

Adolescent Perceptions of Risk and Need for Safer Sexual Behaviors After First Human Papillomavirus Vaccination

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Objectives: To (1) examine perceptions of risk of human papillomavirus (HPV) and other sexually transmitted infections (STIs), (2) examine perceived need for safer sexual behaviors, and (3) determine factors associated with less perceived need for safer sexual behaviors, all in the context of receiving the first HPV vaccination.

Design: Cross-sectional baseline analysis from an ongoing longitudinal cohort study.

Setting: An urban hospital-based adolescent primary care clinic.

Participants: Girls 13 to 21 years (for this article girls are defined as being aged 13 to 21 years) (n=339) receiving their first HPV vaccination and their mothers (n=235).

Main Outcome Measures: (1) Girls' perceived risk of HPV after HPV vaccination, (2) girls' perceived risk of other STIs after vaccination, (3) girls' perceived need for continued safer sexual behaviors after vaccination, and

(4) factors associated with girls' perception of less need for safer sexual behaviors.

Results: Mean age of girls was 16.8 years. Most participants (76.4%) were black, and 57.5% were sexually experienced. Girls perceived themselves to be at less risk for HPV than for other STIs after HPV vaccination ($P < .001$). Although most girls reported continued need for safer sexual behaviors, factors independently associated with perception of less need for safer sexual behaviors included adolescent factors (lower HPV and HPV vaccine knowledge and less concern about HPV) and maternal factors (lower HPV and HPV vaccine knowledge, physician as a source of HPV vaccine information, and lack of maternal communication about the HPV vaccine).

Conclusions: Few adolescents perceived less need for safer sexual behaviors after the first HPV vaccination. Education about HPV vaccines and encouraging communication between girls and their mothers may prevent misperceptions among these adolescents.

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HUMAN PAPILLOMAVIRUS (HPV) is the most common sexually transmitted infection (STI) in the United States, with a prevalence of 29.5% in sexually experienced girls aged 14 to 19 years.¹ Sequelae of HPV infection may include genital warts, cervical dysplasia, and, with long-term viral persistence, cervical cancer. In 2006, the US Federal Drug Administration licensed the first prophylactic HPV vaccine.² This quadrivalent vaccine, which induces immunity to 2 HPV types associated with genital warts (HPV-6 and HPV-11) and 2 HPV types associated with cervical cancer (HPV-16 and HPV-18), is recommended for girls aged 11 to 12 years, with catch-up immunization to age 26 years.³ A bivalent prophylactic HPV vaccine, which induces immunity to HPV-16 and HPV-18, was licensed in 2009. Although the quadriva-

lent vaccine provides protection against HPV, it does not confer immunity to other STIs nor does it alter the natural history of any prevalent HPV infection.

Concerns have been raised that adolescents may perceive themselves to be at less risk for HPV or other STIs after HPV vaccination and, thus, may participate in riskier sexual behaviors.⁴ Studies examining attitudes and behaviors in the context of human immunodeficiency virus (HIV) vaccines⁵⁻⁷ and treatment^{8,9} show conflicting results in terms of whether participants perceive themselves to be at less risk for HIV infection and practice riskier behaviors after these interventions. However, behavioral responses to HIV prevention and treatment may not be applicable to HPV vaccination. In addition, although some adolescents may believe that there is a reduced risk of STI acquisition and less need for safer sexual behaviors after HPV vacci-

nation, others may receive counseling at the time of vaccination that clarifies the specific benefits of vaccination and reinforces the importance of practicing safer sexual behaviors after vaccination. Although there has been speculation about the potential attitudinal and behavioral impact of HPV vaccination,^{4,10-12} to our knowledge, no studies have examined adolescent attitudes and risk perceptions after HPV vaccination.

Because there has been significant uptake of the HPV vaccine, it is critical to understand whether vaccination impacts adolescent risk perceptions, which may in turn affect sexual behaviors. To design interventions to prevent adverse behavioral consequences of vaccination, it is important to identify factors associated with misperceptions, which may include adolescent and parental knowledge and attitudes.¹³⁻¹⁵ The objectives of this study were to (1) examine perceptions of risk of HPV and other STIs, (2) examine perceived need for safer sexual behaviors, and (3) determine factors associated with less perceived need for safer sexual behaviors, all in the context of receiving the first HPV vaccination. The study's primary hypotheses were that (1) adolescent girls would report lower perception of risk of HPV infection after vaccination compared with risk of other STIs and (2) factors associated with perception of less need for safer sexual behaviors would include adolescent factors (age, lower HPV and HPV vaccine knowledge, no history of STIs or abnormal Papanicolaou test results, and less maternal communication about Papanicolaou testing) and maternal factors (lower HPV and HPV vaccine knowledge, no history of abnormal Papanicolaou test results, and less communication with adolescent about Papanicolaou testing and sexual behavior).

METHODS

This study reports baseline findings from an ongoing longitudinal cohort study examining the long-term attitudinal and behavioral impact of HPV vaccination in adolescent girls. Participants were consecutively recruited from an urban hospital-based adolescent primary care office. Eligible participants were aged 13 to 21 years (for this article, girls are defined as being aged 13 to 21 years), had received their first voluntary HPV vaccination within 2 days of study enrollment, and were willing to participate in a 30-month study. Mothers or female legal guardians (hereafter referred to as "mothers") of participants were invited to enroll. The study received approval from the Institutional Review Board of the Cincinnati Children's Hospital Medical Center.

Clinicians approached eligible participants to assess interest in the study. Interested adolescents met with research personnel, who obtained consent from participants who were 18 years or older or, for younger participants, maternal consent and participant assent. Mothers provided separate consent for their own enrollment and could decline participation independent of the participation of their daughter. Adolescents and mothers completed self-administered paper-and-pencil surveys, and all the participants received a \$15 gift card as compensation.

Survey constructs were derived from models of health behavior, including the Theory of Planned Behavior and the Health Belief Model.^{16,17} These models have been useful in examining other aspects of adolescent health behavior.^{18,19} Specific items and scales assessing knowledge and attitudes were adapted from previously validated surveys in similar populations²⁰⁻²³ and are listed in **Table 1**. Exploratory factor analysis was performed to evaluate factor loading for each construct. Cronbach α val-

ues for predictor variable scales for girls ranged from .56 to .96 and for mothers ranged from .56 to .86. Scale items were each measured using a 5-point Likert scale, and scale scores were created by calculating the mean response to scale items. The 3 outcome variables—perceived risk of HPV, perceived risk of other STIs, and perceived need for safer sexual behaviors (such as consistent condom use and having fewer partners)—were each assessed using a 5-item scale, with each item measured using a 10-point visual analog scale from "strongly disagree" to "strongly agree." A mean scale score was calculated for each of the 3 perception scales (possible range, 0-10). These outcome scales were adapted from scales used in studies of HIV/AIDS risk perceptions and HIV treatment attitudes.^{9,24,25} Details regarding the outcome scales are summarized in Table 1. Cronbach α values for the outcome scales ranged from .54 to .62. The relatively low Cronbach α values for some predictor and outcome scales may be due to low variability in responses.

Descriptive analyses were performed to examine participant characteristics and the outcomes, that is, risk perceptions. The outcome for regression modeling, perceived need for safer sexual behaviors, was dichotomized into those in the lowest tertile of risk scores (lowest perceived need for safer sexual behaviors) vs those in the top 2 tertiles (highest perceived need for safer sexual behaviors). The distribution of responses to items assessing perceived need for safer sexual behaviors was significantly skewed in the direction of more perceived need for safer sexual behaviors (median scale score of 9.0, skewness of -1.1). Responses were dichotomized as described to examine predictors of low perceived need for safer sexual behaviors. Univariable logistic regression modeling was used to examine relationships between adolescent predictor variables (including demographics, reproductive health history, and attitudes) and perceived need for safer sexual behaviors. Univariable logistic regression models were used to examine associations between maternal factors and adolescent perception of less need for safer sexual behaviors. Predictor variables for adolescents and mothers that were significant at $P < .10$ in univariable analyses were then entered into separate multivariable logistic regression models to determine adolescent factors (model 1) and maternal factors (model 2) that were independently associated with adolescent perception of less need for safer sexual behaviors. A final model (model 3) was created to assess all predictor variables for adolescents and mothers that were significant at $P < .10$ in univariable analyses to determine overall factors associated with adolescent perception of less need for safer sexual behaviors.

RESULTS

GIRLS: UNIVARIABLE AND MULTIVARIABLE MODELS

Overall, 406 girls were approached for enrollment; 339 (83.5%) agreed to participate. Girls who enrolled did not differ from girls who declined enrollment with respect to age, race, and ethnicity. However, girls who declined enrollment were more likely than girls who enrolled to lack health insurance (8.6% vs 0%) and were less likely to have public insurance (62.1% vs 74.9%). The mean age of enrolled girls was 16.8 years, and most were black (**Table 2**).

The primary outcome measures were scales assessing perceived risk of HPV, perceived risk of other STIs, and perceived need for safer sexual behaviors. Each scale had a possible mean scale score of 0 to 10, with lower numbers indicating lower perceived risk of HPV/STI and less need for safer sexual behaviors. Mean scale scores (range)

Table 1. Survey Scales: Outcome and Predictor Variables

Scale	Cronbach α ^a	No. of Items
Girls		
Outcomes		
Perceived risk of HPV after vaccination ^b	0.62	5
Perceived risk of other STI after vaccination ^c	0.55	5
Perceived need for safer sexual behaviors after vaccination ^d	0.54	5
Constructs		
HPV and HPV vaccine knowledge	NA	13
Barriers to HPV vaccination ^e		
Practical barriers to HPV vaccination	0.72	5
Barriers related to HPV vaccine safety	0.74	4
Barriers related to HPV knowledge	0.88	2
Fear of vaccinations	0.83	4
Benefits of HPV vaccination ^e		
Benefits related to safety of HPV vaccine	0.80	3
Benefits related to protection against cervical cancer and genital warts	0.60	2
Normative beliefs about HPV vaccination	0.72	4
Perceived risk of HPV ^e		
Concern about HPV infection	0.56	3
Susceptibility to HPV-related disease	0.75	2
Severity of HPV infection	0.76	2
Severity of HPV-related disease	0.84	2
Maternal attitude toward adolescent sexual behavior	0.84	5
HPV-related stigma	0.96	21
Clinician communication with adolescent about HPV vaccine	NA	7
Mothers		
Constructs		
HPV and HPV vaccine knowledge	NA	13
Barriers to HPV vaccination ^e		
Practical barriers to HPV vaccination	0.74	5
Barriers related to HPV vaccine safety	0.84	4
Barriers related to HPV knowledge	0.86	2
Daughter's fear of vaccinations	0.80	4
Benefits of HPV vaccination ^e		
Benefits related to safety of HPV vaccine	0.71	3
Benefits related to protection against cervical cancer and genital warts	0.56	2
Normative beliefs about HPV vaccination	0.73	4
Perceived risk of HPV for daughter ^e		
Concern about daughter acquiring HPV	0.58	3
Daughter's susceptibility to HPV-related disease	0.72	2
Severity of HPV infection for daughter	0.74	2
Severity of HPV-related disease for daughter	0.76	2
Maternal attitude toward adolescent sexual behavior	0.80	5
Maternal communication with daughter about HPV vaccine	NA	7

Abbreviations: HPV, human papillomavirus; NA, not applicable; STI, sexually transmitted infection.

^aItems included in constructs with Cronbach α values of "NA" were summed to create an index score reflecting the number of correct knowledge items or the number of endorsed communication items.

^bThe specific 5 items composing this outcome were as follows: "After getting vaccinated (the shot) against HPV. . . (1) I am less worried about getting HPV; (2) I am still just as concerned about getting HPV; (3) I think getting HPV will be less of a problem; (4) I am less worried that one of my sexual partners could get HPV from me; and (5) There is less of a chance that I will get HPV than there used to be."

^cThe specific 5 items composing this outcome were as follows: "After getting vaccinated (the shot) against HPV. . . (1) I am less worried about getting a sexually transmitted infection or disease (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."

^dThe specific 5 items composing this outcome were as follows: "After getting vaccinated (the shot) against HPV. . . (1) I think that condom use during sex is less necessary; (2) I feel it is still just as important to have as few sexual partners as possible; (3) I feel that 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 condoms every time I have sex; and (5) I will be less worried about having unprotected sex."

^eAll the scales were analyzed individually in univariable and multivariable analyses. No scales were combined for analysis.

for these 3 risk perception scales were as follows: risk of HPV, 5.0 (0-10); risk of other STIs, 6.1 (0-10); and need for safer sexual behaviors, 8.5 (3.1-10). Half of the girls (50.7%) had a mean scale score of 9 or higher for perceived need for safer sexual behaviors, which correlates with the highest 10% of possible scores for that scale. For perceived need for safer sexual behaviors, only 3.8% of girls

had a mean scale score lower than 5. For perceived risk of STIs, 23.6% of girls had a mean scale score lower than 5. Overall, girls perceived themselves to be at less risk for HPV than for other STIs (paired *t* test, *P* < .001).

Univariable logistic regression analyses demonstrated that several adolescent factors were associated with perception of less need for safer sexual behaviors (*P* < .05), in-

Table 2. Participant Characteristics

Characteristic	Value
Girls	
Age, mean (SD) [range], y	16.8 (2.5) [13.0-21.9]
Race, No. (%) ^a	
Black	259 (76.4)
White	56 (16.5)
Other	24 (7.1)
Have health insurance, No. (%)	284 (83.8)
History of abnormal Papanicolaou test results, No. (%) ^b	45 (29.8)
Ever sexually active, No. (%)	195 (57.5)
Any history of STI, No. (%) ^c	105 (53.8)
Used condoms at last intercourse ^c	115 (59.0)
HPV and HPV vaccine knowledge score, mean (SD) ^d	5.3 (2.6)
Mothers^e	
Age, mean (SD) [range], y	41.0 (8.3) [27.3-72.3]
Race, No. (%) ^a	
Black	172 (73.2)
White	50 (21.3)
Other	13 (5.5)
Education, No. (%)	
High school diploma or less	125 (53.2)
Some college or more	110 (46.8)
History of abnormal Papanicolaou test result, No. (%)	97 (41.3)
Any history of STI, No. (%)	100 (42.6)
HPV and HPV vaccine knowledge score, mean (SD) ^d	6.9 (2.6)

Abbreviations: HPV, human papillomavirus; STI, sexually transmitted infection.

^aCalculated as the number of girls with a history of an abnormal Papanicolaou test (n=45) divided by the number of girls who had ever had a Papanicolaou test (n=151).

^bCalculated as the number of girls with a history of a sexually transmitted infection (n=105) divided by the number of girls who were ever sexually active (n=195).

^cFor analyses, black and other race were combined.

^dThe total possible score ranged from 0 to 13.

^eIncludes mothers and female legal guardians.

cluding knowledge, attitudes, behavioral factors, and source of HPV vaccine information (**Table 3**). Contrary to the hypotheses, age, adolescent report of maternal communication regarding Papanicolaou testing, and history of STIs or abnormal Papanicolaou test results were not associated with perception of need for safer sexual behaviors. Multi-variable logistic regression models demonstrated that lower HPV and HPV vaccine knowledge, less concern about HPV infection, lack of condom use at last intercourse with male main partner, no lifetime alcohol use, and teacher serving as a source of HPV vaccine information were independently associated with perception of less need for safer sexual behaviors (Table 3).

MOTHERS: UNIVARIABLE AND MULTIVARIABLE MODELS

Overall, 235 mothers completed the survey. The most common reasons that mothers did not participate included daughter not wanting mother included (23.2%), daughter not living with mother (13.1%), staff inability

Table 3. Adolescent Variables Associated With Girls' Perception of Less Need for Safer Sexual Behaviors: Results of Unadjusted and Adjusted Logistic Regression Models (Model 1; n=339)

Variable	OR (95% CI)	
	Unadjusted ^a	Adjusted ^b
Lower HPV and HPV vaccine knowledge ^c	1.27 (1.15-1.39) ^d	1.29 (1.16-1.43) ^d
Less concern about HPV infection ^e	2.21 (1.59-3.07) ^d	1.87 (1.31-2.66) ^d
Less positive attitudes toward immunizations ^e	1.30 (1.05-1.60) ^d	
Less positive normative beliefs toward HPV vaccine ^e	2.02 (1.40-2.92) ^d	
More practical barriers to HPV vaccine ^e	2.10 (1.48-2.98) ^d	
Fewer vaccine safety benefits of HPV vaccine ^e	1.54 (1.10-2.15) ^d	
Less perceived severity of HPV infection ^e	1.34 (1.01-1.78) ^d	
Greater perceived susceptibility to cervical cancer and genital warts ^e	1.29 (1.03-1.62) ^d	
Unsure of getting next Papanicolaou test	1.69 (1.09-2.63) ^d	
Provider did not talk about getting HPV vaccine	2.36 (1.03-5.42) ^d	
No lifetime alcohol use	1.97 (1.27-3.06) ^d	1.84 (1.11-3.08) ^d
Did not use DMPA as contraceptive method at last intercourse (vs used DMPA)	2.29 (1.01-5.19) ^d	
No condom use at last intercourse with main partner (vs condom use)	2.26 (1.22-4.18) ^d	3.48 (1.71-7.05) ^d
No condom use at last intercourse with main partner (vs not sexually active)	1.47 (0.87-2.48) ^d	2.68 (1.44-4.99) ^d
Father is a source of HPV vaccine information	2.30 (1.03-5.11) ^d	
Religious institution is a source of HPV vaccine information	3.48 (1.05-11.53) ^d	
More safety barriers to HPV vaccine ^c	1.33 (0.96-1.85)	
No contraceptive use at last intercourse	2.05 (0.98-4.29)	
Television is not a source of HPV vaccine information	1.49 (0.94-2.34)	
Teacher is a source of HPV vaccine information	1.67 (0.95-2.94) ^d	2.26 (1.20-4.26) ^d

Abbreviations: DMPA, depot medroxyprogesterone acetate; HPV, human papillomavirus; OR, odds ratio.

^aSignificant at $P < .10$ and were entered into the adjusted logistic regression model.

^bVariables with unadjusted ORs with $P < .10$ were entered into the adjusted model. All nonsignificant variables were removed from the final model.

^cThe HPV and HPV vaccine knowledge scores were calculated as the number of correct responses on the 13-item knowledge scale. Thus, lower HPV and HPV vaccine knowledge indicated fewer correct responses to these knowledge items.

^dSignificant at $P < .05$.

^eThese variables are scales as described in Table 1. Each scale item was measured using a 5-point Likert scale, and mean scale scores were calculated and used in the logistic regression models as continuous variables.

to contact mother (11.9%), and lack of interest (10.7%) or time (10.7%). The mean age of mothers was 41.0 years, and most were black (Table 2).

Univariable logistic regression models demonstrated that several maternal factors were associated with girls' perception of less need for safer sexual behaviors ($P < .05$),

Table 4. Maternal Variables Associated With Girls' Perception of Less Need for Safer Sexual Behaviors: Results of Unadjusted and Adjusted Logistic Regression Models (Model 2; n=235)

Variable	OR (95% CI)	
	Unadjusted ^a	Adjusted ^b
Lower HPV and HPV vaccine knowledge ^c	1.22 (1.09-1.36) ^d	1.23 (1.09-1.38) ^d
High school education or less	1.76 (1.04-2.99) ^d	
More practical barriers to HPV vaccine ^e	2.09 (1.30-3.36) ^d	
Physician is a source of HPV vaccine information	2.01 (1.06-3.80) ^d	3.08 (1.49-6.37) ^d
Not talked to daughter about HPV vaccine	2.04 (1.20-3.46) ^d	2.12 (1.19-3.78) ^d
Unsure about getting next Papanicolaou test	2.12 (1.07-4.19) ^d	
No history of STI	1.78 (1.03-3.06) ^d	
More safety barriers to HPV vaccine ^e	1.45 (0.98-2.14)	
No history of abnormal Papanicolaou test results	1.60 (0.94-2.75)	
Source of HPV vaccine information	2.09 (0.96-4.53)	

Abbreviations: HPV, human papillomavirus; OR, odds ratio; STI, sexually transmitted infection.

^aSignificant at $P < .10$ and were entered into the adjusted logistic regression model.

^bVariables with unadjusted ORs with $P < .10$ were entered into the adjusted model. All nonsignificant variables were removed from the final model.

^cThe HPV and HPV vaccine knowledge scores were calculated as the number of correct responses on the 13-item knowledge scale. Thus, lower HPV and HPV vaccine knowledge indicated fewer correct responses to these knowledge items.

^dSignificant at $P < .05$.

^eThese variables are scales as described in Table 1. Each scale item was measured using a 5-point Likert scale, and mean scale scores were calculated and used in the logistic regression models as continuous variables.

including knowledge, educational attainment, attitudes, and source of HPV vaccine information (**Table 4**). Contrary to the hypotheses, maternal history of an abnormal Papanicolaou test result and maternal communication regarding Papanicolaou testing and sexual behavior were not associated with girls' perception of need for safer sexual behaviors. Multivariable logistic regression models demonstrated that 3 maternal factors were independently associated with girls' perception of less need for safer sexual behaviors: lower HPV and HPV vaccine knowledge, lack of communication with the daughter about the HPV vaccine, and a physician serving as a source of information about the vaccine (Table 4).

GIRLS AND MOTHERS: COMBINED MULTIVARIABLE MODEL

For girls who participated with their mothers, a combined multivariable logistic regression model was performed that included girls' and mothers' variables. This model demonstrated that several factors were independently associated with girls' perception of less need for safer sexual behaviors (**Table 5**). Adolescent factors included lower HPV and HPV vaccine knowledge and less concern

Table 5. Variables Associated With Girls' Perception of Less Need for Safer Sexual Behaviors: Results of a Combined Adjusted Logistic Regression Model Including Girl and Mother Variables (Model 3; n=235)^a

Variable	Adjusted OR (95% CI) ^a
Girls	
Lower HPV and HPV vaccine knowledge ^b	1.17 (1.03-1.33)
Less concern about HPV infection ^c	1.84 (1.19-2.85)
Mothers	
Lower HPV and HPV vaccine knowledge ^b	1.17 (1.04-1.32)
Not talked to daughter about HPV vaccine	2.24 (1.22-4.11)
Physician is a source of information about HPV vaccine	2.46 (1.20-5.05)

Abbreviations: HPV, human papillomavirus; OR, odds ratio.

^aOnly ORs that were significant in the adjusted model ($P < .05$) are included. The model is adjusted for all the variables listed. All the nonsignificant variables were removed from the final model. No significant correlations exist among the variables in the multivariable model.

^bThe HPV and HPV vaccine knowledge scores were calculated as the number of correct responses on the 13-item knowledge scale. Thus, lower HPV and HPV vaccine knowledge indicated fewer correct responses to these knowledge items.

^cThis variable is a scale as described in Table 1. Each scale item was measured using a 5-point Likert scale, and a mean scale score was calculated and used in the logistic regression model as a continuous variable.

about HPV infection. Maternal factors included lower HPV and HPV vaccine knowledge, lack of communication with the daughter about the HPV vaccine, and a physician serving as a source of vaccine information.

COMMENT

We examined adolescent and maternal factors associated with girls' perception of less need for safer sexual behaviors after receipt of their first quadrivalent HPV vaccination. This study is unique because it explores adolescent and maternal factors associated with girls' perception of need for safer sexual behaviors. Understanding factors that affect adolescent risk perceptions after HPV vaccination is critical to developing interventions to modify these risk perceptions.

Adolescent girls receiving their first HPV vaccination perceived themselves to be more protected from HPV than other STIs as a result of vaccination. Few girls perceived less need for safer sexual behaviors, with only 3.8% reporting perceived need for safer sexual behaviors in the lower half of the scale. These findings are consistent with those of a previous study¹⁰ of adolescent predictions of behavior after hypothetical HPV vaccination. The present study provides support that most adolescent girls continue to perceive the importance of safer sexual behaviors after receipt of the first HPV vaccination. Although it is appropriate for girls receiving the vaccine to perceive themselves to be at less risk for HPV after vaccination, it is concerning that a small subset of girls also perceived themselves to be at less risk for other STIs, with 23.6% reporting perceived risk of STIs in the lower half of the scale. Clinicians discussing HPV vaccination with girls and their mothers may need to emphasize the limitations of the vaccine and to spe-

cifically address that the vaccine does not prevent other STIs. Further studies are needed to examine the association between risk perceptions after HPV vaccination and future sexual behavior.

Adolescent factors, including lower HPV and HPV vaccine knowledge, less concern about HPV infection, no condom use at last intercourse with male main partner, no lifetime alcohol use, and obtaining HPV vaccine information from a teacher, were associated with girls' perception of less need for safer sexual behaviors. Similarly, in a study¹⁰ assessing adolescents' anticipated attitudes after receipt of an HPV vaccine, lower HPV knowledge was associated with girls anticipating an increase in their sexual risk behaviors after vaccination. Girls who are less concerned about acquiring HPV infection may be less likely to engage in safer sexual behaviors (including condom use), regardless of vaccination status. Girls who have not used alcohol may perceive themselves to be making healthy decisions and thus may not accurately recognize the risks associated with sexual behavior. The association between a teacher serving as a source of HPV vaccine information and perception of less need for safer sexual behaviors may be due to poor teacher knowledge of the vaccine or adolescent misinterpretation of information conveyed by teachers.

Several maternal factors were independently associated with girls' perception of less need for safer sexual behaviors. Mothers with less knowledge may be counseling their daughters erroneously about the efficacy of the vaccine against HPV or other STIs. This may lead to daughters perceiving greater levels of protection against HPV and other STIs than are actually afforded by the vaccine, thus contributing to perceptions of less need for safer sexual behaviors. Mothers who did not communicate with their daughters about the vaccine may have less positive attitudes toward preventive health behaviors, which may translate into less positive preventive health behaviors, such as safer sexual behaviors, among their daughters. Positive maternal attitudes toward prevention are associated with positive adolescent preventive behaviors, including HPV vaccination.²⁶ Therefore, it is plausible that less positive attitudes toward prevention among mothers may translate into less positive preventive behaviors among their daughters. Maternal report of receiving HPV vaccine information from a physician was associated with girls' perception of less need for safer sexual behaviors. Providers may be giving detailed counseling about vaccine effectiveness, which mothers may have difficulty understanding or conveying to their daughters. Alternatively, providers may be presenting overly simplistic messages about HPV vaccine efficacy or may not be communicating the need for continued safer sexual behaviors after receipt of the vaccine. This, in turn, may lead girls to feel more protected by the vaccine. Further studies are needed to explore the relationship between physician-obtained information and adolescent risk perceptions.

When adolescent and maternal factors were considered simultaneously in a multivariable model, several factors were independently associated with girls' perception of less need for safer sexual behaviors after first HPV vaccination. Lower adolescent and maternal HPV and HPV vaccine knowledge, less adolescent concern about HPV

infection, maternal report of a physician serving as a source of information about the HPV vaccine, and absence of maternal communication with the adolescent regarding the vaccine remained significantly associated with girls' perception of less need for safer sexual behaviors. Educating mothers and daughters about HPV and the HPV vaccine and encouraging communication between them about the vaccine may lead to more accurate risk perceptions on the part of adolescent girls receiving their first HPV vaccination.

This study is subject to several limitations. First, participants were recruited from a single clinic that serves a predominantly low-income urban population, possibly limiting the generalizability of the results. Second, these data are derived from surveys completed by girls after receipt of their first HPV vaccination; no conclusions can be drawn about long-term risk perceptions or the impact of these perceptions on actual sexual behaviors. Third, risk perceptions before HPV vaccination were not assessed; direct comparisons between risk perceptions before and after vaccination are not possible. However, to maximize the likelihood of capturing attitudes related to the vaccine itself, the survey questions were framed in the context of receiving the HPV vaccine. Fourth, the Cronbach α values for the scales measuring outcomes were relatively low in this study sample. However, another study (J.A.K. oral communication, May 16, 2011) yielded higher Cronbach α values for these same scales, supporting the internal consistency reliability of these scales. In addition, Cronbach α values of .5 to .7 can be acceptable for comparisons of scale scores between groups, as is the case in this study.²⁷ Fifth, social desirability bias may have led to higher scale scores on the measure of perceived need for safer sexual behaviors. Sixth, perceived need for Papanicolaou testing after vaccination was not measured. Because adolescents often do not understand what a Papanicolaou test is,²⁸ measuring attitudes about Papanicolaou testing may not be valid. Seventh, we evaluated maternal factors associated with adolescent risk perceptions; these results may not be generalizable to fathers or other caregivers. Despite these limitations, this study provides novel information about risk perceptions in adolescent girls after HPV vaccination and factors associated with perceived need for safer sexual behaviors.

In conclusion, among adolescent girls receiving their first HPV vaccination, most participants appropriately felt more protected from HPV than from other STIs, and most participants reported a continued need to practice safer sexual behaviors. A small subset of adolescents, however, perceived less need for safer sexual behaviors after their first HPV vaccination. Effective educational interventions about HPV and HPV vaccines may need to be developed for adolescents and their mothers to provide factual information about HPV and HPV vaccines, including information about the limitations of vaccine efficacy and the lack of protection from other STIs, and to encourage communication about the vaccine between adolescent girls and their mothers.

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Author Contributions: Drs Mullins and Kahn had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Zimet, Rosenthal, Fortenberry, Bernstein, and Kahn. *Acquisition of data:* Morrow and Kahn. *Analysis and interpretation of data:* Mullins, Zimet, Ding, Shew, and Kahn. *Drafting of the manuscript:* Mullins. *Critical revision of the manuscript for important intellectual content:* Zimet, Rosenthal, Morrow, Ding, Shew, Fortenberry, Bernstein, and Kahn. *Statistical analysis:* Ding. *Obtained funding:* Shew and Kahn. *Administrative, technical, and material support:* Mullins, Morrow, Fortenberry, and Bernstein. *Study supervision:* Zimet and Kahn.

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