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Human Papillomavirus Vaccine-Related Risk Perceptions and Subsequent Sexual Behaviors and Sexually Transmitted Infections among Vaccinated Adolescent Women

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Contributors' Statement Page

Tanya L. K. Mullins: Dr. Mullins analyzed and interpreted the data, drafted the initial manuscript, and approved the final manuscript as submitted.

Gregory Zimet: Dr. Zimet conceptualized and designed the study, critically reviewed and revised the manuscript, and approved the final manuscript as submitted.

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All of the authors have approved the final article.

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Abstract

Objective—To examine the association between risk perceptions after human papillomavirus (HPV) vaccination and sexual behaviors and sexually transmitted infection (STI) diagnosis over 30 months following vaccination.

Methods—Participants included 112 sexually experienced girls aged 13–21 years who were enrolled at the time of first HPV vaccination and completed ≥2 of 4 follow-up visits at 2, 6, 18, 30 months and including 30 months. At each visit, participants completed surveys assessing risk perceptions (perceived need for safer sexual behaviors, perceived risk of STIs other than HPV) and sexual behaviors. STI testing was done at 6, 18, and 30 months. Outcomes were condom use at last intercourse with main male partner, number of sexual partners since last study visit, and STI diagnosis. Associations between risk perceptions and sexual behaviors/STIs were examined using generalized linear mixed models.

Results—Mean age was 17.9 years; 88% were Black; 49% had a history of STI at baseline. Scale scores for perceived need for safer sexual behaviors did not change significantly over time. Scale scores for perceived risk of STIs other than HPV significantly changed (p=0.027), indicating that girls perceived themselves to be more at risk of STIs other than HPV over 30 months following vaccination. Multivariable models demonstrated that greater perceived need for safer sexual behaviors following vaccination was associated with condom use (p=0.002) but not with number of partners or STI diagnosis. Perceived risk of STIs other than HPV was not associated with the three outcomes.

Conclusions—The finding that perceived risk for STIs other than HPV was not associated with subsequent sexual behaviors or STI diagnosis is reassuring. The association between perceived need for safer sexual behaviors and subsequent condom use suggests that the HPV vaccination visit is an important opportunity to reiterate the importance of safer sexual behaviors to sexually experienced girls.

Keywords

Papillomavirus vaccines; Adolescent; Sexual behavior; Longitudinal study; Survey study; Sexually transmitted infections (STIs)

Introduction

Despite published Advisory Committee on Immunization Practices (ACIP) recommendations for routine prophylactic vaccination against human papillomavirus (HPV) for girls since 2007,[1] overall uptake remains suboptimal.[2] One contributing factor may be concern about the impact of vaccination on sexual behaviors. Concerns have been raised by parents[3–7] and clinicians[8, 9] that some girls who received the HPV vaccine may

incorrectly perceive themselves to be at less risk of sexually transmitted infections (STIs) other than HPV and thus may engage in riskier sexual behaviors.

Risk homeostasis theory proposes that individuals adjust their behavior based on their perceived level of risk of an outcome (risk perceptions) and the level of risk that they are willing to assume.[10, 11] This theory has been used to examine sexual behaviors among people who are at risk of STIs and human immunodeficiency virus (HIV) infection. The theory posits that individuals who perceive that their risk of a negative outcome is low (for example, after receiving a preventive intervention like HPV vaccination) may participate in less safe behaviors.[12, 13] Studies have shown that risk perceptions play an important role in sexual behaviors,[14–16] although studies of sexual behaviors following primary HIV prevention interventions have generally not demonstrated an increase in risky behaviors.[16, 17] Because risk perceptions may influence behavior, it is critical to understand HPV vaccine-related risk perceptions and whether these perceptions impact behavior among adolescent girls who have been vaccinated against HPV.

To our knowledge, no studies have examined longitudinally the association between adolescent risk perceptions at the time of HPV vaccination and subsequent sexual behaviors and STI diagnosis. Data demonstrating that risk perceptions influence subsequent sexual behaviors or STI diagnoses may provide guidance for educational interventions that can be provided at the time of HPV vaccination. Therefore, the aim of the current study was to examine the associations between HPV vaccine-related risk perceptions and subsequent sexual behaviors and STI diagnosis over the 30 months following the first HPV vaccine dose among sexually experienced 13–21 year-old girls. We hypothesized that greater perceived need for safer sexual behaviors and greater perceived risk of STIs other than HPV would be associated with condom use at last sexual intercourse, fewer sexual partners, and fewer STI diagnoses.

Methods

Data for this analysis were drawn from a longitudinal study of 339 13–21 year-old girls, consecutively recruited from an urban, hospital-based adolescent primary care office within 2 days of receipt of their first HPV vaccine dose. Recruitment took place from 2008 to 2010, and participants were followed longitudinally until 2013. Consent was obtained from girls who were 18 years of age or older, and parental permission (in person or by phone) and assent from the girl was obtained for younger girls. Study staff contacted mothers or female legal guardians of all participants to invite them to enroll in the study; mothers provided consent for their participation. The study received approval from the hospital's institutional review board.

Overall, 195 girls were sexually experienced at the baseline visit. Participants eligible for this analysis were the 112 sexually experienced girls who completed the baseline visit, the final 30-month visit, and at least 1 of the 3 intervening visits at 2, 6, and 18 months (i.e. completed at least 3 of 5 study visits, including the first and last study visits). Girls who were eligible for and included in this analysis differed from girls who were not eligible for this analysis by race (fewer white girls [8.0% of girls who were eligible for analysis vs.

15.7% of girls who were not eligible]; more black girls [88.4% of girls who were eligible for the analysis vs. 72.3% who were not eligible]; p=0.012) and reported number of lifetime sexual partners (28% of girls eligible for analysis vs. 14 % of girls not eligible for analysis reported 0–1 sexual partner; p=0.02); there were no significant differences in age, insurance status, reported condom use at last sexual intercourse with main male partner, smoking in the past month, lifetime alcohol use, or reported history of HPV or other STI. At each visit, girls completed self-administered surveys assessing HPV vaccine-related risk perceptions (perceived need for safer sexual behaviors, perceived risk of STIs other than HPV) and interim sexual behaviors. Sixty-two mothers completed surveys in person or by phone at baseline only. Survey constructs were derived from models of health behavior, including the Theory of Planned Behavior[18] and the Health Belief Model.[19] Specific items and scales assessing knowledge and attitudes were adapted from previously validated surveys in similar populations.[20] Primary predictor variables (HPV vaccine-related risk perceptions) were perceived risk of STIs other than HPV and perceived need for safer sexual behaviors, each of which was measured with a scale comprised of 5 items. Risk perceptions scales were adapted from scales measuring HIV/AIDS risk perceptions and HIV treatment attitudes.[21–23] In order to capture risk perceptions related to HPV vaccination, each item was presented in the context of “getting vaccinated (the shot) against HPV” (see Table1, footnotes e and f). Responses to each of the 5 items were measured using a 10-point visual analog scale ranging from “strongly disagree” to “strongly agree”, with a neutral option in the middle of the scale. The mean response to all scale items was calculated, yielding a scale score which could range from 0–10. Higher scale scores indicated lower perceived risk of STIs and less perceived need for safer sexual behaviors; some scale items were reverse scored to maintain this interpretation. Mean scale scores were dichotomized for analysis into top tertile (lowest perceived risk of STIs, lowest perceived need for safer sexual behaviors) vs. lower two tertiles (greater perceived risk of STIs, greater perceived need for safer sexual behaviors) in order to examine the impact of the most risky attitudes on sexual behavior and STI diagnoses. Covariates included participant demographics, substance use (alcohol, marijuana, tobacco), HPV and HPV vaccine knowledge (10 items assessing knowledge of HPV[24] and three items assessing knowledge about the HPV vaccine), and patient reported lifetime history of HPV (including genital warts) or other STI at baseline. Maternal factors that were associated with perceived need for safer sexual behaviors among girls at baseline were entered as covariates as well. These were maternal knowledge about HPV and the HPV vaccine and maternal report of the source of HPV vaccine information (i.e., where mother obtained information about the HPV vaccine) and communication with the daughter about the HPV vaccine.[20] Outcomes were sexual behaviors and laboratory diagnosis of STIs over the 30 months following HPV vaccination, specifically: 1) condom use at last intercourse with main male partner (“condom use”)[25]; 2) number of sexual partners since last study visit (“sexual partners”); and 3) laboratory diagnosis of gonorrhea, chlamydia, and/or trichomonas at any visit (“positive STI testing”). Girls were tested for *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, and *Trichomonas vaginalis* at the 6, 18, and 30 month visits.

Descriptive analyses were performed to examine participant characteristics, HPV vaccine-related risk perceptions, sexual behaviors, and STI diagnosis. Linear mixed effects models

examined changes in HPV vaccine-related risk perceptions (perceived risk of STIs other than HPV and perceived need for safer sexual behaviors after vaccination) over the 30 months of the study. The associations between predictor variables (i.e. perceived risk of other STIs other than HPV, perceived need for safer sexual behaviors), covariates, and sexual behaviors/STI outcomes were examined using generalized linear mixed effects models, which account for time-varying covariates. We examined separate univariable and multivariable models for each of the three outcomes (condom use, number of sexual partners, and positive STI testing). Predictors or covariates that were associated with an outcome at $p<0.10$ in univariable analyses were included in the multivariable mixed model for that outcome, and the variables remaining statistically significant at $p<0.05$ were retained in the final models.

Results

Demographics

For the girls included in this analysis, mean age was 17.9 years (SD 2.2). Nearly 90% of girls were self-reported Black, and 88% were insured. At baseline, 72% of girls reported having more than one male lifetime sexual partner, 54% had used a condom at last sex with their main male partner, and 49% had a history of HPV or another STI (Table 1). Girls whose mothers participated in the study were younger than girls whose mothers did not participate (mean age 16.8 vs. 19.3 years; $p<0.0001$). Over the 30 months of the study, 23–55% of girls reported having more than one sexual partner between study visits, and 37–50% of girls reported condom use with main male partner at last sexual intercourse. At each study visit, nearly 25% of girls had a positive STI test (Table 2).

HPV Vaccine-Related Risk Perceptions

Overall, most girls still perceived themselves to be at risk for STIs other than HPV and perceived a continued need for safer sexual behaviors following HPV vaccination. Mean scale scores at baseline for these risk perception scales were as follows (lower numbers indicate higher perceived risk of STIs other than HPV and higher perceived need for safer sexual behaviors following vaccination): perceived risk of STIs 3.8 out of 10 (SD 1.96) and need for safer sexual behaviors 1.8 out of 10 (SD 1.8) (Table 1). Over the 30 months of the study, scale scores for perceived need for safer sexual behaviors did not change significantly. However, scale scores for perceived risk of STIs other than HPV decreased over time ($p=0.027$), indicating that girls perceived themselves to be more at risk of STIs other than HPV over the 30 months following HPV vaccination. Perceived risk of STIs other than HPV was not associated with having a diagnosed STI at the previous study visit (data not shown).

Factors Associated with Condom Use

Greater perceived need for safer sexual behaviors was associated with girls' use of a condom with main male partner at last sexual intercourse in univariable generalized linear mixed effects models. In contrast, perceived risk of STIs other than HPV was not associated with condom use with main male partner at last sexual intercourse. Covariates associated with condom use in univariable models at $p<0.10$ included younger age, no history of HPV or other STIs at baseline, maternal communication with the daughter about the HPV vaccine,

and having health insurance (Table 3). A multivariable mixed effects model demonstrated that greater perceived need for safer sexual behaviors was independently associated with condom use with the main male partner at last sexual intercourse when covariates were included in the model. Maternal report of communication with her daughter about the HPV vaccine also remained in the model.

Factors Associated with Number of Sexual Partners

Univariable mixed effects models demonstrated that neither perceived need for safer sexual behaviors nor perceived risk of STIs other than HPV was associated with number of sexual partners since the last study visit. Covariates associated with number of sexual partners at $p<0.10$ included older age, history of smoking in the past 30 days, history of marijuana use, history of alcohol use, and history of HPV or other STI at baseline (Table 4). A multivariable mixed effects model demonstrated that older age and smoking in the past 30 days both remained independently associated with greater number of sexual partners since the last study visit.

Factors Associated with Positive Testing for STIs

Univariable mixed effects models demonstrated that neither perceived need for safer sexual behaviors nor perceived risk of STIs other than HPV was associated with positive testing for STIs. Covariates associated with positive STI testing at $p<0.10$ included greater total number of sexual partners, older age, and history of marijuana use (Table 5). Multivariable mixed effects models showed that greater number of lifetime sexual partners remained independently associated with positive STI testing.

Discussion

We examined the associations between HPV vaccine-related risk perceptions and subsequent sexual behaviors and STIs over the 30 months following the first HPV vaccination among 13–21 year-old girls. We found that greater perceived need for safer sexual behaviors was associated in a multivariable model with condom use at last intercourse, but not with number of sexual partners or STI diagnosis, and that perceived risk of STIs was associated with neither sexual behaviors nor STI diagnosis. Although prior studies have examined associations between HPV vaccination and subsequent sexual behaviors and STIs,[26–28] this study is unique because it used individual-level data to examine longitudinally the association between HPV vaccine-related risk perceptions and subsequent sexual behaviors and STIs, and included maternal factors as covariates.

We found that adolescent girls who were sexually experienced at the time of HPV vaccination generally perceived themselves to be at risk of STIs other than HPV and believed that safer sexual behaviors were needed after vaccination. Additionally, rates of condom use remained fairly stable from baseline to 30 months. Prior cohort studies demonstrated no significant differences between vaccinated and unvaccinated girls and women with respect to age of sexual debut[27]; number of sexual partners[27, 29]; testing for or diagnosis of pregnancy or STI[26, 28] and counseling about contraception[26]; condom use[29]; and the proportion of girls who were sexually active.[29] Our previous

study of girls' sexual behaviors in the first 6 months after HPV vaccination found no association between baseline HPV vaccine-related risk perceptions and sexual initiation or subsequent sexual behaviors.[30] Our current findings support and extend the results of these prior studies by 1) examining the association between risk perceptions and subsequent sexual behaviors and STI diagnosis, 2) assessing maternal factors associated with outcomes, and 3) demonstrating that over the 30 months following HPV vaccination, girls continued to perceive a need for safer sexual behaviors and perceived themselves to be *more* at risk of STIs other than HPV.

We examined the associations between risk perceptions after HPV vaccination and three different outcomes - condom use with main male partner at last sexual intercourse, number of sexual partners, and positive testing for STIs controlling for other sociodemographic and behavioral variables. As hypothesized, greater perceived need for safer sexual behaviors was associated with condom use at last sexual intercourse with the main male partner. In order to promote girls' beliefs in the need for safer sexual behaviors post-vaccination, clinicians should educate sexually active girls who are receiving the HPV vaccine about the continued importance of condom use. On the other hand, we did not find evidence supporting an association between perceived risk of STIs after HPV vaccination and girls' reported condom use at last sex. Maternal report of communication about the HPV vaccine was associated with condom use, which suggests that mothers may take the opportunity to discuss safer sexual behaviors when their daughter is being vaccinated against HPV.[31–33] In addition, mothers who discuss HPV vaccination with their daughters may be more likely to play an active role in educating their daughters about STI prevention. Because maternal report of communication with the daughter about the HPV vaccine was associated with condom use, clinicians should also encourage mothers to discuss sexual health topics, including HPV vaccination, with daughters. Such communication may be fostered by educating parents about the HPV vaccine and providing suggestions for how parents might approach sexual health topics with their children, as recommended by clinical care guidelines such as the American Academy of Pediatrics' Bright Futures Guidelines.[34]

Neither of the HPV-vaccine related risk perceptions perceived need for safer sexual behaviors and perceived risk of STIs other than HPV - was associated with number of sexual partners since the last study visit. In our prior analysis of vaccine-related risk perceptions and sexual behaviors in the first 6 months following HPV vaccination, neither perceived risk of STIs other than HPV nor perceived need for safer sexual behaviors was associated with number of partners.[30] Our current results show that this lack of statistically significant association persists for 30 months following vaccination. Covariates that were independently associated with number of sexual partners since the last study visit included older age and recent smoking. Older girls are likely to have a greater number of partners as compared to younger girls as adolescents may accumulate more partners over time.[35] Recent smoking may be a marker for girls who are more likely to participate in riskier behaviors, such as having more sexual partners. Smoking has been associated with earlier onset of sexual activity, greater number of sexual partners, and other risky sexual behaviors.[36, 37]

Neither perceived need for safer sexual behaviors nor perceived risk of STIs other than HPV was associated with positive test results for STIs, providing further evidence that HPV

vaccine-related risk perceptions are not associated with riskier sexual behaviors. We included laboratory diagnosis of an STI as an outcome because this is an objective measure of risky sexual behavior that does not rely on self-report. Total number of sexual partners was the only predictor variable associated with positive STI results. This finding is not unexpected, as a greater number of sexual partners increases one's risk of exposure to STIs and is one of the strongest predictors of STI diagnosis.[38, 39]

This study is subject to several limitations. First, participants were recruited from a medical practice that serves a low-income, urban population, which may limit the generalizability of the findings. Second, social desirability bias may have led to girls reporting higher perceived need for safer sexual behaviors. Third, due to our relatively small sample size, we may have had insufficient statistical power to detect associations between some variables. Fourth, participants who were not eligible for these analyses because they did not complete at least 3 of the 5 study visits may have differed from those who did in terms of sexual behaviors and STI diagnosis. Fifth, no information about risk perceptions is available for these participants prior to their receipt of the first HPV vaccine dose. Therefore, we cannot examine changes between pre- and post-vaccination risk perceptions. Finally, we did not examine the risk perceptions of girls who did not receive the HPV vaccine; therefore, we cannot draw conclusions about differences in risk perceptions of vaccinated vs. unvaccinated girls.

Conclusions

Over 30 months following receipt of the first HPV vaccine dose, most sexually experienced adolescent girls perceived themselves to be at continued risk of STIs other than HPV, and the vast majority of girls reported high perceived need to practice safer sexual behaviors. In general, HPV vaccine-related risk perceptions were not associated with subsequent sexual behaviors or STI diagnosis, which should provide reassurance to clinicians and parents. The finding that greater perceived need for safer sexual behaviors among girls and mothers' communication with daughters about HPV vaccination were associated with condom use implies that clinicians and parents should educate girls about the continued need for safer sexual behaviors after HPV vaccination.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

ACIP	Advisory Committee on Immunization Practices

HPV	human papillomavirus
STIs	sexually transmitted infections

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Highlights

- The majority of girls perceived a need for safer sexual behaviors after vaccination.
- Most girls perceived themselves to be at risk for STIs other than HPV.
- Greater perceived need for safer sexual behaviors was associated with condom use.
- Perceived risk of STIs other than HPV was not associated with sexual behavior or STI.

Table 1

Participant Characteristics and Covariates at Baseline

Characteristic	Number (%)	Mean (SD)
Age		17.9 (2.2)
Race[a]		
Black	99 (88)	
White	9 (8)	
Other	4 (4)	
Have health insurance	98 (88)	
Lifetime number of male sexual partners[b]		
0–1	31 (28)	
2 or more	79 (72)	
Condom use at last sex with main male partner	55 (54)	
Smoking in the past month	19 (17)	
Lifetime history of alcohol use	66 (59)	
Participant reported lifetime history of HPV (including genital warts) or other STI	55 (49)	
HPV and HPV vaccine knowledge score[c]		5.4 (2.6)
Perceived risk of STI other than HPV after HPV vaccination[d,e]		3.8 (2.0)
Perceived need for safer sexual behaviors after HPV vaccination[d,f]		1.8 (1.8)
Maternal HPV and HPV vaccine knowledge score[c]		6.6 (2.7)
Maternal report of communication with daughter about HPV vaccine	29 (47)	
Maternal report that doctor is a source of information about the HPV vaccine	42 (68)	

SD=standard deviation; HPV=human papillomavirus; STI=sexually transmitted infection

[a] Race was self-reported.

[b] Two participants did not answer this question.

[c] The total possible score ranged from 0–13. The scale consisted of 10 items assessing knowledge of HPV [20] and three items assessing knowledge about the HPV vaccine (i.e., need for Pap testing after vaccination, vaccine protects against all cervical cancer, and vaccine protects against all HPV associated with cancer).

[d] For both perceived risk of STI other than HPV and perceived need for safer sexual behaviors, the possible range of mean scale scores was 0–10, with higher scale scores indicate riskier attitudes. For example, a higher mean scale score for perceived risk of STIs indicates lower perceived risk of STIs other than HPV after vaccination, and a higher mean scale score for perceived need for safer sexual behaviors indicates lower perceived need for safer sexual behaviors following HPV vaccination.

[e] Specific items comprising this scale included: “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 other than HPV than there used to be.”

[f] Specific items comprising this scale included: “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.”

Table 2

Sexual Behavior and STI Outcomes over 30 Months[a]

Variable	Baseline N (%)	2 Months	6 Months N (%)	18 Months N (%)	30 Months N (%)
Number of sexual partners since prior study visit		55 (77)	53 (71)	38 (45)	50 (48)
1		14 (20)	20 (27)	22 (26)	26 (25)
2		2 (3)	2 (3)	24 (29)	28 (27)
≥3					
Condom use with main male partner at last sex	55 (54)	41 (61)	44 (60)	37 (46.8)	50 (51.6)
Positive STI results [b]	N/a	N/a	25 (25)	20 (22)	26 (23)
Gonorrhea			3 (3)	1 (1)	2 (2)
Chlamydia			12 (12)	12 (13)	17 (15)
Trichomonas			14 (14)	10 (11)	10 (9)

STI: sexually transmitted infection

[a]Frequencies may not add up to 112; percentages calculated using denominator that is adjusted for missing values. Percentages may not add to 100 due to rounding.

[b]Positive STI testing for *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, and/or *Trichomonas vaginalis*.

Table 3

Predictor variables associated with condom use with main male partner at last sexual intercourse: Results of univariable and multivariable mixed effects models

Variable	Univariable Estimate (standard error)[a,b]	Multivariable Estimate(standard error)[b,c]
Perceived need for safer sexual behaviors (lower 2 tertiles vs. highest tertile)	**0.718 (0.22)**	**0.712 (0.23)**
Maternal report of communication with daughter about HPV vaccine, baseline	**0.752 (0.31)**	**0.744 (0.32)**
Age (years)	**−0.098 (0.05)**	
No history of HPV or other STI, baseline	**0.635 (0.22)**	
Have medical insurance	0.496 (0.28)	

HPV: Human papillomavirus; STI: sexually transmitted infection

[a]Estimates presented are significant at p<0.10 and were entered into the multivariable mixed effects model. Univariable estimates in bold are significant at p<0.05.

[b]Mixed effects model with a spatial power covariance structure.

[c]Estimates in bold were significant in the adjusted model (p<0.05). All non-significant variables were removed from the final model.

Table 4

Predictor variables associated with number of sexual partners since last study visit: Results of univariable and multivariable mixed effects models

Variable	Univariable Estimate (standard error)[a]	Multivariable Estimate (standard error)[b]
Age (years)	**0.051 (0.02)**	**0.044 (0.02)**
No smoking in the past 30 days	**−0.416 (0.10)**	**−0.400 (0.10)**
No marijuana use, lifetime	**−0.261 (0.11)**	
History of alcohol use, lifetime	0.188 (0.11)	
No history of HPV or other STI, baseline	−0.185 (0.11)	

HPV: Human papillomavirus; STI: sexually transmitted infection

[a] Estimates presented are significant at p<0.10 and were entered into the multivariable mixed effects model. Univariable estimates in bold are significant at p<0.05.

[b] Estimates in bold were significant in the adjusted model (p<0.05). All non-significant variables were removed from the final model.

Table 5

Predictor variables associated with positive testing for STI: Results of univariable and multivariable mixed effects models

Variable	Univariable Estimate (standard error)[a,b]	Multivariable Estimate (standard error)[b,c]
Total number of sexual partners	**0.381 (0.10)**	**0.381 (0.10)**
Age (years)	−0.100 (0.06)	
No marijuana use, lifetime	−0.519 (0.31)	

STI: sexually transmitted infection

[a]Estimates presented are significant at p<0.10 and were entered into the multivariable mixed effects model. Univariable estimates in bold are significant at p<0.05.

[b]Mixed effects model with a spatial power covariance structure.

[c]Estimates in bold were significant in the adjusted model (p<0.05). All non-significant variables were removed from the final model.