Role of Insurance, Income, and Affordability in Human Papillomavirus Vaccination

Nadereh Pourat, PhD; and Jenna M. Jones, MPH

Objectives: To examine knowledge of and financial barriers to early adoption of human papillomavirus (HPV) vaccination, specifically the role played by insurance, income, and affordability (measured by forgoing or delaying needed medical care due to cost/no insurance).

Study Design: We used the 2007 California Health Interview Survey. Females aged 18 to 26 years (n = 1840) and parents with daughters aged 8 to 17 years (n = 5765) were analyzed separately.

Methods: Logistic regression models were used with the following dependent variables: (1) heard of the HPV vaccine, (2) received 1 dose only, (3) completed the series, (4) have not previously heard of HPV vaccine but interested in receiving it, and (5) interested and willing to pay $360 for it.

Results: Individuals enrolled in private health maintenance organizations (HMOs) were more likely to have heard of the vaccine compared with the uninsured and those enrolled in public HMOs. Young adults enrolled in private HMOs were also more likely to have initiated HPV vaccination or completed the series compared with uninsured young adults or those insured in non-HMO plans. Higher income parents were more willing to pay the cost of the vaccine. Forgoing needed care due to costs led to lower odds of initiating HPV vaccination among parents and completing the series among young adults.

Conclusions: Strategies to increase HPV vaccination rates should consider insurance or cost barriers for adults and those with high medical care expenditures. Disparities in receipt of the HPV vaccine are likely to continue without targeted outreach to more vulnerable populations.

(Am J Manag Care. 2012;18(6):320-330)

For author information and disclosures, see end of text.

Infection with human papillomavirus (HPV) is a serious public health concern with significant morbidity and financial consequences. The most prevalent strains of HPV, subtypes 16 and 18, are leading causes of cervical and anal cancers nationally.[1,2] Cervical cancers caused by persistent HPV infections have led to an estimated 8.1 deaths per 100,000 women nationally and 8.3, 6.4, and 11 deaths per 100,000 for whites, African Americans, and Latinos, respectively, in California.[3] The prevalence of HPV is highest (45%) among young women aged 20 to 24 years,[4,5] and the likelihood of HPV infection is about 75% among adults aged 15 to 49 years.[2] The costs of treating HPV and its related disease are estimated at or above $4 billion annually.[6]

Two HPV vaccines, Gardasil and Cervarix, became available in 2006 and 2009, respectively.[7,8] Gardasil guards against subtypes 6, 11, 16, and 18; Cervarix guards against subtypes 16 and 18 only. Both are nearly 100% effective against precancerous lesions, with Cervarix more effective against persistent infections (nearly 100%) than Gardasil (86-89%).[1,2] The vaccines are recommended for young females aged 12 to 26 years and may have some benefits for older women.[9-11] Financial constraints may be a significant barrier to HPV vaccination. The vaccine, at an estimated cost of $360 for the 3-dose vaccine plus the associated administration and visit fees (estimated at $92), is too expensive without insurance coverage for most low-income families.[12]

Free vaccine for children may be obtained from various sources including the federally funded Vaccine for Children (VFC) program, which covers about 40% of poor children[2]; and the Immunization Grant Program (Section 317), which is subject to budget shortfalls.[2] Vaccine manufacturers may cover uninsured adults and Medicaid may cover vaccine costs for adults.[4] The scope of these forms of coverage is unknown and the underinsured may still have limited access.[13]

Among privately insured patients, the vaccine may not be covered or covered fully.[14] In early 2008, some preferred provider organizations (PPOs) in California did not cover the vaccine.[12] Lack of coverage or knowledge of coverage for the vaccine is a frequently reported reason for not vaccinating against HPV.[15] Differential rates of compliance with the federal Advisory Committee on Immunization Practices by PPOs versus health maintenance organizations (HMOs) shortly after availability of the HPV vaccine, as well as higher cost-sharing requirements by PPOs, may have led to additional barri-

In this article
Take-Away Points / p321
www.ajmc.com
Full text and PDF

ers to vaccination according to the type of private insurance coverage. Overall, high costs and inadequate coverage of the HPV vaccine are likely to lead to uneven vaccination rates among low-income and other disadvantaged groups. Understanding the impact of financial barriers on adherence to HPV vaccination is needed to improve HPV vaccination rates and to prevent HPV infection and its disease sequelae among all eligible-age females.[16]

Take-Away Points

Insurance coverage, income, and other indicators of affordability affect human papillomavirus (HPV) vaccination rates.

- To ensure effective prevention of HPV, it is important to provide targeted education to subgroups, particularly young adults aged 22 to 26 years, parents 56 years and older with young daughters aged 8 to 17 years, Latinos and Asian Americans, and members of public HMOs.
- Strategies to increase HPV vaccination rates should consider insurance or cost barriers for adults and those with high medical care expenditures.

METHODS

Data and Sample

We used the 2007 California Health Interview Survey (CHIS) for this study. The survey is a representative random-dial telephone survey of more than 53,600 households, including about 51,000 adults, and is conducted in English, Spanish, Mandarin, Cantonese, Korean, and Vietnamese languages to capture the great majority of non–English speaking populations. It has an overall response rate of 21.2% and has been found in multiple studies to be representative of the California population.[17] The sample included all females aged 18 to 26 years (n = 1840) as well as girls aged 8 to 17 years (n = 5765) who are recommended to receive HPV vaccination. Parents of teenagers answered the CHIS vaccination questions to increase the reliability of responses and because the vaccination decision is most likely to be made by parents of minors.

Conceptual Framework, Research Questions, and Hypotheses

We used Andersen and Davidson's conceptual framework for healthcare use.[18] Based on this conceptual framework, HPV vaccination or intent to vaccinate was determined by enabling factors (insurance, income, and affordability of care), predisposing factors (eg, age, race), and need (eg, health status). Our primary interest was to assess the impact of enabling factors. Specifically, we wanted to determine how insurance, income, and affordability of care affect HPV vaccination rates and patients' willingness to pay.

We hypothesized that rates of HPV vaccination or intent to vaccinate and willingness to pay for the vaccination are lower for individuals without insurance coverage or with PPO or fee-for-service (FFS) coverage, for some low-income populations (as measured by federal poverty level [FPL]), and for individuals who reported that care has been unaffordable (as measured by having delayed or forgone needed healthcare due to cost/no insurance in the past year). We assumed that some eligible individuals fell through the gaps despite availability of VFC and other programs. We also examined the role of enabling factors in knowledge of the HPV vaccine, hypothesizing that vaccine knowledge was lower among lower income and uninsured groups who were not targeted by vaccine manufacturers' advertising campaigns early on.

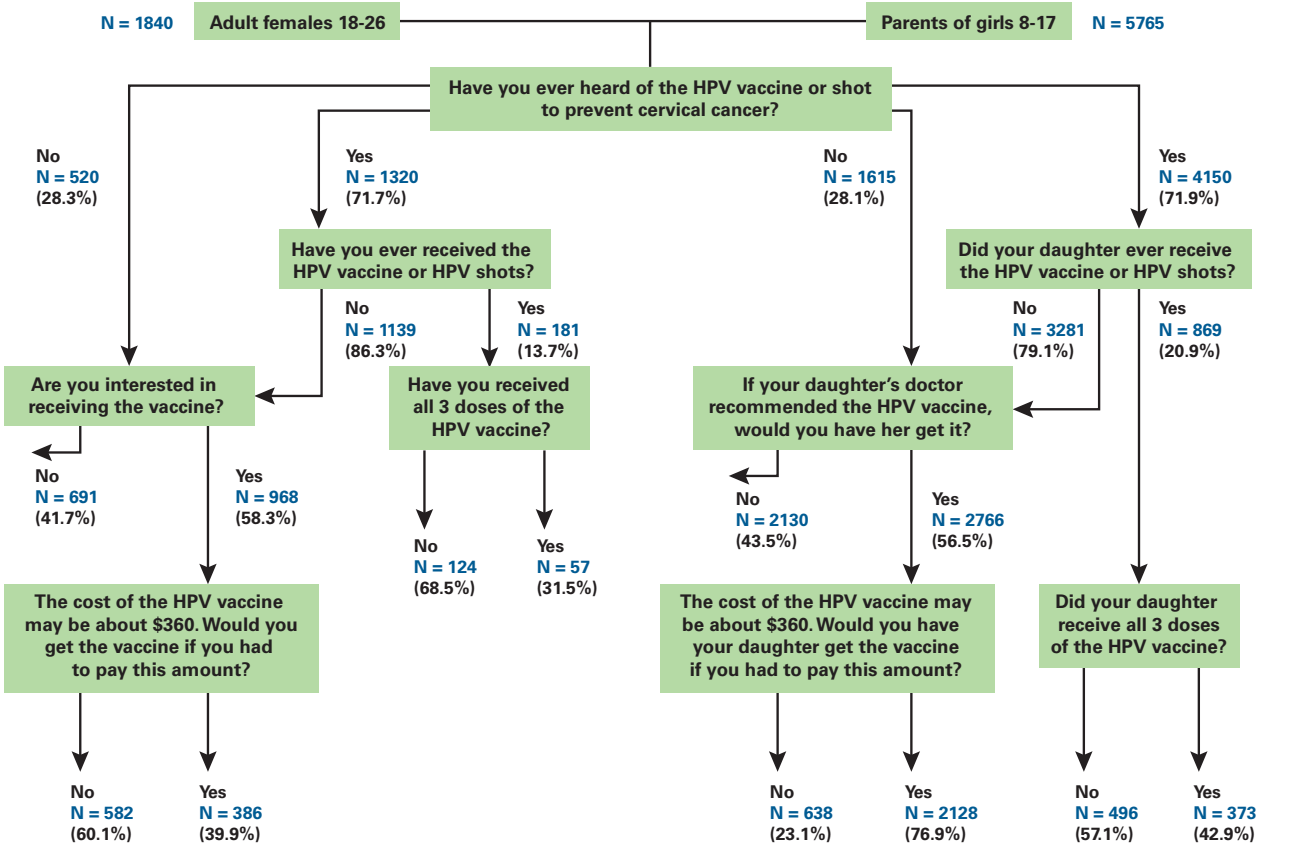
Dependent Variables

Five different dependent variables are included in this study. Adults and parents (**Figure**) were asked (1) if they had heard of the HPV vaccine prior to the survey. Those who had heard of the vaccine were asked (2) if they/their daughters had received at least 1 dose of the HPV vaccine, and if so (3) whether they/their daughters had received all 3 doses. Respondents who had not heard of the vaccine were informed of the existence and intent of the vaccine and were then asked (4) if they were interested in receiving the vaccine (adults) or giving it to their daughter if a doctor recommended it. Those who were interested in receiving the vaccine were asked (5) if they were willing to pay $360 for the 3-dose vaccine.

Independent Variables

The independent variables of interest were insurance, poverty level, and affordability, as indicated by forgone or delayed care due to cost/no insurance. Insurance coverage was defined as private HMO, private PPO, public HMO, public FFS, or uninsured. The private HMO category includes variations in HMO types including point-of-service plans and exclusive provider organizations. The private PPO category includes PPOs and FFS options; the latter is an increasingly uncommon form of insurance in California. Public HMOs may also include some exclusive provider organizations but are primarily HMOs. Public non-HMO coverage in California is an FFS form of coverage. The distinctions in form or coverage were included to account for differences in benefit levels, cost-sharing requirements, restrictions imposed on use of various services, provider networks, and provider compensation and incentives. HMOs are more likely to cover all vaccinations and have lower cost sharing but may impose authorization requirements on services, while PPOs are more likely to have higher cost sharing but fewer restrictions on use. Public FFS coverage does not include

Figure. Dependent Variable Question Sequence, Adult Females Aged 18 to 26 Years and Parents of Girls Aged 8 to 17 Years[a]



HPV indicates human papillomavirus.
[a]*Note:* The percentages presented in this figure are not weighted and are not representative of the population due to survey design effect.

cost sharing, but provider participation in the program and subsequent access to care may be more limited.

Poverty level was indicated by FPL—less than 100%, 100% to 299%, and 300% or higher—and was used to assess the individual's ability to pay for the associated out-of-pocket costs of HPV vaccine if insured or the full cost of the vaccine if uninsured and unable to receive free vaccination. Affordability was indicated by reports of having forgone or delayed receipt of needed medical care due to cost/no insurance in the past year and was intended to account for financial barriers to access not captured by other variables in the models. Forgone or delayed care due to other reasons was also included in the models to control for nonfinancial reasons such as lack of time that lead individuals and parents not to obtain the HPV vaccination.

All models were also controlled for predisposing factors and other potentially confounding factors. Predisposing control variables included age, race/ethnicity, education, and family status. Age was categorized as 18 to 21 and 22 to 26 years for the young adult females and 18 to 35, 36 to 55, and 56 years and older for the parents. Race and ethnicity were defined as white, Latino, Asian American, African American, and other groups. Education was dichotomized into any college education versus less. Marital and family status was defined as married, single with children, and single without children in the adult sample, and single with children versus married with children in the parent sample. We included the receipt of the flu vaccine in the past year as a measure of a health-seeking behavior. Need was controlled for with perceived health status noted as excellent, very good, or good versus fair or poor.

Analytic Methods

Logistic regression models were used to assess the role of financial determinants of HPV vaccination, controlling for other potential modifiers. Insurance categories with very small sample sizes were combined in the models predicting completion of the vaccine series to improve reliability of findings. Health status and education were excluded from the model predicting completion of the vaccine series for adults due to small sample size and collinearity. All analyses were weighted and adjusted for the complex survey design of CHIS.

Table 1. Characteristics of Females Aged 18 to 26 Years and Parents of Young Girls Aged 8 to 17 Years, California, 2007[a]

Characteristics	Females 18-26 y	Parents of Girls 8-17 y
Dependent variables		
Heard of the HPV vaccine or shot to prevent cervical cancer	70%	63%
Received at least 1 dose of the HPV vaccine if heard of vaccine	16%	21%
Received all 3 doses of the HPV vaccine if received at least 1 dose	36%	43%
Interested in receiving the vaccine if have not previously heard of vaccine	61%	57%
Willing to pay $360 to get vaccine if interested in vaccine	41%	79%
Enabling factors: insurance, poverty level, and delays in access		
Insurance status		
Uninsured	22%	17%
Public HMO	12%	7%
Public non-HMO	12%	9%
Private non-HMO	20%	26%
Private HMO	34%	41%
Federal poverty level		
<100%	27%	18%
100%-299%	37%	35%
≥300%	36%	47%
Delayed or forgone needed medical care in the past 12 months		
No delay	81%	82%
Delayed or forgone needed care due to cost/no insurance	12%	8%
Delayed or forgone needed care for other reasons	7%	10%
Predisposing factors: demographics and behaviors		
Age, y		
18-21	51%	—
22-26	49%	—
18-35	—	19%
36-55	—	76%
≥56	—	6%
Race/ethnicity		
Latino	43%	44%
Asian American	15%	11%
African American	6%	5%
Other race	3%	2%
White	33%	38%
Some college (vs no college)	51%	51%
Marital and family status		
Single with no children	70%	—
Single with children	11%	17%
Married with or without children	19%	83%
Received a flu shot in the past 12 months	21%	23%
Need: health status		
Perceived health status		
Excellent to good health	88%	80%
Fair to poor health	12%	20%

HMO indicates health maintenance organization; HPV, human papillomavirus.
[a]Estimates are weighted for survey design effect.

Table 2. Odds of HPV Awareness, Vaccination, Interest in Getting the Vaccine, and Willingness to Pay for It Among Females Aged 18 to 26 Years, California, 2007[a]

	Heard About HPV Vaccine Before the Survey			Received at Least 1 Dose of HPV Vaccine		
Characteristics	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
Enabling factors: insurance, poverty level, and delays in access						
Insurance status						
Uninsured	**0.5**	0.31-0.83	.01	**0.3**	0.13-0.79	.01
Public HMO	**0.5**	0.29-0.90	.02	0.6	0.18-1.78	.33
Public FFS	0.7	0.37-1.27	.22	0.4	0.18-1.04	.06
Private PPO	**1.9**	1.16-2.99	.01	0.6	0.35-1.07	.08
Private HMO (reference)						
Federal poverty level						
<100%	**0.4**	0.26-0.63	.00	1.4	0.62-3.02	.44
100%-299%	0.9	0.63-1.36	.70	0.7	0.41-1.31	.29
≥300% (reference)						
Delayed or forgone needed medical care in the past 12 months						
Delayed or forgone needed care due to cost/no insurance	1.4	0.62-2.99	.44	1.3	0.64-2.81	.43
Delayed or forgone needed care for other reasons	1.3	0.77-2.05	.37	0.6	0.27-1.51	.31
Predisposing factors: demographics and behaviors						
Age 18-21 y (vs 22-26 y)	1.0	0.70-1.53	.87	**2.2**	1.27-3.96	.01
Race/ethnicity						
Latino	**0.6**	0.39-0.96	.03	1.0	0.56-1.66	.90
Asian American	**0.3**	0.18-0.58	.00	1.2	0.52-2.72	.68
African American[d]	0.6	0.28-1.47	.29	—[c]	—[c]	—[c]
Other race[d]	1.0	0.49-1.96	.95	**0.3**	0.10-0.81	.02
White (reference)						
Some college (vs no college)	**1.7**	1.11-2.46	.01	0.8	0.52-1.24	.32
Marital and family status						
Single with no children	**1.6**	1.07-2.31	.02	1.7	0.83-3.35	.15
Single with children	1.0	0.52-1.85	.96	1.3	0.42-4.29	.62
Married with or without children (reference)						
Received a flu shot in past 12 months (vs no flu shot)	1.3	0.82-1.91	.30	**1.9**	1.03-3.43	.04
Need: health status						
Perceived health status						
Fair and poor (vs excellent and good)	0.9	0.54-1.61	.80	0.4	0.12-1.60	.21
Sample size	840			1320		
Pseudo R^2	16%			6%		

CI indicates confidence interval; FFS, fee-for-service; HMO, health maintenance organization; HPV, human papillomavirus; OR, odds ratio; PPO, preferred provider organization.
[a]Bold-faced entries are statistically significant.
[b]Public HMO and public non-HMO categories were combined in this model due to small cell sizes. The uninsured odds ratio may be unstable due to small cell size. Health status and college were excluded due to small cell sizes.
[c]Due to small sample size and collinearity, the variable was left out of the model.
[d]The African American category was combined with other race category in models where the sample size was too small (>10) and led to unreliable estimates.

The pseudo R^2 was calculated based on the Nagelkerke method and indicates the approximate variance in the dependent variable explained by the independent variables.

RESULTS

The characteristics of the adult and parent samples are presented in Table 1. Most adult females aged 18 to 26 years (70%) and parents of girls aged 8 to 17 years (63%) had heard of the HPV vaccine prior to the survey. Among those who had heard of the vaccine, 16% of adults and 21% of girls aged 8 to 17 years had received at least 1 dose of the vaccine. Among those who had received at least 1 dose of the vaccine, 36% of adults and 43% of young girls had completed the 3-dose series. The respondents who had not heard of the vaccine were informed of the existence and purpose of

Received All 3 Doses of HPV Vaccine (Among Those Who Had at Least 1 Dose[b])			Interested in Receiving the HPV Vaccine (Among Those Who Have Not Heard of It)			Willing to Pay $360 for the HPV Vaccine (Among Those Who Are Interested in Receiving the Vaccine)		
OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
0.5	0.02-14.17	.68	1.1	0.75-1.63	.63	0.5	0.22-0.19	.15
—[c]	—[c]	—[c]	0.9	0.52-1.56	.71	0.6	0.27-1.32	.12
0.2	0.04-1.43	.12	1.3	0.70-2.3	.43	0.8	0.43-1.54	.20
0.3	0.08-1.34	.12	0.9	0.60-1.21	.36	0.6	0.32-1.19	.52
1.4	0.17-12.29	.75	0.9	0.59-1.43	.71	1.0	0.57-1.86	.92
0.6	0.20-1.81	.37	**0.7**	0.48-0.99	.04	1.0	0.57-1.59	.84
0.1	0.01-1.63	.11	**1.6**	1.02-2.65	.04	0.5	0.21-1.40	.20
0.04	0.00-0.52	.02	1.0	0.63-1.65	.93	**0.4**	0.17-0.77	.00
0.1	0.02-0.26	.00	1.2	0.79-1.68	.45	1.3	0.81-1.96	.30
0.3	0.10-0.92	.03	1.3	0.89-1.84	.18	1.1	0.67-1.92	.63
0.6	0.15-2.17	.41	1.0	0.60-1.53	.85	0.5	0.24-0.99	.50
—[c]	—[c]	—[c]	0.8	0.46-1.53	.56	1.5	0.69-3.42	.16
0.5	0.09-3.21	.49	1.4	0.69-2.79	.36	**0.2**	0.08-0.70	.00
—[c]	—[c]	—[c]	0.9	0.65-1.26	.55	**0.6**	0.35-0.98	.04
—[c]	—[c]	—[c]	0.8	0.52-1.12	.17	0.7	0.43-1.28	.28
1.7	0.28-10.39	.56	0.7	0.40-1.33	.30	0.6	0.23-1.49	.26
1.8	0.32-9.82	.51	**1.5**	1.05-2.28	.03	1.3	0.74-2.39	.34
—[c]	—[c]	—[c]	1.3	0.85-2.00	.22	1.0	0.58-1.85	.90
181			1659			968		
33%			3%			8%		

the vaccine. Many adults (61%) responded that they would be interested in receiving it and 57% of parents reported that they would be interested if the doctor recommended it. Among those who said they would be interested or would follow the doctor's recommendation, 41% of adults and 79% of parents said that they would be willing to pay $360 for the 3-dose vaccine. Nearly all adults (99%) and parents (98%) who were unwilling to pay for the vaccine reported willingness to receive it for free in a follow-up question to this effect (data not shown in table).

Adult Females Aged 18 to 26 Years

Predictors of Having Heard of the HPV Vaccine. The odds of having heard of the vaccine were lower for those who were uninsured (odds ratio [OR] 0.5) and those with public HMO coverage (0.5), but higher for those with private PPO

compared with private HMO coverage (Table 2). Adults with family incomes under 100% of FPL had lower odds than those with incomes at or above 300% of FPL. The odds of forgoing or delaying needed medical care were not significant. The odds of having heard of the vaccine were also lower for Latinos and Asian Americans, and higher for those with some college education and single adults without children.

Predictors of Having Received at Least 1 Dose of HPV Vaccine. Among adults who had heard of the vaccine, the odds of having received at least 1 dose of the vaccine were lower for uninsured individuals (0.3) compared with those who had private HMO coverage. The odds were higher for younger adults and for those who received the flu shot. Poverty level and having forgone or delayed needed care were not significant.

Predictors of Having Received All 3 Doses of HPV Vaccine. Among adults who had received at least 1 dose of the HPV vaccine, the odds of having completed the vaccine series were not significantly affected by insurance coverage or poverty, or by having forgone or delayed needed medical care due to cost/no insurance. However, the odds were lower for adults who did not get or delayed needed medical care in the past 12 months for other reasons (0.04) compared with those who did not forgo or delay care. The odds were lower for younger adults and Latinos.

Predictors of Interest in Receiving the HPV Vaccine. Among adults who had not previously heard of the vaccine, insurance did not play a significant role in the odds of being interested in the vaccine, but the odds were lower for those earning between 100% and 299% of FPL (0.7) compared with those earning 300% or more of FPL. The odds were higher for those who had forgone or delayed care due to cost/no insurance (1.6). The odds were higher for those who received the flu vaccine.

Predictors of Willingness to Pay for HPV Vaccine. Among adults who were interested in receiving the vaccine, the odds of being willing to pay $360 for the vaccine did not differ by insurance, poverty, or having forgone or delayed care due to cost/no insurance. However, the odds were lower for those who had forgone or delayed needed medical care for other reasons (0.4). The odds also were lower for those with some college education.

Parents of Daughters Aged 8 to 17 Years

Predictors of Having Heard of the HPV Vaccine. The odds of having heard of the vaccine were lower among the parents who were uninsured (0.6) compared with those who had private HMO coverage (Table 3). Also, the odds were lower for parents with incomes between 100% and 299% of FPL (0.7) compared with those who had incomes at or above 300% of FPL. The odds were higher for parents who had forgone or delayed getting needed medical care due to cost/no insurance (1.8).The odds were lower for all nonwhite groups and those in fair or poor health, but higher in college-educated parents and those who had received a flu shot.

Predictors of Having Received at Least 1 Dose of HPV Vaccine. Among parents who had heard of the vaccine, insurance and poverty level were not significant predictors, but daughters of parents who had forgone or delayed needed medical care in the past year due to cost/no insurance had lower odds (0.6) of initiating the vaccine series. The odds were higher for parents 56 years and older, Latinos, and those who had received a flu shot.

Predictors of Having Received All 3 Doses of HPV Vaccine. Among parents whose daughters who had received at least 1 dose of the HPV vaccine, insurance status, poverty level, and having forgone or delayed getting needed medical care did not predict the odds of parents having their daughter complete the series. The odds were lower for parents with some college education.

Predictors of Interest in Following Physician Recommendation to Vaccinate. Among parents who had not vaccinated their daughters, the odds of interest in following physician recommendation to do so were higher for those with public HMO coverage (1.9) compared with those parents who had private HMO coverage. The odds did not differ by poverty or having forgone or delayed needed medical care. Latinos, single parents, and those who had received a flu shot had higher odds, and African Americans had lower odds.

Predictors of Willingness to Pay for HPV Vaccine. Among parents who were interested in following their physician's recommendation to vaccinate, the odds of willingness to pay $360 for vaccination did not differ by insurance but were lower for those who earned less than 100% of FPL (0.3) and 100% to 299% of FPL (0.5). The odds were also lower for parents who had forgone or delayed needed medical care due to cost/no insurance (0.5). Latinos had higher odds, and Asian Americans and those in fair or poor health had lower odds.

DISCUSSION

We found an independent association between 1 or more of the enabling predictors of HPV vaccination and all the outcome variables, except for having received all 3 vaccine doses for young girls. Insurance, poverty level, and affordability played different roles in models that examined knowledge of HPV vaccine, rates of vaccination, intent to vaccinate, and willingness to pay. The relationship of specific independent variables to the dependent variables requires further discussion.

■ **Table 3.** Odds of HPV Awareness, Vaccination, Intention to Vaccinate, and Willingness to Pay for Vaccine Among Parents With Daughters Aged 8 to 17 Years, California, 2007[a]

	Heard About HPV Vaccine Before the Survey			Daughter Received at Least 1 Dose of HPV Vaccine			Daughter Received All 3 Doses of HPV Vaccine (Among Parents Whose Daughter Received at Least 1 Dose)			Daughter Will Receive the HPV Vaccine if Doctor Recommends It (Among Parents Whose Daughter Has Not Received It)			Willing to Pay $360 for HPV Vaccine (Among Those Who Are Interested in Getting HPV Vaccine for Their Daughter)		
Characteristics	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
Enabling factors: insurance, poverty level, and delays in access															
Insurance status															
Uninsured	**0.6**	0.44-0.80	.00	0.8	0.52-1.27	.36	0.9	0.37-2.09	.77	1.0	0.73-1.42	.92	0.8	0.46-1.48	.53
Public HMO	0.9	0.61-1.25	.47	1.1	0.66-1.96	.66	0.5	0.22-1.13	.10	**1.9**	1.21-2.80	.00	0.8	0.42-1.36	.34
Public FFS	0.8	0.54-1.14	.20	1.2	0.69-2.24	.46	0.9	0.33-2.24	.76	1.5	1.00-2.12	.05	0.9	0.49-1.50	.59
Private PPO	1.1	0.82-1.41	.59	1.0	0.76-1.24	.84	1.3	0.81-1.94	.31	1.0	0.85-1.22	.87	1.2	0.87-1.67	.26
Private HMO (reference)															
Federal poverty level															
<100%	0.9	0.58-1.26	.43	1.0	0.60-1.70	.96	0.9	0.41-1.92	.76	1.0	0.71-1.43	.97	**0.3**	0.17-0.56	.00
100%-299%	**0.7**	0.58-0.95	.02	1.0	0.74-1.45	.84	1.0	0.69-1.59	.84	0.9	0.70-1.06	.16	**0.5**	0.33-0.67	.00
≥300% (reference)															
Delayed or forgone needed medical care in the past 12 months															
Delayed or forgone needed care due to cost/no insurance	**1.8**	1.35-2.39	.00	**0.6**	0.39-0.84	.00	0.8	0.34-1.71	.52	0.8	0.56-1.03	.07	**0.5**	0.32-0.77	.00
Delayed or forgone needed care for other reasons	1.1	0.82-1.55	.46	0.7	0.52-1.0	.05	0.6	0.33-1.23	.18	0.9	0.70-1.18	.48	0.7	0.42-1.14	.15
Predisposing factors: demographics and behaviors															
Age, y															
18-35 (reference)															
36-55	0.9	0.64-1.18	.37	1.4	0.97-2.03	.08	1.6	0.79-3.08	.20	1.0	0.80-1.37	.74	1.3	0.88-2.03	.17
≥56	0.9	0.59-1.32	.53	**1.6**	1.05-2.55	.03	1.2	0.47-2.87	.74	1.2	0.82-1.89	.31	1.1	0.52-2.38	.79
Race/ethnicity															
Latino	**0.5**	0.42-0.60	.00	**1.5**	1.15-1.96	.00	0.8	0.48-1.31	.36	**1.3**	1.06-1.59	.01	**1.6**	1.08-2.50	.00
Asian American	**0.4**	0.30-0.53	.00	1.1	0.78-1.66	.52	1.4	0.78-2.47	.27	0.9	0.66-1.16	.36	**0.5**	0.33-0.74	.00
African American	**0.6**	0.41-0.90	.01	1.0	0.62-1.54	.93	0.6	0.245-1.30	.18	**0.7**	0.47-0.97	.03	1.7	0.88-3.23	.12
Other race	0.9	0.53-1.46	.61	1.1	0.60-1.70	.64	0.4	0.14-1.08	.07	0.9	0.50-1.47	.57	1.2	0.57-2.56	.62
White (reference)															
Some college (vs no college)	**1.6**	1.30-2.01	.00	1.0	0.75-1.31	.93	**0.5**	0.32-0.85	.01	0.9	0.70-1.02	.09	0.7	0.48-1.02	.06
Single with children (vs married with children)	1.0	0.71-1.33	.87	0.8	0.58-1.17	.27	0.7	0.42-1.20	.20	**1.8**	1.42-2.34	.00	0.7	0.46-1.00	.05
Received a flu shot in past 12 months (vs no flu shot)	**1.6**	1.21-1.98	.00	**1.5**	1.15-1.95	.00	1.3	0.91-1.85	.16	**1.4**	1.10-1.66	.00	0.8	0.61-1.19	.34
Need: health status															
Perceived health status															
Fair and poor (vs excellent and good)	**0.7**	0.58-0.93	.01	1.0	0.75-1.45	.90	1.5	0.88-2.61	.13	1.1	0.84-1.54	.40	**0.6**	0.40-0.93	.02
Sample size	5742[b]			4150			869			4896			2766		
Pseudo R^2	12%			2%			5%			4%			7%		

CI indicates confidence interval; FFS, fee-for-service; HMO, health maintenance organization; HPV, human papillomavirus; OR, odds ratio; PPO, preferred provider organization.

[a]Bold-faced entries are statistically significant.

[b]Twenty-three observations were dropped due to missing information in independent variables. The number of parents who had heard of the HPV vaccine prior to the survey was 5765.

For example, the question on delayed or forgone care was not specific to HPV vaccination, and the impact of this variable on HPV knowledge, vaccination, and interest is likely to reflect general difficulties in access to services due to costs or lack of insurance. For those individuals, any services requiring cost sharing may be unaffordable. Also, further research is also required into other reasons for delayed or forgone care that led to lower rates of completion of the series or willingness to pay by adults.

Adult age differentials in vaccine initiation may indicate perceptions of older adults about vaccine necessity, perhaps due to the level of sexual activity or previous exposure to HPV. Parental age differentials (daughters of older parents were more likely to have received at least 1 dose of vaccine) may reflect the perceptions of parents about when vaccination should be initiated. The negative association of college education and willingness to pay among adults may indicate their knowledge of low-cost sources of the vaccine. But the negative association of parental education and completion of the 3-dose series requires further investigation. The negative association of parental fair or poor health with knowledge and willingness to vaccinate may reflect the competing demands parents face in seeking needed care for themselves and preventive care for their children.

This study has the following limitations. The data were collected between June 2007 and March 2008. For some respondents only 1 year had passed since the availability of the first vaccine. The rates of vaccine initiation in our data were close to those identified in the National Health Interview Survey by the end of 2008: 11.7% of women aged 18 to 26 years and 22.5% of girls aged 11 to 17 years had initiated the vaccine.[19,20] However, our data primarily represent 2007, and the national rates of vaccine initiation or intention to vaccinate for 2007 may have been lower than those in our data. Data from the National Immunization Survey were collected for women aged 18 to 26 years for 2007 and indicated that 78.9% had knowledge of the vaccine and 10% had initiated it.[21] Data were available for teens aged 13 to 17 years and showed an increase from 2008 to 2009 for the first dose (37.2%-44.3%) and the third dose (17.9%-26.7%).[22] Despite the limitation of California data, our findings represent the earliest data on knowledge of the vaccine and vaccine initiation among teens, and intention to vaccinate and willingness to pay for all age-eligible females. Also, our data were not confounded by system-level differences or population variations among states.

Lack of data on sexual health behaviors, religious and moral beliefs, and vaccine efficacy in CHIS prevented us from directly assessing the role of these factors. The small sample size of adults who completed the vaccine series may have led to fewer significant variables. The differences in the rates of vaccine initiation and completion may be because many respondents had responded to the survey shortly after the receipt of the first or second dose and prior to receipt of the final dose. HPV vaccination requires approximately 6 months, with each dose administered in 2-month intervals.[23] We also lacked data on how many vaccinated children or adults obtained the vaccine through the VFC or other free sources. Finally, we did not discuss results with probability values greater than .05 because of the lower level of certainty about the contribution of those variables.

The patterns of HPV vaccination specified in our study may follow the patterns in national hepatitis B vaccination rates,[24,25] which rose from zero in 1993 to 67% in 2000 for adolescents ages 13 to 15.[26] However, the observed access barriers to HPV vaccination should be addressed for rates to improve evenly among all eligible populations. Our findings indicated that vaccine costs seem to be a barrier to vaccine initiation among uninsured adults. Insurance, income, and experiences of delayed or forgone care also played a role in vaccine initiation, interest in receipt of vaccine, and in some cases willingness to pay for vaccine, which could reflect either knowledge of low-cost or free vaccine or concerns about affordability. Potential barriers due to affordability of the vaccine for individuals with and without coverage should be addressed by reducing the price, providing subsidies, or limiting cost sharing for populations who do not benefit from existing programs or those who find any costs associated with vaccination unaffordable. Increased demand for HPV vaccination is likely to be challenging to VFC and the immunization grant program, given past funding limitations. Healthcare reform may change the relationship between affordability and HPV vaccination rates after 2014, but barriers to vaccination may persist.

Significant and widespread media and advertising campaigns by both vaccine manufacturers and the Centers for Disease Control and Prevention followed the release of the first HPV vaccine. These campaigns were aimed at raising awareness of the link between HPV infections and cervical cancer, and the availability of HPV vaccines. Our findings indicate the failure of these campaigns to reach lower income adults and parents, adults with public HMO coverage, Latino and Asian American adults and parents, and African American parents. Also, these campaigns seem to have reached adults with private PPO coverage, college-educated adults and parents, and single adults without children, but not their counterparts with private HMO coverage, lower education, or married adults.

Other studies have also found racial/ethnic differences in interest in vaccination,[27-30] and our findings may reflect unmeasured factors such as social/cultural responses to pro-

fessional recommendations or vaccine availability at usual source of care.[31] Intentions were found to correlate highly with actual vaccination among Latino and African American parents.[32] The higher likelihood of vaccine initiation among Latino parents may reflect the impact of targeted vaccination programs in some communities.[6,32]

Improvement in HPV vaccination rates among eligible populations (eg, older age eligible women, college-educated individuals, young daughters of married parents) is most effectively accomplished by addressing differences among these groups in knowledge of the vaccine, completion of the series, and initiating the vaccine at an early age.[33,34] Successful outreach should also emphasize the importance of vaccination despite religious or moral beliefs surrounding sexual activity among young females, alleviating skepticism about the effectiveness of the vaccine,[33,34] changing normative beliefs about the society's approval of the decision to vaccinate,[12] and framing the importance of vaccination to different populations.[35]

The positive relationship of receipt of a flu shot to parental HPV knowledge, vaccine initiation by adults and parents, and interest in HPV vaccination may indicate better effectiveness of advertising or educational campaigns among those who are prevention oriented and have a higher propensity for preventive care. The state-by-state variations in population and healthcare system characteristics indicates that policy solutions to improve HPV vaccination should vary. For example, the racial/ethnic diversity of the California population indicates the need for multiple tailored and culturally competent outreach strategies that are not needed in states with lower diversity. Mandatory HPV vaccination is another strategy to increase vaccination rates and is proposed in 41 states; Virginia and District of Columbia have enacted this law.[36] However, public education campaigns to instill the prevention orientation are still needed and could be further reinforced in current attempts to increase delivery of preventive and primary care under the medical home model. Also, efforts to improve HPV vaccination rates should focus on barriers not examined here, such as restrictions in availability of the vaccine in clinical settings and consent law requirements.

Author Affiliations: From University of California Los Angeles Center for Health Policy Research (NP), Department of Health Services (NP, JMJ), University of California Los Angeles, Los Angeles, CA.

Funding Source: None.

Author Disclosures: The authors (NP, JMJ) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (NP); acquisition of data (NP, JMJ); analysis and interpretation of data (NP, JMJ); drafting of the manuscript (NP, JMJ); critical revision of the manuscript for important intellectual content (NP, JMJ); statistical analysis (NP, JMJ); provision of study materials or patients (NP); obtaining funding (NP); administrative, technical, or logistic support (NP); and supervision (NP).

Address correspondence to: Nadereh Pourat, PhD, UCLA Center for Health Policy Research, 10960 Wilshire Blvd, Ste 1550, Los Angeles, CA 90024. E-mail: pourat@ucla.edu.

REFERENCES

1. Chesson HW, Ekwueme DU, Saraiya M, Markowitz LE. Cost-effectiveness of human papillomavirus vaccination in the United States. *Emerg Infect Dis.* 2008;14(2):244-251.

2. Spurgeon SA, Johnston D, Pefole M, Fleishman V. *Challenges in Vaccine Policy: A Case Study of the HPV Vaccine.* Cambridge, MA: New England Healthcare Institute; August 2006. www.nehi.net/uploads/full.../hpv_report_final_color_8.29.06.pdf. Accessed April 19, 2012.

3. The Henry J. Kaiser Family Foundation. California: cervical cancer incidence rate per 100,000 women by race/ethnicity, 2007. http://www.statehealthfacts.org/profileind.jsp?ind=474&cat=10&rgn=6. Accessed September 20, 2011.

4. The Henry J. Kaiser Family Foundation. *HPV Vaccine: Implementation and Financing Policy in the U.S.* Washington, DC: The Henry J. Kaiser Family Foundation; 2008.

5. Koutsky L. Epidemiology of genital human papillomavirus infection. *Am J Med.* 1997;102(5A)(suppl):3-8.

6. Markowitz LE, Dunne EF, Saraiya M, Lawson HW, Chesson H, Unger ER; Centers for Disease Control and Prevention (CDC); Advisory Committee on Immunization Practices (ACIP). Quadrivalent human papillomavirus vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 2007;56(RR-2):1-24.

7. Kim JJ, Goldie SJ. Health and economic implications of HPV vaccination in the United States. *N Engl J Med.* 2008;359(8):821-832.

8. Stanley M. Introduction: the human papillomavirus VLP vaccines. *Gynecol Oncol.* 2010;118(1)(suppl 1):S1.

9. Chao C, Velicer C, Slezak JM, Jacobsen SJ. Correlates for completion of 3-dose regimen of HPV vaccine in female members of a managed care organization. *Mayo Clin Proc.* 2009;84(10):864-870.

10. Castellsagué X, Schneider A, Kaufmann AM, Bosch FX. HPV vaccination against cervical cancer in women above 25 years of age: key considerations and current perspectives. *Gynecol Oncol.* 2009;115(3)(suppl):S15-S23.

11. Franco EL, Villa LL, Sobrinho JP, et al. Epidemiology of acquisition and clearance of cervical human papillomavirus infection in women from a high-risk area for cervical cancer. *J Infect Dis.* 1999;180(5):1415-1423.

12. California Health Benefits Review Program. *A Report to the 2007-2008 California State Legislature: Analysis of Assembly Bill 1429: Human Papillomavirus Vaccination.* Oakland, CA: California Health Benefits Review Program; 2007.

13. Vetter KM, Geller SE. Moving forward: human papillomavirus vaccination and the prevention of cervical cancer. *J Womens Health (Larchmt).* 2007;16(9):1258-1268.

14. National Conference of State Legislatures. HPV vaccine. http://www.ncsl.org/default.aspx?tabid=14381. Updated March 2010. Accessed September 1, 2010.

15. Conroy K, Rosenthal SL, Zimet GD, et al. Human papillomavirus vaccine uptake, predictors of vaccination, and self-reported barriers to vaccination. *J Womens Health (Larchmt).* 2009;18(10):1679-1686.

16. Dempsey AF, Davis MM. Overcoming barriers to adherence to HPV vaccination recommendations. *Am J Manag Care.* 2006;12(17)(suppl):S484-S491.

17. California Health Interview Survey. *CHIS 2005 Methodology Series. Report One. Sample Design.* http://www.chis.ucla.edu/pdf/CHIS2005_method1.pdf. Published April 2007. Accessed April 15, 2008.

18. Andersen RM, Davidson PL. Improving access to care in America: individual and contextual indicators. In: Andersen RM, Rice TH, Kominski GF, eds. *Changing the U.S. Health Care System.* 3rd ed. San Francisco, CA: Jossey Bass; 2007.

19. Anhang Price R, Tiro JA, Saraiya M, Meissner H, Breen N. Use of human papillomavirus vaccines among young adult women in the United States: an analysis of the 2008 National Health Interview Survey. *Cancer.* 2011;117(24):5560-5568.

20. Wong CA, Berkowitz Z, Dorell CG, Anhang Price R, Lee J, Saraiya M. Human papillomavirus vaccine uptake among 9- to17-year-old girls: National Health Interview Survey, 2008. *Cancer.* 2011;117(24): 5612-5620.

21. Jain N, Euler GL, Shefer A, Lu P, Yankey D, Markowitz L. Human papillomavirus (HPV) awareness and vaccination initiation among women in the United States, National Immunization Survey—Adult 2007. *Prev Med.* 2009;48(5):426-431.

22. Centers for Disease Control and Prevention (CDC). National, state, and local area vaccination coverage among adolescents aged 13-17 years—United States, 2009. *MMWR Morb Mortal Wkly Rep.* 2010;59(32):1018-1023.

23. Centers for Disease Control and Prevention (CDC). FDA licensure of bivalent human papillomavirus vaccine (HPV2, Cervarix) for use in females and updated HPV vaccination recommendations from the Advisory Committee on Immunization Practices (ACIP) [published correction appears in *MMWR Morb Mortal Wkly Rep.* 2010;59(36):1184]. *MMWR Morb Mortal Wkly Rep.* 2010;59(20):626-629.

24. Mast EE, Margolis HS, Fiore AE, et al; Advisory Committee on Immunization Practices (ACIP), Centers for Disease Control and Prevention. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part I: immunization of infants, children, and adolescents. *MMWR Recomm Rep.* 2005;54(RR-16):1-23.

25. Mast EE, Weinbaum CM, Fiore AE; Advisory Committee on Immunization Practices (ACIP), Centers for Disease Control and Prevention. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part II: immunization of adults [published correction appears in *MMWR Morb Mortal Wkly Rep.* 2007;56(42):1114]. *MMWR Recomm Rep.* 2006;55(RR-16):1-33.

26. Centers for Disease Control and Prevention (CDC). Hepatitis B vaccination—United States, 1982-2002. *MMWR Morb Mortal Wkly Rep.* 2002;51(25):549-552, 563.

27. Yeganeh N, Curtis D, Kuo A. Factors influencing HPV vaccination status in a Latino population; and parental attitudes towards vaccine mandates. *Vaccine.* 2010;28(25):4186-4191.

28. Read DS, Joseph MA, Polishchuk V, Suss AL. Attitudes and perceptions of the HPV vaccine in Caribbean and African-American adolescent girls and their parents. *J Pediatr Adolesc Gynecol.* 2010;23(4): 242-245.

29. Bastani R, Glenn BA, Tsui J, et al. Understanding suboptimal HPV vaccine uptake among ethnic minority girls. *Cancer Epidemiol Biomarkers Prev.* 2011;20(7):1463-1472.

30. Gerend MA, Magloire ZF. Awareness, knowledge, and beliefs about human papillomavirus in a racially diverse sample of young adults. *J Adolesc Health.* 2008;42(3):237-242.

31. Bynum SA, Brandt HM, Sharpe PA, Williams MS, Kerr JC. Working to close the gap: identifying predictors of HPV vaccine uptake among young African American women. *J Health Care Poor Underserved.* 2011;22(2):549-561.

32. Perkins RB, Pierre-Joseph N, Marquez C, Iloka S, Clark JA. Why do low-income minority parents choose human papillomavirus vaccination for their daughters? *J Pediatr.* 2010;157(4):617-622.

33. Daley EM, Vamos CA, Buhi ER, et al. Influences on human papillomavirus vaccination status among female college students. *J Womens Health (Larchmt).* 2010;19(10):1885-1891.

34. Zimet GD, Weiss TW, Rosenthal SL, Good MB, Vichnin MD. Reasons for non-vaccination against HPV and future vaccination intentions among 19-26 year-old women. *BMC Women's Health.*10(1):27.

35. Kahn JA, Rosenthal SL, Jin Y, Huang B, Namakydoust A, Zimet GD. Rates of human papillomavirus vaccination, attitudes about vaccination, and human papillomavirus prevalence in young women. *Obstetrics Gynecol.* 2008;111(5):1103-1110.

36. Gostin LO. Mandatory HPV vaccination and political debate. *JAMA.* 2011;306(15):1699-1700. ■