



Review

Predictors of HPV vaccine acceptability: A theory-informed, systematic review

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Abstract

Objective. To inform future human papillomavirus (HPV) vaccination programs, we systematically reviewed studies of HPV-related beliefs and HPV vaccine acceptability, organizing the findings using health behavior theory and cervical cancer risk factors.

Methods. We searched Medline, CINAHL, and PsycINFO from 1995 to January, 2007 for studies of HPV beliefs and HPV vaccine acceptability among adolescents, young adults, and parents of adolescents in the United States.

Results. We identified 28 studies. Most were small, cross-sectional studies of parents and adults. Most parents reacted positively to the possibility of vaccinating their daughters against HPV. Vaccination acceptability was higher when people believed the vaccine was effective, a physician would recommend it, and HPV infection was likely. Cost and, for 6% to 12% of parents, concerns that vaccination would promote adolescent sexual behavior were barriers to vaccination. African American, Hispanic, and white respondents were equally accepting of the HPV vaccine. Parents with lower levels of education reported higher vaccine acceptability. Many studies inadequately reported on other variables associated with cervical cancer mortality.

Conclusions. HPV vaccine programs in the United States should emphasize high vaccine effectiveness, the high likelihood of HPV infection, and physicians' recommendations, and address barriers to vaccination.

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Keywords: HPV vaccines; Vaccination; Attitude to health; Health behavior; Women's health

Contents

Introduction	0
Methods	0
Results	0
Awareness and knowledge	0
Health belief model constructs	0
Perceived likelihood	0
Perceived severity	0
Perceived effectiveness	0
Perceived barriers	0
Cues to action	0
Other factors	0
Role of variables known to predict cervical cancer	0
Discussion	0
Conclusions	0
Acknowledgments	0
References	0

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Introduction

The advent of new human papilloma virus (HPV) vaccines with the potential to prevent the majority of cases of invasive cervical cancer presents a remarkable public health achievement (Markowitz et al., 2007; Villa et al., 2006). However, much of the existing behavioral research on the vaccines appears to be missing important opportunities. Our review's primary aim is to inform HPV vaccination programs by synthesizing findings relevant to HPV vaccine acceptability using a theoretical framework. This review differs from previous ones (e.g., Waller et al., 2004; Zimet et al., 2006) by (1) systematically reviewing the literature, (2) using theory to identify predictors of HPV vaccine acceptability, and (3) placing special emphasis on the populations most affected by cervical cancer.

The epidemiology of cervical cancer is fundamental to its prevention (Green and Kreuter, 2004). Yet, acceptability has not been adequately characterized for the groups that may benefit most from the HPV vaccine. Invasive cervical cancer is one of the leading causes of cancer-related deaths among women in the world, killing an estimated 237,500 women a year, mostly in developing countries in Africa and Asia (Globocan, 2002). In the United States, about 3670 women will die of the cervical cancer in 2007 (American Cancer Society, 2007), but this number does not adequately describe the disease's many well-documented disparities.

Race and ethnicity play a central role in the epidemiology of cervical cancer in the United States. Twice as many African American women die from cervical cancer as white women (5.0 vs. 2.4 deaths, respectively, per 100,000 women annually); Hispanic women also have a higher cervical cancer mortality rate than white women (3.4 deaths per 100,000 women annually) (Ries et al., 2002). Cervical cancer is increasingly a disease of poor women in the United States, as socioeconomic deprivation is associated with cervical cancer screening, diagnosis, treatment, and survival differentials (Newmann and Garner, 2005). Cervical cancer mortality rates are higher among rural populations than urban populations, and factors that place women at high risk for developing or dying from cancer are concentrated disproportionately in rural areas of the United States (Newmann and Garner, 2005). Other risk factors for cervical cancer include smoking, HIV infection, and, possibly, multiple pregnancies and long-term oral contraceptive use (Gottlieb, 2002).

Theories of health behavior can offer *a priori* predictions about beliefs likely to increase adoption of the HPV vaccine. Our review emphasizes the health belief model because of its proven relevance to vaccination behavior. The constructs in the health belief model (Becker, 1974) – perceived risk, perceived effectiveness of the vaccine, perceived barriers to vaccination, and cues to action – are among the most important predictors of influenza vaccination (Brewer et al., 2007a; Chapman and Coups, 1999). Perceived likelihood, in the context of HPV vaccination, is the belief that HPV infection and cervical cancer are likely to happen. It is a statement of probability in numerical or non-numerical terms. Perceived severity, another dimension of perceived risk, is the belief that HPV infection or cervical

cancer would have serious negative consequences for health or well being. Perceived effectiveness (i.e., a perceived benefit) is the belief that the HPV vaccine will reduce the likelihood or severity of HPV infection or cervical cancer. Perceived barriers to being vaccinated against HPV can be any perceived impediment to vaccination such as vaccine side effects and cost. Cues to action are situational factors that trigger one to get vaccinated.

We also review awareness of HPV and knowledge about HPV infection, cervical cancer, and the HPV vaccine, even though these commonly assessed constructs are not formally part of the health belief model. Because many consider them prerequisites for making informed decisions about vaccination, awareness and knowledge appear in other conceptual approaches to studying health behaviors (Weinstein, 1988). Lastly, we report other beliefs that do not neatly fit into the health belief model framework but that were examined in the studies. The review focuses on HPV vaccine acceptability among adolescents, young adults, and parents of adolescents in the United States.

Methods

Two investigators searched Medline, CINAHL, and PsycINFO from 1995 to January, 2007, the approximate time frame during which HPV was known to cause cervical cancer, for articles related to HPV vaccine acceptability and its likely predictors identified from behavioral theory, among adolescents, young adults, and parents. Although physicians are not the focus of our review, we acknowledge that they are likely to play a central role in prompting vaccination. All studies were conducted prior to the federal approval of the vaccine (Markowitz et al., 2007), and none examined actual vaccine uptake. The search terms were human papillomavirus (and variants such as HPV); AND attitude*, aware*, barrier*, belief, communicat*, educat*, know, knowl*, perceive*, perception*, psychology, psychosocial, perceived effective*, side effect, benefit*, cue* to action, risk perception*, perceived risk*, perceived severity, or perceived susceptibility; and AND vaccin* and accept*, consent, decision*, prefer*, or uptake. We also searched the reference sections of included articles. Inclusion criteria were examining awareness, knowledge, or attitudes related to HPV infection or HPV vaccines and reporting original data (editorials or review papers were excluded). One investigator coded the included studies using an abstraction form. A second reviewer checked these data. They consulted with a third investigator in the few cases when there were disagreements in coding. When four or more studies reported contradictory findings, we examined the studies' characteristics to explain the discrepancy.

Results

As shown in Fig. 1, the search identified 1682 articles. Of the 53 articles that met inclusion criteria, 22 reported data collected in Europe, Canada, or Australia, two in Latin America, and one in Africa. Twenty-eight studies were conducted in the United States. We review only studies conducted in the United States because of the many differences with health care systems in other countries and potential cross-cultural differences in beliefs and motivations related to HPV vaccination.

The United States studies' sample sizes ranged from 20 to 840 (see Table 1). Most were small, cross-sectional studies of parents and adults. Only one study used a quasi-experimental design, another used a controlled experimental design, and many others used qualitative methods. All but two reported data

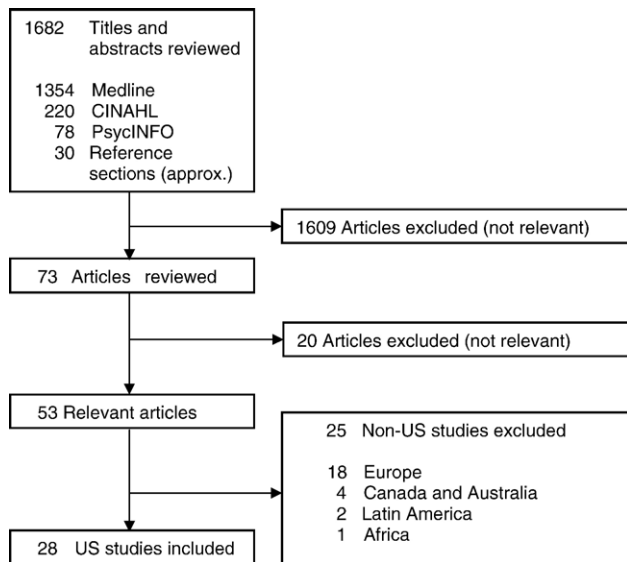


Fig. 1. Review of articles for inclusion in systematic review.

collected in urban settings. Most studies examined either awareness, knowledge, or attitudes about HPV infection, but few empirically examined these variables' relationships to acceptability. Because of the uniformly limited quality of the evidence that these studies offer, we present the findings in the form of a qualitative review. We first review the public's level of HPV vaccine acceptability, followed by potential predictors of acceptability, including awareness, knowledge, beliefs, and cervical cancer risk factors.

Despite news accounts to the contrary, a large number of parents were willing to vaccinate their adolescent children against HPV (55% to 100%) (Constantine and Jerman, 2007; Davis et al., 2004; Gerend et al., 2006; Kahn et al., 2003; Mays et al., 2004; Slomovitz et al., 2006). Even so, some parents have decided against or remain undecided about vaccinating their adolescent daughters and sons (Dempsey et al., 2006; Olshen et al., 2005).

Studies of adults and young adults find substantial interest in the HPV vaccine (Boehner et al., 2003; Gerend et al., 2006; Hoover et al., 2000; Kahn et al., 2003). (In our review, we group college students with young adults.) A study of adolescents and young adults found that 32% would pay for an HPV vaccine (Hoover et al., 2000). Another study reported that acceptability of the HPV vaccine among parents and adolescents was highly concordant (Zimet et al., 2000). Assumptions that parents will decide, without input from their children, on whether to vaccinate them may explain the paucity of similar research on acceptability of the HPV vaccine among adolescents.

Awareness and knowledge

Turning to potential predictors of HPV vaccine acceptability, knowledge of HPV ranged by topic and study (see Table 2), but was modest overall. The majority of men and women in the studies reviewed had never heard of HPV. Across seven studies, 42% (range 0%–72%) of respondents were aware of HPV.

Only 21% (range 0%–34%, three studies) of respondents knew that HPV is common. Fifty-nine percent (range 31%–88%, eight studies) of respondents knew the purpose of a Pap test, and 68% (range 41%–88%, six studies) knew that HPV is a sexually transmitted infection. Knowledge of the remaining topics was modest, varying greatly from study to study. Knowledge that HPV can cause genital warts was moderate, 55% (range 9%–84%, six studies). Forty-nine percent of respondents (10%–98%, seven studies) knew that HPV infection can lack symptoms. Knowledge that HPV causes cervical cancer was relatively low, but it varied greatly across studies, 44% (range 1%–89%, eight studies).

Studies show mixed findings for the relationship of HPV knowledge to vaccine acceptability (Boehner et al., 2003; Dempsey et al., 2006; Kahn et al., 2003). One educational intervention that presented brief factual information on HPV increased vaccine acceptability, but because changes in knowledge were not reported, the study findings cannot be tied to knowledge with any certainty (Davis et al., 2004). Limited knowledge and awareness of HPV make it difficult for some people to discuss HPV vaccine acceptability (Friedman and Sheppard, 2006; Olshen et al., 2005). Even so, HPV vaccine acceptability is high despite generally low levels of HPV knowledge.

Health belief model constructs

Perceived likelihood

Between 21% and 46% of adolescents and young adult respondents perceived themselves to have some chance of being infected with HPV (Ramirez et al., 1997; Yacobi et al., 1999); and adult women reported high perceived chances of getting cervical cancer (Anhang et al., 2004; Kahn et al., 2003, 2005a). Higher perceived likelihood of HPV exposure or infection was related to higher acceptability (Boehner et al., 2003; Friedman and Sheppard, 2006; Olshen et al., 2005). The association of perceived likelihood of getting cervical cancer (as distinct from HPV infection) was related to vaccine acceptability in one small study (Gerend et al., 2006).

Perceived severity

Although women believed cervical cancer is a health problem with severe consequences (Anhang et al., 2004; Hoover et al., 2000; Kahn et al., 2003, 2005a; Mays et al., 2000; Mays et al., 2004), higher perceived severity of HPV infections was not related to greater vaccine acceptability in three studies (Boehner et al., 2003; Dempsey et al., 2006; Kahn et al., 2003). However, perceived severity was the second most influential factor in rating the acceptability of sexually transmitted infection vaccines among parents (Zimet et al., 2005). The relationship of perceived severity of cervical cancer (as distinct from HPV infection) to HPV vaccine acceptability has not been investigated in published reports.

Perceived effectiveness

Although no published studies reported mean levels of perceived vaccine effectiveness, higher perceived effectiveness

Table 1
Characteristics of studies of awareness, knowledge, and attitudes toward HPV and the HPV vaccines in the United States

Author	State	Study design	N	Age	Sex	Location	Black (%)	Hispanic (%)	Study examined awareness knowledge, or attitudes about	
									HPV	HPV vaccine
Anhang et al., 2004	MA	Qualitative	48	A	F	–	13	44	●	
Baer et al., 2000	Northeast	Cross-sectional	322	CS	F,M	–	4	9	●	
Boehner et al., 2003	Midwest	Cross-sectional	256	CS	F,M	–	13	–		●
Constantine and Jerman, 2007	CA	Cross-sectional and qualitative	522	P	F, M	U,R	7	38		●
Davis et al., 2004	GA	Cross-sectional and experimental	506	P	F,M	U	45	–	●	●
Dempsey et al., 2006	WA	Cross-sectional and experimental	840	P	F,M	–	5	4	●	●
Friedman and Sheppard, 2006	Multiple	Qualitative	314	A	F,M	U,R	34	34	●	●
Gerend et al., 2006	FL	Cross-sectional	58	A	F	U	59	9		●
Gerhardt et al., 2000	OH	Cross-sectional	50	Y,A	F	–	88	–	●	
Holcomb et al., 2004	MI	Cross-sectional	289	A,CS	F,M	U	11	5	●	
Hoover et al., 2000	NJ	Cross-sectional	60	A,Y	F	U	3	0	●	●
Kahn et al., 2001	OH	Cross-sectional	490	A,Y	F	U	50	22	●	
Kahn et al., 2003	OH	Cross-sectional	52	A	F	U,V	35	2	●	●
Kahn et al., 2005a	OH	Cross-sectional	100	A,Y	F	U	82	1	●	
Keller et al., 2000	Midwest	Cross-sectional	92	A	F,M	U	–	–	●	
Lambert, 2001	NY	Cross-sectional	60	A,CS	F,M	U	–	–	●	
Mays et al., 2000	IL/IN	Qualitative	40	A,Y	F	U	48	–	●	
Mays et al., 2004*	IN	Qualitative	34	P	F,M	U	29	0		●
McMullin et al., 2005	CA	Qualitative	20	A	F	U	0	100	●	
McPartland et al., 2005	WA	Cross-sectional	166	CS	M	–	2	3	●	
Olshen et al., 2005	Northeast	Qualitative	25	P	F,M	U	25	16		●
Pruitt et al., 2005	TX	Cross-sectional	175	A	F	U	17	34	●	
Ramirez et al., 1997	CA	Cross-sectional	110	CS	F	U	4	13	●	
Reed et al., 1999	MI	Cross-sectional	155	A	F	U	–	–	●	
Slomovitz et al., 2006	TX	Cross-sectional	200	P	F	U	24	30		●
Yacobi et al., 1999	FL	Cross-sectional	289	CS	F,M	V	5	7	●	
Zimet et al., 2000	IL/IN	Cross-sectional	40	A,Y	F	U	50	–		●
Zimet et al., 2005*	IL/IN	Cross-sectional	278	P	F,M	U	39.6	2		●

Note. We reviewed studies published between January, 1995 and January, 2007. Age: A=adults, CS=college students, P=parents, Y=adolescents. Location: R=rural, U=urban, V=university. –=data not available. *=study not specific to HPV but examines HPV vaccine characteristics. ●=study examined this construct.

Table 2
Awareness and knowledge of HPV in the United States

	Awareness, %	Knowledge					Purpose of Pap tests, %
		HPV is an STD, %	HPV is common, %	HPV causes cervical cancer, %	HPV can lack symptoms, %	HPV can cause genital warts, %	
Anhang et al., 2004	23	–	–	–	–	–	–
Baer et al., 2000	33	–	–	12	–	9	–
Davis et al., 2004	–	88	34	87	–	84	88
Friedman and Sheppard, 2006	–	–	0	1	–	–	–
Gerhardt et al., 2000	–	–	–	–	58	–	–
Holcomb et al., 2004	67	48	–	39	–	38	42
Hoover et al., 2000	23	–	–	–	–	–	–
Kahn et al., 2003	–	87	–	40	98	–	85
Lambert, 2001	–	–	27	53	85	–	–
Mays et al., 2000	18	–	–	–	–	–	38
McMullin et al., 2005	0	–	–	–	–	–	–
McPartland et al., 2005	45	–	–	89*	80*	75*	–
Pruitt et al., 2005	–	70	–	47	66	43	71
Ramirez et al., 1997	72	84	–	44	27	83	47
Yacobi et al., 1999	38	41	–	27	10	–	35
Summary	44	68	21	44	49	55	59

Note. The summary percent for each column was calculated by dividing the number of respondents in all studies who answered affirmatively by the number who was asked the question. Readers may wish to interpret the summary percentages with caution as many of the studies used different items to assess a given construct. – indicates that construct was not assessed in the study. *Assessed after an intervention to increase knowledge. STD = sexually transmitted disease.

was associated with greater HPV vaccination intentions for both parents of adolescents and adults in several studies (Davis et al., 2004; Dempsey et al., 2006; Zimet et al., 2000). Parents rated vaccine effectiveness as the most important attribute of an acceptable sexually transmitted infection vaccine (Zimet et al., 2005). While perceived effectiveness of the vaccine, specifically against HPV infection, predicted vaccine acceptability in one study (Gerend et al., 2006), no studies report on the role of perceived effectiveness of the vaccine against genital warts or cervical cancer in acceptability.

Perceived barriers

One perceived barrier is a concern among some parents that vaccination could promote adolescent sexual activity. In the four studies that quantified how common this concern was, only 6% to 12% of parents endorsed it (Constantine and Jerman, 2007; Davis et al., 2004; Mays et al., 2004; Zimet et al., 2005). In contrast, two qualitative studies, that did not quantify how common this theme was, reported that parents had strong concerns that administering the HPV vaccine would implicitly condone youth sexual behaviors (Friedman and Sheppard, 2006; Olshen et al., 2005).

Cost is a commonly stated barrier to receiving the HPV vaccine (Boehner et al., 2003; Friedman and Sheppard, 2006; Hoover et al., 2000; Zimet et al., 2000). Low perceived vaccine safety is another barrier to vaccination (Constantine and Jerman, 2007; Boehner et al., 2003; Dempsey et al., 2006). One study reported that getting multiple shots was not perceived to be a barrier to vaccination (Gerend et al., 2006). Anticipated side effects from the HPV vaccine such as pain or discomfort are also reasons for low acceptability (Davis et al., 2004; Dempsey et al., 2006; Slomovitz et al., 2006).

Cues to action

HPV vaccine acceptability was higher among parents and young adults who believed that their physician would recommend it (Boehner et al., 2003; Davis et al., 2004; Dempsey et al., 2006; Gerend et al., 2006; Kahn et al., 2003; Olshen et al., 2005), but few studies report the frequency of this belief. Additionally, parents who opposed the HPV vaccine were less likely to be influenced by physician recommendations than parents who were more accepting of the vaccine (Davis et al., 2004). School requirements for children to receive the HPV vaccine were associated with higher acceptability of the HPV vaccine (Davis et al., 2004).

Other factors

Studies examined several other potentially important factors. Parents may be more likely to vaccinate older children than younger children against HPV (Dempsey et al., 2006; Zimet et al., 2005), but one qualitative study found that child age was not associated with vaccine acceptability (Friedman and Sheppard, 2006). Several small cross-sectional studies and one qualitative study found that children's sex had no bearing on parental acceptability (Davis et al., 2004; Mays et al., 2004; Olshen et al., 2005; Slomovitz et al., 2006; Zimet et al., 2000), but a large

study found parents more in favor of vaccinating their adolescent daughters than sons (Dempsey et al., 2006). Not surprisingly, parents willing to accept an HPV vaccine for themselves were more likely to allow their children to be vaccinated (Slomovitz et al., 2006; Zimet et al., 2000). Acceptability was also higher when people believed that important others wanted them to be vaccinated or held favorable beliefs toward the vaccine (Kahn et al., 2003; Constantine and Jerman, 2007), including peers of parents (Kahn et al., 2003), parents and partners of young adults, and the husbands, steady partners, or parents of adult women (Boehner et al., 2003; Kahn et al., 2003).

Parents reported that adolescents who are currently sexually active should receive the HPV vaccine, but those who are not sexually active should not (Kahn et al., 2003; Slomovitz et al., 2006). Parents who were not accepting of sexually transmitted infection vaccines believed adolescents were unaware of sexual issues, and those who considered the possibility of their adolescent children's future sexual activity were more accepting (Mays et al., 2004). Parents who were born-again or evangelical Christian, as compared to other religions, reported lower vaccine acceptability for their daughters, and Catholics and infrequent religious-service attenders reported higher acceptability (Constantine and Jerman, 2007). Politically conservative respondents were least likely to endorse HPV vaccination for their daughters (Constantine and Jerman, 2007).

Parents with a history of genital warts or HPV infection were more willing to vaccinate their adolescents (Davis et al., 2004; Dempsey et al., 2006). However, two studies provide contradictory findings on whether parent's history of other sexually transmitted infections influences acceptance of the HPV vaccine (Gerend et al., 2006; Mays et al., 2004). Mothers with histories of abnormal Pap tests were not more willing to vaccinate their children against HPV (Gerend et al., 2006; Davis et al., 2004; Slomovitz et al., 2006). Women previously tested for HIV were more likely to accept the HPV vaccine for themselves (Gerend et al., 2006).

Role of variables known to predict cervical cancer

Those who self-identified as African American did not differ from other respondents regarding HPV vaccine acceptability (Boehner et al., 2003; Davis et al., 2004; Gerend et al., 2006; Kahn et al., 2003; Mays et al., 2004; Slomovitz et al., 2006), nor did those who self-identified as Hispanic (Gerend et al., 2006; Slomovitz et al., 2006). However, one study that appears to be an outlier found that Hispanic parents reported higher HPV vaccine acceptability, while African American and Asian American parents reported lower acceptability (Constantine and Jerman, 2007). With regard to predictors of acceptability, one study with 24% African American and 30% Hispanic respondents found no differences when participants were stratified by race and ethnicity (Slomovitz et al., 2006), but no other studies reported on whether predictors of vaccine acceptability differed across racial or ethnic groups.

No behavioral research, that identified factors that influence vaccine acceptability among people living in rural areas, was published at the time of this review. The two studies with both

rural- and urban-dwelling adults did not stratify their findings based on this characteristic (Constantine and Jerman, 2007; Friedman and Sheppard, 2006).

Current research provides mixed findings on the role of socioeconomic status in parents' and adults' acceptance of the HPV vaccines. The location of survey administration may be one indication of socioeconomic status (e.g., parents using privately and publicly provided medical services may have different socioeconomic status). Parents attending public clinics were more likely to accept the HPV vaccine than those attending private clinics (Mays et al., 2004; Zimet et al., 2005). In five studies, parents with lower levels of education reported higher vaccine acceptability for their children (Constantine and Jerman, 2007; Davis et al., 2004; Mays et al., 2004; Slomovitz et al., 2006; Zimet et al., 2005), but two studies found that education was unrelated to vaccine acceptability for a child or for oneself (Gerend et al., 2006; Slomovitz et al., 2006). In two studies, higher income predicted greater vaccine acceptability (Davis et al., 2004; Gerend et al., 2006), but another study did not find this effect (Slomovitz et al., 2006). Two studies found that insurance status was unrelated to vaccine acceptability among adults (Gerend et al., 2006; Kahn et al., 2003), but another found that parents who pay for medical services out of pocket or have Medicaid were more likely to accept a sexually transmitted infection vaccine for their child than others (Zimet et al., 2005). These findings suggest mixed effects of socioeconomic status, with lower education associated with higher acceptability, while higher income is associated with higher acceptability.

Despite the handful of studies that have looked at racial and ethnic differences in acceptability, existing behavioral research that can inform our understanding of HPV vaccine acceptability has largely been conducted without appropriate emphasis on some populations most affected by cervical cancer. Few studies specifically reported on the attitudes of Hispanics, smokers, or those with a history of a sexually transmitted infection or HPV infection.

Discussion

Parents in the United States have generally positive evaluations of HPV vaccination. The same theoretical constructs that have been pivotal in promoting uptake of other vaccines also influenced HPV vaccine acceptability. The studies had substantial limitations in their designs, study populations, and likely generalizability. Current literature on HPV acceptability is generally limited to cross-sectional studies based on small, largely Caucasian samples, with few studies of Hispanic women, and even fewer studies of women in rural areas. Few studies reported what information, if any, was provided to respondents about the vaccine.

Although it is unclear to what extent interventions that enhance awareness and knowledge will successfully increase HPV vaccination, many people's knowledge of HPV and the HPV vaccines is currently insufficient to make informed decisions about HPV vaccination. Educational campaigns should emphasize that HPV infection is common, can be asymptomatic,

and is often transient, given the very low knowledge of these facts. Many people incorrectly believed that HPV vaccination is most appropriate for those who are already sexually active; therefore, campaigns should emphasize that HPV is most effective when delivered prior to sexual debut. They should also anticipate a small but vocal opposition to the vaccine (Lo, 2006).

Those who perceived HPV infection to be more likely were more accepting of HPV vaccination, but perceived severity was largely unrelated to acceptability. Perceived risk of cervical cancer has been reported in only one published study of HPV vaccine acceptability. This is surprising as perceived cancer risk is a strong motivator of other health behaviors such as breast cancer screening (McCaul et al., 1996; Vernon, 1999). Many studies appeared not to have adequately assessed perceived risk, limiting the value of these studies' findings (Brewer et al., 2004, 2007a). Perceived risk remains an important topic for future research on Pap screening and HPV vaccination (Waller et al., 2004).

Perceived effectiveness of vaccines in preventing HPV infection was a key predictor of vaccine acceptability. Additional research is needed on the role of perceived effectiveness of the vaccine against genital warts or cervical cancer given the importance of this construct.

Perceived barriers to HPV vaccination may present challenges, such as the belief among a small minority of parents that an HPV vaccine may implicitly condone, and thus increase, adolescent sexual behavior (Brewer et al., 2007b). Two qualitative studies concluded that parents were concerned that HPV vaccines would promote sexual behavior among their children, but this may be an artifact of qualitative data synthesis that can highlight distinct themes or beliefs that may not be widespread.

Among various possible cues to action, physician recommendation is likely to be a key ingredient of successful HPV vaccination programs. Physicians may be uniquely persuasive in addressing perceived barriers, for example by initiating a conversation with patients about their concerns, clarifying any misunderstandings, and recommending the vaccine. A related issue is that some physicians and other health care providers may not yet have adequate knowledge of patients' attitudes that act as barriers to vaccination of adolescents (Riedesel et al., 2005; Kahn et al., 2005b). However, for the many adolescent girls and adult women who do not receive routine medical care, vaccine programs may need to rely on other strategies including direct appeals.

Most determinants of cervical cancer, including Hispanic ethnicity, rural/urban residence, and smoking, require greater attention in studies of HPV vaccine acceptability. Furthermore, very few research studies examined whether the *predictors* of acceptability differed among these groups (e.g., whether physician recommendation would play the same role among African American and white respondents). Such information is invaluable for developing more culturally sensitive educational materials and targeted media campaigns.

Although the developing world was not a focus of this review, it is striking that only three published studies have reported on HPV vaccine acceptability in these regions despite

their exceptionally high burden of cervical cancer mortality. The absence of HPV vaccine acceptability research in developing countries represents a significant gap that may hinder global cervical cancer prevention. Additional formative research is needed to identify which, if any, of these constructs drive vaccine acceptability developing countries.

Conclusions

Vaccine programs should consider that those lacking access to routine Pap screening and follow-up care can benefit most from HPV vaccination because of their high-risk. Research on HPV vaccine acceptability does not reflect those who are most in need of vaccination such as Hispanic adolescents and young adults, those living in rural areas, and those with low socioeconomic status. Future studies are urgently needed to address the dearth of HPV vaccine acceptability research in developing countries. Despite the shortcomings of the existing research literature, this review provides guidance about the health beliefs that are likely to influence young adult women and parents of adolescent girls as they decide about HPV vaccination.

Although we believe the review provides explicit and often self-evident directions for future *research*, we caution readers that most reviewed studies, when considered on their own, yielded evidence of inadequate quality to direct future *interventions*. However, the reviewed findings, taken in combination with well-know health behavior theories and the body of empirical literature on vaccination and related interventions, suggest that HPV vaccine programs in the United States should emphasize the high likelihood of HPV infection, high vaccine effectiveness, and physicians' recommendations, and address barriers to vaccination. Because of the potential for misunderstanding, campaigns may need to take care to communicate that the HPV vaccines provide less than total protection against cervical cancer.

HPV vaccines offer a promising alternative for preventing cervical cancer among women who do not receive regular Pap tests. If HPV vaccine uptake is harmed by the existing disparities in health care access and use, the vaccines may widen rather than narrow existing disparities in cervical cancer deaths.

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References

American Cancer Society, Inc., 2007. Estimated New Cancer Cases and Deaths by Sex for all Sites, US. American Cancer Society, Inc., Atlanta, GA.
Anhang, R., Wright Jr., T.C., Smock, L., Goldie, S.J., 2004. Women's desired information about human papillomavirus. *Cancer* 100, 315–320.

Baer, H., Allen, S., Braun, L., 2000. Knowledge of human papillomavirus infection among young adult men and women: implications for health education and research. *J. Commun. Health* 25, 67–78.
Becker, M.H., 1974. The health belief model and personal health behavior. *Health Educ. Monogr.* 2, 324–508.
Boehner, C.W., Howe, S.R., Bernstein, D.I., Rosenthal, S.L., 2003. Viral sexually transmitted disease vaccine acceptability among college students. *Sex. Transm. Dis.* 30, 774–778.
Brewer, N.T., Weinstein, N.D., Cuite, C.L., Herrington, J.E., 2004. Risk perceptions and their relation to risk behavior. *Ann. Behav. Med.* 27, 125–130.
Brewer, N.T., Chapman, G.B., Gibbons, F.X., Gerard, M., McCaul, K.D., Weinstein, N.D., 2007a. A meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychol.* 26, 136–145.
Brewer, N.T., Weinstein, N.D., Cuite, C.L., Herrington, J.E., 2007b. Risk compensation and vaccination: can getting vaccinated cause people to engage in risky behaviors? *Ann. Behav. Med.* 33.
Chapman, G.B., Coups, E.J., 1999. Predictors of influenza vaccine acceptance among healthy adults. *Prev. Med.* 29, 249–262.
Constantine, N.A., Jerman, P., 2007. Acceptance of human papillomavirus vaccination among Californian parents of daughters: a representative statewide analysis. *J. Adolesc. Health* 40, 108–115.
Davis, K., Dickman, E.D., Ferris, D., Dias, J.K., 2004. Human papillomavirus vaccine acceptability among parents of 10- to 15-year-old adolescents. *J. Low. Genit. Tract Dis.* 8, 188–194.
Dempsey, A.F., Zimet, G.D., Davis, R.L., Koutsky, L., 2006. Factors that are associated with parental acceptance of human papillomavirus vaccines: a randomized intervention study of written information about HPV. *Pediatrics* 117, 1486–1493.
Friedman, A.L., Sheppard, H., 2006. Exploring the knowledge, attitudes, beliefs, and communication preferences of the general public regarding HPV: findings from CDC focus group research and implications for practice. *Health Educ. Behav.* 22, 1–15.
Gerend, M.A., Lee, S.C., Shepherd, J.E., 2006. Predictors of human papillomavirus vaccination acceptability among underserved women. *Sex. Transm. Dis.* 33, 1–4.
Gerhardt, C.A., Pong, K., Kollar, L.M., Hillard, P.J., Rosenthal, S.L., 2000. Adolescents' knowledge of human papillomavirus and cervical dysplasia. *J. Pediatr. Adolesc. Gynecol.* 13, 15–20.
Globocan, 2002. Cancer incidence, mortality, and prevalence worldwide [database on CD-ROM]. In: Ferlay, J., Bray, F., Pisani, P., Parkin, D.M. (Eds.), IARC CancerBase No. 5, version 2.0, 2004. IARC Press, Lyon, France.
Gottlieb, N., 2002. A primer on HPV. *Natl. Cancer Inst.: BenchMarks Series* 2, 4–24.
Green, L.W., Kreuter, M.W., 2004. *Health Program Planning: An Educational and Ecological Approach*. McGraw-Hill, New York.
Holcomb, B., Bailey, J.M., Crawford, K., Ruffin, M.T., 2004. Adults' knowledge and behaviors related to human papillomavirus infection. *J. Am. Board Fam. Pract.* 17, 26–31.
Hoover, D.R., Carfioli, B., Moench, E.A., 2000. Attitudes of adolescent/young adult women toward human papillomavirus vaccination and clinical. *Health Care Women Int.* 21, 375–391.
Kahn, J.A., Emans, S.J., Goodman, E., 2001. Measurement of young women's attitudes about communication with providers regarding papanicolaou smears. *J. Adolesc. Health* 5, 344–351.
Kahn, J.A., Rosenthal, S.L., Hamann, T., Bernstein, D.I., 2003. Attitudes about human papillomavirus vaccine in young women. *Int. J. STD AIDS* 14, 300–306.
Kahn, J.A., Slap, G.B., Bernstein, D.I., Kollar, L.M., Tissot, A.M., Hillard, P.A., Rosenthal, S.L., 2005a. Psychological, behavioral, and interpersonal impact of human papillomavirus and Pap test results. *J. Womens Health (Larchmt.)* 14, 650–659.
Kahn, J.A., Zimet, G.D., Bernstein, D.I., Riedesel, J.M., Lan, D., Huang, B., Rosenthal, S.L., 2005b. Pediatricians' intention to administer human papillomavirus vaccine: the role of practice characteristics, knowledge, and attitudes. *J. Adolesc. Health* 37, 1–502.
Keller, M.L., von Sadovszky, V., Pankratz, B., Hermsen, J., 2000. Self-disclosure of HPV infection to sexual partners. *West. J. Nurs. Res.* 285–296.

- Lambert, E.C., 2001. College students' knowledge of human papillomavirus and effectiveness of a brief educational intervention. *J. Am. Board Fam. Med.* 14, 178–183.
- Lo, B., 2006. HPV vaccine and adolescents' sexual activity. *BMJ* 332, 1106–1107.
- Markowitz, L.E., Dunne, E.F., Saraiya, M., Lawson, H.W., Chesson, H., Unger, E.R., 2007. Quadrivalent human papillomavirus vaccine. *Morb. Mortal. Wkly. Rep.* 56, 1–24.
- Mays, R.M., Zimet, G.D., Winston, Y., Kee, R., Dickes, J., Su, L., 2000. Human papillomavirus, genital warts, Pap smears, and cervical cancer: knowledge and beliefs of adolescent and adult women. *Health Care Women Int.* 5, 361–374.
- Mays, R.M., Sturm, L.A., Zimet, G.D., 2004. Parental perspectives on vaccinating children against sexually transmitted infections. *Soc. Sci. Med.* 58, 1405–1413.
- McCaul, K.D., Branstetter, A.D., Schroeder, D.M., Glasgow, R.E., 1996. What is the relationship between breast cancer risk and mammography screening? A meta-analytic review. *Health Psych.* 15, 423–429.
- McMullin, J.M., De Alba, I., Chavez, L.R., Hubbell, F.A., 2005. Influence of beliefs about cervical cancer etiology on pap smear use among Latina immigrants. *Ethn. Health* 10, 3–18.
- McPartland, T.S., Weaver, B.A., Lee, S.K., Koutsky, L.A., 2005. Men's perceptions and knowledge of human papillomavirus (HPV) infection and cervical cancer. *J. Am. Coll. Health* 53, 225–230.
- Newmann, S.J., Garner, E.O., 2005. Social inequities along the cervical cancer continuum: a structured review. *Cancer Causes Control* 16, 63–70.
- Olshen, E., Woods, E.R., Austin, S.B., Luskin, M., Bauchner, H., 2005. Parental acceptance of the human papillomavirus vaccine. *J. Adolesc. Health* 37, 248–251.
- Pruitt, S.L., Parker, P.A., Peterson, S.K., Le, T., Follen, M., Basen-Engquist, K., 2005. Knowledge of cervical dysplasia and human papillomavirus among women seen in a colposcopy clinic. *Gynecol. Oncol.* 99, S236–S244.
- Ramirez, J.E., Ramos, D.M., Clayton, L., Kanowitz, S., Moscicki, A.B., 1997. Genital human papillomavirus infections: knowledge, perception of risk, and actual risk in a nonclinic population of young women. *J. Womens Health* 6, 113–121.
- Reed, B.D., Ruffin, M.T., Gorenflo, D.W., Zazove, P., 1999. The psychosexual impact of human papillomavirus cervical infections. *J. Fam. Pract.* 48, 110–116.
- Riedesel, J.M., Rosenthal, S.L., Zimet, G.D., Bernstein, D.I., Huang, B., Lan, D., Kahn, J.A., 2005. Attitudes about human papillomavirus vaccine among family physicians. *J. Pediatr. Adolesc. Gynecol.* 18, 391–398.
- Ries, L.A.G., Eisner, M.P., Kosary, C.L., Hankey, B.F., Miller, B.A., Mariotto, A., Feuer, E.J., Edwards, B.K., 2002. SEER Cancer Statistics Review, 1975–2002. National Cancer Institute, Bethesda, MD.
- Slomovitz, B.M., Sun, C.C., Frumovitz, M., Soliman, P.T., Schmeler, K.M., Pearson, H.C., Berenson, A., Ramirez, P.T., Lu, K.H., Bodurka, D.C., 2006. Are women ready for the HPV vaccine? *Gynecol. Oncol.* 103, 151–154.
- Vernon, S.W., 1999. Risk perception and risk communication for cancer screening behaviors: a review. *J. Natl. Cancer Inst. Monographs* 25, 101–119.
- Villa, L.L., Ault, K.A., Giuliano, A.R., Costa, R.L., Petta, C.A., Andrade, R.P., Brown, D.R., Ferenczy, A., Harper, D.M., Koutsky, L.A., Kurman, R.J., Lehtinen, M., Malm, C., Olsson, S.E., Ronnett, B.M., Skjeldstad, F.E., Steinwall, M., Stoler, M.H., Wheeler, C.M., Taddeo, F.J., Yu, J., Lupinacci, L., Railkar, R., Marchese, R., Esser, M.T., Bryan, J., Jansen, K.U., Sings, H.L., Tamms, G.M., Saah, A.J., Barr, E., 2006. Immunologic responses following administration of a vaccine targeting human papillomavirus Types 6, 11, 16, and 18. *Vaccine* 24, 5571–5583.
- Waller, J., McCaffery, K.J., Forrest, S., Wardle, J., 2004. Human papillomavirus and cervical cancer: issues for biobehavioral and psychosocial research. *Ann. Behav. Med.* 27, 68–69.
- Weinstein, N.D., 1988. The precaution adoption process. *Health Psychol.* 7, 355–386.
- Yacobi, E., Tennant, C., Ferrante, J., Pal, N., Roetzheim, R., 1999. University students' knowledge and awareness of HPV. *Prev. Med.* 28, 535–541.
- Zimet, G.D., Mays, R.M., Winston, Y., Kee, R., Dickes, J., Su, L., 2000. Acceptability of human papillomavirus immunization. *J. Womens Health Gen.-Based Med.* 9, 47–50.
- Zimet, G.D., Mays, R.M., Sturm, L.A., Ravert, A.A., Perkins, S.M., Juliar, B.E., 2005. Parental attitudes about sexually transmitted infection vaccination for their adolescent children. *Arch. Pediatr. Adolesc. Med.* 159, 132–137.
- Zimet, G.D., Liddon, N., Rosenthal, S.L., Lazzano-Ponce, E., Allen, B., 2006. Chapter 24: psychosocial aspects of vaccine acceptability. *Vaccine* 24, S201–S2109.