Risk Perceptions and Subsequent Sexual Behaviors After HPV Vaccination in Adolescents

WHAT'S KNOWN ON THIS SUBJECT: Concerns have been raised that human papillomavirus (HPV) vaccination could lead to riskier behaviors in vaccinated adolescents, but it is unknown whether changes in risk perceptions after vaccination lead to riskier sexual behaviors.

WHAT THIS STUDY ADDS: Risk perceptions following HPV vaccination were not associated with subsequent riskier sexual behaviors in sexually experienced and inexperienced young women. These data contribute to the growing evidence that HPV vaccination does not lead to changes in sexual behaviors among adolescents.

abstract

NIH FREE

OBJECTIVES: Concerns have been raised that human papillomavirus (HPV) vaccination could lead to altered risk perceptions and an increase in risky sexual behaviors among adolescents. The aim of this study was to assess whether adolescent risk perceptions after the first vaccine dose predicted subsequent sexual behaviors.

METHODS: Young women 13 to 21 years of age (N = 339) completed questionnaires immediately after HPV vaccination, and 2 and 6 months later, assessing demographic characteristics, knowledge/attitudes about HPV vaccination, risk perceptions, and sexual behaviors. Risk perceptions were measured by using 2 5-item scales assessing: (1) perceived risk of sexually transmitted infections (STI) other than HPV, and (2) perceived need for safer sexual behaviors after HPV vaccination. We assessed associations between risk perceptions at baseline and sexual behaviors over the next 6 months by using logistic regression, stratifying participants by sexual experience at baseline and age (13–15 vs 16–21 years).

RESULTS: Among all sexually inexperienced participants (42.5%), baseline risk perceptions were not associated with subsequent sexual initiation; in age-stratified analyses, girls 16 to 21 years of age who reported lower perceived risk for other STI (an inappropriate perception) were less likely to initiate sex (odds ratio [OR] 0.13, 95% confidence interval [CI] 0.03–0.69). Among all sexually experienced participants (57.5%) and in age-stratified analyses, baseline risk perceptions were not associated with subsequent number of sexual partners or condom use.

CONCLUSIONS: Risk perceptions after HPV vaccination were not associated with riskier sexual behaviors over the subsequent 6 months in this study sample. *Pediatrics* 2014;133:404–411

AUTHORS: Allison Mayhew, BA,[a] Tanya L. Kowalczyk Mullins, MD, MS,[a,b] Lili Ding, PhD,[b] Susan L. Rosenthal, PhD,[c] Gregory D. Zimet, PhD,[d] Charlene Morrow, RN,[b] and Jessica A. Kahn, MD, MPH[a,b]

[a]University of Cincinnati College of Medicine, Cincinnati, Ohio; [b]Department of Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [c]Department of Pediatrics, Columbia University Medical Center and New York-Presbyterian Morgan Stanley Children's Hospital, New York, New York; and [d]Department of Pediatrics, Indiana University, Indianapolis, Indiana

KEY WORDS

HPV vaccines, risk, perception, sexual behavior, adolescent

ABBREVIATIONS

ACIP—US Advisory Committee on Immunization Practices
CI—confidence interval
HPV—human papillomavirus
OR—odds ratio
STI—sexually transmitted infection

Ms Mayhew analyzed and interpreted the data and drafted the initial manuscript; Dr Mullins analyzed and interpreted the data and revised the manuscript critically for important intellectual content; Dr Ding analyzed and interpreted the data and revised the manuscript critically for important intellectual content; Dr Rosenthal made substantial contributions to conception and design as well as interpretation of data and revised the article critically for important intellectual content; Dr Zimet made substantial contributions to conception and design as well as interpretation of data and revised the article critically for important intellectual content; Ms Morrow made substantial contributions to design of the study and acquisition of data and revised the article critically for important intellectual content; Dr Kahn conceptualized and designed the study, supervised the data collection and analyses, and drafted portions of the manuscript; and all authors approved the final manuscript as submitted.

(Continued on last page)

Human papillomavirus (HPV) infection is extremely common, affecting an estimated 7.5 million females between the ages of 14 and 24 years in the United States, with a peak prevalence of 44.8% among 20- to 24-year-olds.[1] Two prophylactic HPV vaccines are widely available: a bivalent and a quadrivalent vaccine. Both prevent the 2 HPV types (HPV-16 and -18) that cause ~70% of cervical cancers, and the quadrivalent vaccine prevents 2 types (HPV-6 and -11) that cause ~90% of anogenital warts.[2–4] The US Advisory Committee on Immunization Practices (ACIP) currently recommends the bivalent and quadrivalent vaccines for girls and women 11 to 26 years of age, and recommends the quadrivalent vaccine for all boys 11 to 21 years of age and men 22 to 26 years of age who are at high risk for HPV.[5,6]

Despite the known effectiveness of HPV vaccines, concerns have been raised among parents and clinicians that HPV vaccination of adolescents could lead to riskier sexual behaviors,[7–9] placing adolescents at higher risk for acquiring non-vaccine type HPVs and other sexually transmitted infections (STIs), and in turn diminishing the positive public health benefits of vaccination. These concerns are consistent with risk homeostasis theory, which suggests that individuals maintain a desired level of health risk by continually evaluating and adjusting their risk perceptions and risk behaviors.[10] Concerns about riskier behaviors after HPV vaccination may derive in part from previous studies of HIV-infected individuals that suggested receipt of an experimental HIV vaccine or initiation of highly active antiretroviral therapy impacted subsequent sexual behaviors or STI diagnosis.[11–17] Decreased perceived risk for acquiring or transmitting HIV appeared to be a significant factor driving these associations.[12,13,15–17] However, the evidence supporting risk homeostasis theory has been mixed overall, and whether it applies in any given circumstance likely depends on the disease, the nature of the health behavior, the characteristics of the population, and the perceptions of personal risk.[18,19]

We previously examined risk perceptions after HPV vaccination and found that although few adolescent girls reported less need for safer sexual behaviors after receipt of their first vaccine dose, 23.6% reported decreased perceived risk for acquiring STIs other than HPV.[20] To our knowledge, no longitudinal studies have examined whether risk perceptions after HPV vaccination are associated with a change in sexual behaviors. Further understanding of this association is important to address parental and clinician concerns and enable clinicians to provide tailored counseling to patients receiving the vaccine, to maximize the positive health impact of this intervention. Thus, the aim of this study was to examine whether adolescent risk perceptions at the time of first HPV vaccine dose predicted sexual behaviors 2 and 6 months after vaccination. We hypothesized that adolescent perceptions of less need to practice safer sexual behaviors and reduced susceptibility to STIs other than HPV as a result of vaccination would be associated with riskier sexual behaviors.

METHODS

Participants

Girls 13 to 21 years of age receiving care at a hospital-based adolescent primary care center, who had received the first HPV vaccine dose within the previous 2 days, were eligible to participate in this longitudinal study. For participants ≥18 years of age, we obtained consent to participate, and for those <18 years of age, we obtained participant assent and parental permission to participate. All participants received $15 for participation in the baseline study visit and $25 for the 2- and 6-month visits. This study was reviewed and approved by the hospital's Institutional Review Board.

Procedures

Before vaccination, participants were given standard written information and recommendations regarding HPV and HPV vaccines by clinicians, and vaccines were administered based on the clinic protocol. After vaccination, participants completed previously validated paper-and-pencil surveys[20,21] assessing demographic characteristics, knowledge and attitudes regarding HPV and HPV vaccination, risk perceptions, and sexual behaviors. Participants returned 2 and 6 months after the initial vaccine dose to complete follow-up surveys and receive the second and third doses of the HPV vaccine, per vaccination guidelines.

Measures

Sexual experience was assessed by using the following item: "have you ever had sex with a male or female (by sex we mean vaginal or anal sex)?" Participants were stratified for analysis based on self-reported sexual experience at baseline. The primary independent variables for this analysis were two 5-item risk perceptions scales measured at baseline: (1) perceived risk for STIs other than HPV after vaccination, and (2) perceived need for safer sexual behaviors after vaccination. To assess risk perceptions using these scales, participants were asked to respond to statements on a 10-point continuous scale where 0 indicated that the participant strongly disagreed with the statement and 10 indicated that she strongly agreed with the statement. Some items were reverse-scored so that lower scores indicated more appropriate risk perceptions

(ie, perception that there is still a risk for STIs other than HPV after vaccination, and perception that safer sexual behaviors are still important after vaccination). Mean and median scale scores were calculated for each of the risk perception subscales, and subscales were dichotomized for analysis into the top tertile versus the lower 2 tertiles.[20,21] Other independent variables included age, self-reported race and ethnicity, insurance coverage, smoking, substance use, and HPV knowledge. Dependent variables were sexual behaviors measured at 2 and 6 months. For participants who were sexually inexperienced at baseline, the dependent variable was sexual initiation as reported at 2 and 6 months, dichotomized for analysis into those who initiated versus did not initiate sex. For participants who identified as sexually experienced at baseline, the dependent variables included number of sexual partners and condom use at last sexual intercourse as reported at 2 and 6 months. Both were dichotomized for analysis: number of sexual partners was dichotomized as ≥ 2 versus <2, and condom use at last sexual intercourse was dichotomized as no versus yes.

Analysis

Descriptive analyses were performed to examine participant characteristics, risk perceptions, and sexual behaviors. Univariable logistic regression was used to assess associations between independent variables (participant characteristics and risk perceptions) assessed at baseline and sexual behaviors assessed at 2 and 6 months. For logistic regression analyses, participants were stratified by sexual experience at baseline and by age (13–15 and 16–21 years).

RESULTS

A total of 339 young women were recruited for the study. Of those, 280 (82.6%) returned for the 2-month follow-up visit and 258 (76.1%) returned for the 6-month follow-up visit. Compared with those who did not return at 2 and 6 months, those who did return differed only in terms of insurance status: those who returned were more likely than those who did not to have health insurance (86.4% vs 74.6% at 2 months and 86.4% vs 77% at 6 months, $P < .05$ for both comparisons). Those who returned at 2 and 6 months did not differ from those who did not return in terms of race, ethnicity, sexual behaviors, or risk perceptions.

Participants' demographic characteristics, substance use, and knowledge about HPV and HPV vaccines are shown in Table 1, and participants' sexual behaviors are shown in Table 2. Seventy-five percent reported that they were black, 17% white (including 4% of Appalachian descent), and 3% Hispanic. At baseline, 195 participants (57.5%) were sexually experienced, and of those, the majority of participants (74.8%) reported >1 lifetime male partner. Of the remaining 144 participants (42.5%) who were sexually inexperienced, few (8.3%) reported previous sexual contact (ie, genital, skin-to-skin contact only). The mean age of participants was 16.8 years, and those who were sexually experienced were significantly older than those who were sexually inexperienced. Sexually experienced compared with inexperienced participants also had significantly greater knowledge about HPV and HPV vaccines, and were significantly more likely to report tobacco, alcohol, and marijuana use. Among sexually experienced participants, age was positively associated with lifetime number of sexual partners ($P < .0001$) and inversely associated with report of condom use at baseline ($P = .004$) and 6 months ($P = .008$) (data not shown). Age was positively associated with report of alcohol use at baseline ($P = .02$). Marijuana use, alcohol use, and smoking frequency during the past 30 days were positively associated with lifetime number of sexual partners reported at baseline ($P = .006$, 0.002, and 0.049, respectively), and marijuana use at baseline was associated with number of recent sexual partners reported at baseline ($P = .02$) and 6 months ($P = .03$).

As described in a previous manuscript,[20] immediately after vaccination the majority of participants did not perceive decreased risk for STIs other than HPV and did not perceive less need for safer sexual behaviors. We found no significant differences in mean scale scores for perceived risk for other STIs or perceived need for safer sexual behaviors after vaccination among sexually experienced versus sexually inexperienced participants (Table 3). Age was not associated with perceived risk for other STIs or perceived need for safer sexual behaviors.

The primary outcome measures for this study were sexual risk behaviors at 2 and 6 months. Of those who were sexually inexperienced at baseline, 20.2% (20/99) initiated sex during the 6-month study period: 6.9% (8/116) between 0 and 2 months and 12.1% (12/99) between 2 and 6 months. Missing data account for the variation in denominators. Among sexually experienced participants at baseline, most (61.8% at 2 months and 62.7% at 6 months) reported having used a condom at last intercourse and a minority (21.8% at 2 months and 34.8% at 6 months) reported 2 or more partners since the last study visit.

Univariable analyses demonstrated that there were no significant associations between risk perceptions and subsequent sexual behaviors among all sexually inexperienced and all sexually experienced participants (Table 4). Among participants who were sexually

TABLE 1 Demographic Characteristics, Substance Use, and Knowledge at Baseline Among Study Participants

	All (n = 339)		Sexually Experienced at Baseline (n = 195)		Sexually Inexperienced at Baseline (n = 144)		P value[a]
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)	
Demographic characteristics							
Age		16.8 (2.5)		18.1 (2.2)		15.0 (1.4)	<0.0001
Race							0.01
White	56/339 (16.5)		22/195 (11.3)		34/144 (23.6)		
Black	259/339 (76.4)		159/195 (81.5)		100/144 (69.4)		
Other	24/339 (7.1)		14/195 (7.2)		10/144 (6.9)		
Hispanic	11/339 (3.2)		10/195 (5.1)		1/144 (0.7)		0.03
Appalachian descent	13/339 (3.8)		4/195 (2.1)		9/144 (6.3)		0.05
Have health insurance	286/339 (84.4)		162/195 (83.1)		124/144 (86.1)		0.45
Substance use							
Cigarettes							
Ever smoked >100 cigarettes	34/339 (10.0)		30/195 (15.4)		4/144 (2.8)		0.0001
Smoked >1 d in past month	40/339 (11.8)		36/195 (18.5)		4/144 (2.8)		<0.0001
Alcohol: ever used	170/339 (50.2)		125/195 (64.1)		45/144 (31.3)		<0.0001
Marijuana: ever used	69/339 (20.4)		65/195 (33.3)		4/144 (2.8)		<0.0001
Knowledge about HPV and HPV vaccines							
Knowledge (12-item scale)		5.3 (2.6)		5.6 (2.7)		4.9 (2.4)	0.02

[a] P value represents the comparison between sexually experienced and sexually inexperienced participants; a χ^2 or Fisher's Exact test was used to compare proportions and a Wilcoxon or t test to compare means.

TABLE 2 Sexual Behaviors Among Study Participants at Baseline, 2 Months, and 6 Months

Sexual Behaviors	All (n = 339)		Sexually Experienced at Baseline (n = 195)		Sexually Inexperienced at Baseline (n = 144)		P value[b]
	N (%)[a]	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)	
Sexual Behaviors							
At baseline							
Ever had sexual contact	207/339 (61.1)		195/195 (100)		12/144 (8.3)		<0.0001
Ever had sexual intercourse	195/339 (57.5)		195/195 (100)		0/144 (0)		N/A[c]
Number of male partners, lifetime		5.6 (7.3)		5.6 (7.3)		0 (0)	N/A
≤1	42/189 (22.2)		42/189 (22.2)		0/144 (0)		N/A
>1 to <5	72/189 (38.1)		72/189 (38.1)		0/144 (0)		N/A
≥5	75/189 (39.7)		75/189 (39.7)		0/144 (0)		N/A
Number of male partners, past 3 mo[d]		1.2 (0.9)		1.2 (0.9)		0 (0)	N/A
≥2	49/194 (25.3)		49/194 (25.3)		0/144 (0)		N/A
Condom use at last intercourse	114/193 (59.1)		114/193 (59.1)		0/144 (0)		N/A
At 2 mo							
Had sexual intercourse for the first time since first study visit (0–2 mo)	8/116 (6.9)		0/195 (0)		8/116 (6.9)		N/A
Number of male partners (0–2 mo)[d]		1.3 (1.3)		1.3 (1.3)		1.1 (0.4)	0.90
≥2	23/117 (19.7)		22/110 (20.0)		1/7 (14.3)		1.00
Condom use at last intercourse	75/117 (64.1)		68/110 (61.8)		7/7 (100)		0.05
At 6 mo							
Had sexual intercourse for the first time since last study visit (2–6 mo)	12/99 (12.1)		0/195 (0)		12/99 (12.1)		N/A
Had sexual intercourse for the first time during the study (0–6 mo)	20/99 (20.2)		0/195 (0)		20/99 (20.2)		N/A
Number of male partners (2–6 mo)[d]		1.4 (0.8)		1.4 (0.9)		1.1 (0.3)	0.08
≥2	42/137 (30.7)		40/118 (33.9)		2/19 (10.5)		0.04
Condom use at last intercourse	88/137 (64.2)		74/118 (62.7)		14/19 (73.7)		0.35

[a] The denominator represents the total number of subjects who were asked to respond to this survey item.

[b] P value represents the comparison between sexually experienced and sexually inexperienced participants; a χ^2 or Fisher's Exact test was used to compare proportions and a Wilcoxon or t test to compare means.

[c] N/A, not applicable.

[d] Number of sexual partners for the past 3 mo was assessed at baseline, number of sexual partners between 0 and 2 mo was assessed at the 2-mo visit (ie, between the baseline and the 2-mo visits), and number of sexual partners between 2 and 6 mo was assessed at the 6-mo visit (ie, between the 2-mo and the 6-mo visits). In this way, we were able to assess the number of partners from 3 mo before enrollment until 6 mo after enrollment.

inexperienced at baseline, risk perceptions (perceived risk for STIs other than HPV and perceived need for safer sexual behaviors) were not associated with sexual initiation at 2 or 6 months. In contrast, in age-stratified analyses, girls 16 to 21 years of age with higher scores on the scale measuring perceived risk for STIs other than HPV, indicating lower perceived risk for other STI (an inappropriate perception) were less likely to initiate sex over the next 6 months (OR, 0.13; 95% CI, 0.03–0.69). Among participants who were sexually experienced at baseline, neither perceived risk for other STIs nor perceived need for safer sexual behaviors was associated with sexual behaviors (number of sexual partners and condom use) at 2 or 6 months. Similarly, these 2 measures of perceived risk were not associated with sexual behaviors when participants were stratified by age (13–15 vs 16–21 years).

TABLE 3 Risk Perceptions Among Study Participants

	All (n = 339)	Sexually Experienced at Baseline (n = 195)	Sexually Inexperienced at Baseline (n = 144)	
	Mean (SD)	Mean (SD)	Mean (SD)	P value[a]
Risk perceptions (5-item subscales)				
Need for safer sexual behaviors[b]	1.6 (1.6)	1.6 (1.7)	1.5 (1.4)	0.59
STI risk perceptions[c]	3.9 (2.0)	3.7 (2.1)	4.0 (2.0)	0.18

[a] P value represents the comparison between sexually experienced and sexually inexperienced participants; a Wilcoxon test was used to compare means.

[b] Need for safer sexual behaviors was measured by using a 5-item scale comprised of the following items: After getting vaccinated against HPV … (1) I think that condom use during sex is less necessary, (2) I feel it is just as important to have as few sexual partners as possible, (3) I feel it is not as important to talk to my sex partners about safe sex, (4) I think it is still just as important to use a condom every time I have sex, and (5) I will be less worried about having unprotected sex. Responses were on a scale ranging from 0 to 10. Some items were reverse-scored so that lower scores indicated more appropriate risk perceptions (ie, perception that safer sexual behaviors are still important after vaccination). Median scale score was 1.0 and range was 0 to 6.9.

[c] STI risk perceptions were measured using a 5-item scale comprised of the following items: After getting vaccinated against HPV … (1) I am less worried about getting an STI or STD other than HPV, (2) I am still just as concerned about getting an STI or STD other than HPV, (3) I think getting an STI or STD other than HPV will be less of a problem, (4) I am less worried that one of my sex partners could get an STI or STD other than HPV from me, and (5) There is less of a chance that I will get an STI or STD other than HPV than there used to be. Responses were on a scale ranging from 0 to 10. Some items were reverse-scored so that lower scores indicated more appropriate risk perceptions (ie, perception that there is still a risk for STIs other than HPV after vaccination). Median scale score was 4.0 and range was 0 to 10.0.

TABLE 4 Associations Between Risk Perceptions at Baseline and Sexual Behaviors Over the Subsequent 6 Months Among Sexually Inexperienced and Sexually Experienced Participants

Risk Perceptions	Sexual Behaviors	Odds Ratio (95% CI)[a]	P value
Sexually inexperienced at baseline			
Perceived risk for other STI	Initiated sex between 0 and 2 mo	0.22 (0.03–1.82)	0.16
	Initiated sex between 2 and 6 mo	0.74 (0.21–2.66)	0.65
	Initiated sex between 0 and 6 mo	0.44 (0.15–1.33)	0.15
Perceived need for safer sexual behaviors	Initiated sex between 0 and 2 mo	0.42 (0.08–2.16)	0.30
	Initiated sex between 2 and 6 mo	1.42 (0.42–4.75)	0.57
	Initiated sex between 0 and 6 mo	0.88 (0.32–2.40)	0.81
Sexually experienced at baseline			
Perceived risk for other STI	≥2 partners between 0 and 2 mo	1.31 (0.51–3.37)	0.57
	≥2 partners between 2 and 6 mo	1.91 (0.87–4.16)	0.11
	Condom use at last sex at 2 mo	1.14 (0.50–2.60)	0.76
	Condom use at last sex at 6 mo	0.86 (0.40–1.86)	0.70
Perceived need for safer sexual behaviors	≥2 partners between 0 and 2 mo	1.23 (0.50–3.07)	0.65
	≥2 partners between 2 and 6 mo	0.99 (0.46–2.18)	0.98
	Condom use at last sex at 2 mo	0.80 (0.37–1.74)	0.57
	Condom use at last sex at 6 mo	0.91 (0.43–1.94)	0.82

[a] Logistic regression analyses were conducted to compare outcomes in participants who had high- versus low-risk perception scale scores (upper tertile versus lower 2 tertiles) after vaccination.

DISCUSSION

In this study, we examined the relationship between risk perceptions immediately after HPV vaccination and sexual behaviors 2 and 6 months later. To our knowledge, this is the first study to assess longitudinally the association between risk perceptions and sexual behaviors after HPV vaccination, and it provides additional support to the growing literature suggesting that HPV vaccination does not lead to sexual behavior change among adolescents.

We previously published the findings that at baseline, most participants in this study did not perceive that they had a lower risk for STIs other than HPV and most believed that safer sexual behaviors were still important.[20] In this study, we further demonstrated that baseline risk perceptions did not differ between sexually experienced and sexually inexperienced participants, despite the finding that sexually inexperienced participants had lower knowledge of HPV and HPV vaccines.

We found no correlation between risk perceptions immediately after vaccination and sexual risk behaviors over the subsequent 6 months among all sexually inexperienced participants and those 13 to 15 years of age. Similarly, we found no correlation among all sexually experienced participants and those 13 to 15 and 16 to 21 years of age. The only significant association we found was in age-stratified analyses of sexually inexperienced participants: those 16 to 21 years of age who had higher scores on the scale measuring perceived risk for STIs other than HPV, indicating lower perceived risk for other STI (an inappropriate perception) were less likely to initiate sex over the next 6 months, contrary to our initial hypothesis. A possible explanation for this finding is that those young women

who self-identified or whose parents or clinicians identified them as less likely to initiate sex over the next 6 months received less education about HPV vaccines, and therefore had less appropriate risk perceptions. Another possible explanation is that young women not considering sexual initiation may have incorrect risk perceptions because they are simply not contemplating whether vaccination may put them at less risk for STIs.

Overall, we did not find support for the theory of risk homeostasis in this population. One explanation for the lack of a more consistent association between risk perceptions and sexual behaviors after HPV vaccination is that risk perceptions related to vaccination are not a salient enough factor in an adolescent's decision-making process to affect sexual behaviors. Previous research has demonstrated that there are numerous contributing factors to adolescents' decisions about sexual intercourse and condom use. These include individual factors such as adolescent psychosocial characteristics, attitudes and beliefs, as well as contextual factors such as family structure, peer and romantic relationships, peer norms, and media exposure.[22–24] Beliefs about reduced risk after HPV vaccination simply may not play an important enough role to influence sexual behaviors, in the context of these more significant factors. In addition, the theory of risk homeostasis was developed in the area of road safety research and through studies conducted largely in adult populations.[10,25] This theory may not be applicable to adolescent sexual behaviors in that youth may not evaluate risk in the same ways as adults. Social norms, adolescent egocentrism, unrealistic optimism, decreased perceived vulnerability, and bias from lack of experience with negative health outcomes may all play a role in the evaluation of risk in adolescents.[26,27] Although it is currently unknown what effect each of these factors may have on the overall perception of risk by adolescents, it is possible that any of these characteristics may alter the way in which adolescents perceive risk, view negative health outcomes, and evaluate their degree of participation in risky behavior.

These findings contribute to the growing literature suggesting that HPV vaccination is unlikely to alter sexual risk behaviors in young women. Some investigators have reported that adolescents anticipate their sexual behaviors will change after receiving the HPV vaccine[7,28]: in 1 study, 16.9% of adolescent girls reported that they would be more likely to have sex after HPV vaccination, and 8.4% reported that they would be more likely to have unprotected sex.[28] However, despite these predicted changes in sexual behaviors, likely influenced by risk perceptions, studies have shown no change in actual sexual behaviors after HPV vaccination.[18,29,30] A recent longitudinal study examining behaviors after HPV vaccination found that vaccinated, compared with unvaccinated, adolescents were not more likely to initiate sex or participate in risky sexual behaviors after vaccination.[29] In addition, a large retrospective study using electronic medical records demonstrated no significant increase in pregnancy, STI testing or diagnosis, or contraceptive counseling among HPV-vaccinated young women.[30]

Our finding that inappropriate risk perceptions are not associated with sexual behaviors after HPV vaccination, combined with previous evidence that sexual behaviors do not change after HPV vaccination, has important clinical implications. Current HPV vaccination uptake rates are suboptimal: from 2010 to 2012, HPV vaccination coverage among 13-to 17-year-old girls increased from only 48.7% to 53.8% for at least 1 dose, and from only 32.0% to 33.4% for at least 3 doses.[31] One contributing factor to these relatively low vaccination rates is parental or clinician concern that vaccination may lead to changes in risk perceptions and riskier sexual behaviors.[9,28,32,33] Beliefs among providers and parents that adolescents who are vaccinated may practice riskier sexual behaviors may adversely impact provider recommendations for HPV vaccines and parental agreement for their child to be vaccinated, both key factors driving vaccine uptake. In a survey conducted among parents of 10- to 15-year-olds, 24% of parents opposed to the HPV vaccine believed it would promote earlier sexual initiation, compared with 9% of parents supportive of vaccination ($P = .003$).[34] Parental concerns may also present a barrier to clinician recommendations. A substantial proportion of pediatricians and family physicians who participated in 2 national survey studies and a qualitative study we conducted believed parents would be concerned about riskier sexual behaviors in vaccinated adolescents, and further reported that parental concerns would represent a barrier to their recommending HPV vaccines.[8,35,36] In another study conducted among Texas physicians, 46% reported that parental concern that HPV vaccination would lead to riskier sexual behaviors was a barrier to recommending the vaccine.[37] Data demonstrating that HPV vaccination does not lead to riskier behaviors may allow clinicians to provide accurate, evidence-based information to address parental concerns and thereby increase vaccination rates.

This study had several limitations, including the possibility that there was not sufficient power to detect associations of a smaller magnitude between risk perceptions and behaviors. Sexual behaviors were self-reported, possibly

limiting their validity. Although those who returned at 2 and 6 months did not differ from those who did not return in terms of race, ethnicity, sexual behaviors, and risk perceptions, we cannot exclude the possibility that those who did not return may have practiced riskier behaviors. Given that the study was intentionally designed to be conducted in the context of a real-world clinical setting, it is not possible for us to determine the impact of specific prevention messages on risk perceptions and subsequent behaviors. Another limitation is that we did not assess oral sexual behaviors after vaccination; thus, we were unable to assess whether oral sexual behaviors changed after vaccination because sex was defined as vaginal or anal. Finally, the study was conducted in a study population comprised predominantly of low-income adolescents, the majority of whom were black, which could limit generalizability.

CONCLUSIONS

Education to prevent misperceptions about risk after HPV vaccination is important and may promote safer sexual behaviors. However, this study provides reassuring evidence that changes in risk perceptions after vaccination are not associated with riskier sexual behaviors, providing additional support for the increasing evidence that HPV vaccination does not lead to changes in sexual behaviors among adolescents.

REFERENCES

1. Dunne EF, Unger ER, Sternberg M, et al. Prevalence of HPV infection among females in the United States. *JAMA*. 2007;297(8):813–819
2. Garland SM, Hernandez-Avila M, Wheeler CM, et al; Females United to Unilaterally Reduce Endo/Ectocervical Disease (FUTURE) I Investigators. Quadrivalent vaccine against human papillomavirus to prevent anogenital diseases. *N Engl J Med*. 2007;356(19):1928–1943
3. Muñoz N, Kjaer SK, Sigurdsson K, et al. Impact of human papillomavirus (HPV)-6/11/16/18 vaccine on all HPV-associated genital diseases in young women. *J Natl Cancer Inst*. 2010;102(5):325–339
4. Lehtinen M, Paavonen J, Wheeler CM, et al; HPV PATRICIA Study Group. Overall efficacy of HPV-16/18 AS04-adjuvanted vaccine against grade 3 or greater cervical intraepithelial neoplasia: 4-year end-of-study analysis of the randomised, double-blind PATRICIA trial. *Lancet Oncol*. 2012;13(1):89–99
5. 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). *MMWR Morb Mortal Wkly Rep*. 2010;59(20):626–629
6. Centers for Disease Control and Prevention (CDC). Recommendations on the use of quadrivalent human papillomavirus vaccine in males—Advisory Committee on Immunization Practices (ACIP), 2011. *MMWR Morb Mortal Wkly Rep*. 2011;60(50):1705–1708
7. Brabin L, Roberts SA, Stretch R, et al. A survey of adolescent experiences of human papillomavirus vaccination in the Manchester study. *Br J Cancer*. 2009;101(9):1502–1504
8. Kahn JA, Zimet GD, Bernstein DI, et al. Pediatricians' intention to administer human papillomavirus vaccine: the role of practice characteristics, knowledge, and attitudes. *J Adolesc Health*. 2005;37(6):502–510
9. Kahn JA, Ding L, Huang B, Zimet GD, Rosenthal SL, Frazier AL. Mothers' intention for their daughters and themselves to receive the human papillomavirus vaccine: a national study of nurses. *Pediatrics*. 2009;123(6):1439–1445
10. Wilde GJ. Risk homeostasis theory: an overview. *J Int Soc Child Adolesc Inj Prev*. 1998;4(2):89–91
11. Chesney MA, Chambers DB, Kahn JO. Risk behavior for HIV infection in participants in preventive HIV vaccine trials: a cautionary note. *J Acquir Immune Defic Syndr Hum Retrovirol*. 1997;16(4):266–271
12. Ostrow DE, Fox KJ, Chmiel JS, et al. Attitudes towards highly active antiretroviral therapy are associated with sexual risk taking among HIV-infected and uninfected homosexual men. *AIDS*. 2002;16(5):775–780
13. Vanable PA, Ostrow DG, McKirnan DJ. Viral load and HIV treatment attitudes as correlates of sexual risk behavior among HIV-positive gay men. *J Psychosom Res*. 2003;54(3):263–269
14. Wilson TE, Gore ME, Greenblatt R, et al. Changes in sexual behavior among HIV-infected women after initiation of HAART. *Am J Public Health*. 2004;94(7):1141–1146
15. Stolte IG, Dukers NH, Geskus RB, Coutinho RA, de Wit JB. Homosexual men change to risky sex when perceiving less threat of HIV/AIDS since availability of highly active antiretroviral therapy: a longitudinal study. *AIDS*. 2004;18(2):303–309
16. Crepaz N, Hart TA, Marks G. Highly active antiretroviral therapy and sexual risk behavior: a meta-analytic review. *JAMA*. 2004;292(2):224–236
17. van der Snoek EM, de Wit JB, Mulder PG, van der Meijden WI. Incidence of sexually transmitted diseases and HIV infection related to perceived HIV/AIDS threat since highly active antiretroviral therapy availability in men who have sex with men. *Sex Transm Dis*. 2005;32(3):170–175
18. Cummings T, Zimet GD, Brown D, et al. Reduction of HPV infections through vaccination among at-risk urban adolescents. *Vaccine*. 2012;30(37):5496–5499
19. Zimet GD, Rosberger Z, Fisher WA, Perez S, Stupiansky NW. Beliefs, behaviors and HPV vaccine: correcting the myths and the misinformation. *Prev Med*. 2013;57(5):414–418
20. Mullins TL, Zimet GD, Rosenthal SL, et al. Adolescent perceptions of risk and need for safer sexual behaviors after first human papillomavirus vaccination. *Arch Pediatr Adolesc Med*. 2012;166(1):82–88
21. Kahn JA, Xu J, Zimet GD, et al; Adolescent Trials Network for HIV/AIDS Interventions.

Risk perceptions after human papillomavirus vaccination in HIV-infected adolescents and young adult women. *J Adolesc Health*. 2012;50(5):464–470

22. Widdice LE, Cornell JL, Liang W, Halpern-Felsher BL. Having sex and condom use: potential risks and benefits reported by young, sexually inexperienced adolescents. *J Adolesc Health*. 2006;39(4):588–595
23. Buhi ER, Goodson P. Predictors of adolescent sexual behavior and intention: a theory-guided systematic review. *J Adolesc Health*. 2007;40(1):4–21
24. DiClemente RJ, Crittenden CP, Rose E, et al. Psychosocial predictors of HIV-associated sexual behaviors and the efficacy of prevention interventions in adolescents at-risk for HIV infection: what works and what doesn't work? *Psychosom Med*. 2008;70(5):598–605
25. Wilde G. The theory of risk homeostasis: implications for safety and health. *Risk Anal*. 2006;2(4):209–225
26. Greening L, Stoppelbein L, Chandler CC, Elkin TD. Predictors of children's and adolescents' risk perception. *J Pediatr Psychol*. 2005;30(5):425–435
27. Cohn LD, Macfarlane S, Yanez C, Imai WK. Risk-perception: differences between adolescents and adults. *Health Psychol*. 1995;14(3):217–222
28. Marlow LA, Forster AS, Wardle J, Waller J. Mothers' and adolescents' beliefs about risk compensation following HPV vaccination. *J Adolesc Health*. 2009;44(5):446–451
29. Forster AS, Marlow LA, Stephenson J, Wardle J, Waller J. Human papillomavirus vaccination and sexual behaviour: cross-sectional and longitudinal surveys conducted in England. *Vaccine*. 2012;30(33):4939–4944
30. Bednarczyk RA, Davis R, Ault K, Orenstein W, Omer SB. Sexual activity-related outcomes after human papillomavirus vaccination of 11- to 12-year-olds. *Pediatrics*. 2012;130(5):798–805
31. Centers for Disease Control and Prevention (CDC). Human papillomavirus vaccination coverage among adolescent girls, 2007-2012, and postlicensure vaccine safety monitoring, 2006–2013 - United States. *MMWR Morb Mortal Wkly Rep*. 2013;62(29):591–595
32. Daley MF, Liddon N, Crane LA, et al. A national survey of pediatrician knowledge and attitudes regarding human papillomavirus vaccination. *Pediatrics*. 2006;118(6):2280–2289
33. Friedman AL, Shepeard H. 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*. 2007;34(3):471–485
34. Davis K, Dickman ED, Ferris D, Dias JK. Human papillomavirus vaccine acceptability among parents of 10- to 15-year-old adolescents. *J Low Genit Tract Dis*. 2004;8(3):188–194
35. Tissot AM, Zimet GD, Rosenthal SL, Bernstein DI, Wetzel C, Kahn JA. Effective strategies for HPV vaccine delivery: the views of pediatricians. *J Adolesc Health*. 2007;41(2):119–125
36. Riedesel JM, Rosenthal SL, Zimet GD, et al. Attitudes about human papillomavirus vaccine among family physicians. *J Pediatr Adolesc Gynecol*. 2005;18(6):391–398
37. Kahn JA, Cooper HP, Vadaparampil ST, et al. Human papillomavirus vaccine recommendations and agreement with mandated human papillomavirus vaccination for 11-to-12-year-old girls: a statewide survey of Texas physicians. *Cancer Epidemiol Biomarkers Prev*. 2009;18(8):2325–2332

(Continued from first page)

www.pediatrics.org/cgi/doi/10.1542/peds.2013-2822

doi:10.1542/peds.2013-2822

Accepted for publication Dec 9, 2013

Address correspondence to Jessica Kahn, Division of Adolescent Medicine, Cincinnati Children's Hospital Medical Center, MLC 4000, 3333 Burnet Ave, Cincinnati, OH 45229. E-mail: jessica.kahn@cchmc.org

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: Dr Zimet and Dr Rosenthal have received investigator-initiated grants from Merck, and Dr Zimet has received an unrestricted program development grant from GlaxoSmithKline. Dr Kahn has served as co-chair of 2 clinical trials of HPV vaccines in HIV-infected individuals: the trials are funded by NIH but immunogenicity testing and HPV vaccines are provided by Merck. The remaining authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: This study was supported through National Institutes of Health (NIAID) grant R01 073713 (Principal Investigator, Jessica Kahn, MD, MPH) and Medical Student Summer Research Program Training grant T35 DK 060444 (J Heubi, Principal Investigator). Funded by the National Institutes of Health.

POTENTIAL CONFLICT OF INTEREST: Dr Kahn chaired a grant review committee for the Society for Adolescent Health and Medicine evaluating public health demonstration project proposals to improve adolescent vaccination; grant funding for this program was from Merck, Inc. The remaining authors have indicated they have no potential conflicts of interest to disclose.