantly more likely to report that they have discussed the HPV vaccine with their daughter's physician/nurse and have been offered the HPV vaccine by a clinician. Our multivariate analyses confirm

that having a clinician discuss or offer the HPV vaccine is more strongly associated with having received ≥ 1 dose of the HPV vaccine, than the other factors such as knowledge and beliefs. Our results concur with other studies that report physician recommendation as one of the most influential motivators for HPV vaccination (Javanbakht et al. 2012; Glenn et al. 2015; Berenson 2015; Gerend et al. 2013; Tsui et al. 2013; Ylitalo et al. 2013). A recent systematic review and meta-analysis of 79 studies conducted with 840,838 parents across 15 countries (Newman et al. 2018) also reports that physician recommendation had the greatest influence on vaccine uptake. This suggests that factors such as health systems, clinics, or providers may be the main drivers of vaccine receipt among this binational sample of Mexican mothers.

We also found that daughter's age is associated with HPV vaccine uptake. In Mexico, the average age of the daughters was 10.6 years, and in the USA, it was 13.1 years. This is probably due to the higher age range for HPV vaccination in the USA, which includes youths aged 9–18 years, while in Mexico only girls who are in 5th grade are vaccinated (aged 9–10 years). Our multivariate analyses indicate that increasing age is associated with a greater likelihood of being vaccinated, which is consistent with the higher uptake rates observed among girls in the USA, as compared to Mexico (49% vs. 40%, respectively). Since more girls (aged 9–18 years) were vaccinated in the USA and a lower number of girls (aged 9–10) were vaccinated in Mexico, it follows that the average age in the US sample would be older than the sample in Mexico and that increasing age would be associated with the receipt of the HPV vaccine. Interestingly, our multivariate analyses also indicate that the likelihood of vaccine uptake is significantly higher among the daughters of mothers who report a younger acceptable age for HPV vaccination.

One of our aims was to investigate the reasons why certain mothers did not vaccinate their daughters. A substantial portion of mothers of unvaccinated girls in both countries report that they do not have enough information to make a decision about vaccinating their daughter and that they are very worried about the HPV vaccine side effects. Mothers of unvaccinated girls in the USA are significantly more likely to believe that the HPV vaccine might cause future health problems, including trouble getting pregnant, than mothers in Mexico. Fortunately, most of the mothers with unvaccinated daughters in both countries report that they would vaccinate their daughter(s) if their doctor recommends it ($> 90\%$). This finding also reinforces the importance of having clinicians discuss and promote the HPV vaccine among their eligible patients.

This study has some limitations. Data collection activities in Mexico took place during 2012, while the US data

were obtained in 2013. Ideally, the data should have been collected simultaneously. This study is cross-sectional, so we can only report on the observed associations between certain predictors of HPV vaccine uptake and cannot establish causality. We did not verify the daughters' vaccination history through a medical record review, which could result in an under- or over-reporting of the actual HPV vaccination rates. Participants were recruited at clinics where they can obtain free or low-cost preventative healthcare services, so they may have more favorable attitudes regarding HPV vaccination than parents without access to such services. Another limitation is that mothers in Mexico were significantly more likely to be younger, insured, more educated, and have a higher income than mothers in the USA. However, except for mother's age, these specific factors were not found to be significantly associated with increased vaccine uptake in this binational study. This sample of mothers may not be representative of other Mexico-born women living in the USA or Mexico, or other Latina women in the USA or abroad. While these results may not be generalizable to other groups, they do suggest key shared beliefs and experiences regarding HPV vaccination among Mexico-born mothers in Southern California and central Mexico who have access to healthcare services.

Despite these limitations, this study explores some of the factors that might help explain why HPV vaccination rates in the USA and Mexico remain suboptimal. Our findings support the need for more education among clinicians in both countries to inform them how important it is that they discuss and offer the HPV vaccine to their eligible patients. Future studies should explore the role of specific barriers, the experiences of parents/caregivers without access to preventive healthcare services, as well as other racial/ethnic groups in Mexico and the USA, since their beliefs and practices may differ. Additionally, more research is needed to understand the low rates of HPV vaccination completion among Mexican mothers and other underserved populations.

In conclusion, this study provides some insight into certain barriers and facilitators to HPV vaccination among Mexican mothers of adolescent girls in the USA and Mexico. We found that having discussed and/or been offered the HPV vaccine by a clinician are the main predictors of uptake in this binational sample of Mexican mothers. Another important finding is the fact that most mothers would vaccinate their unvaccinated daughters if recommended by a doctor. These results highlight the importance of the clinician's role in helping to increase HPV vaccine uptake in the USA and Mexico. Interventions and programs that encourage clinicians to offer the HPV vaccine to all vaccine-eligible girls and boys should be developed to help increase vaccine uptake rates in both

countries. Ideally, clinicians should consistently recommend and co-administer the HPV vaccine along with other age-appropriate vaccines (such as Tdap and MenACWY) to increase uptake and completion rates. This will optimize the protection of adolescents against vaccine-preventable diseases, including several HPV-associated cancers. Efforts to increase the rates of HPV vaccination through clinician recommendation are likely to improve uptake and completion of the vaccine series among eligible Latino adolescents in the USA and Mexico.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests to disclose.

Ethical standard All study procedures were performed in accordance with the ethical standards of the UCLA and IMSS research committees and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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