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Risk Factors for Anogenital Human Papillomavirus Infection in Men

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Abstract

Background—Human papillomavirus (HPV) is strongly associated with cervical and other anogenital cancers. Identification of risk factors for HPV infection in men may improve our understanding of HPV transmission and prevention.

Methods—HPV testing for 37 types was conducted in 463 men 18–40 years old recruited from 2 US cities. The entire anogenital region and semen were sampled. A self-administered questionnaire was completed. Multivariate logistic regression aided the identification of independent risk factors for any HPV type, oncogenic HPV types, and nononcogenic HPV types.

Results—Prevalence was 65.4% for any HPV, 29.2% for oncogenic HPV, and 36.3% for nononcogenic HPV. Factors significantly associated with any HPV were smoking ≥10 cigarettes per day (odds ratio [OR], 2.3 [95% confidence interval {CI}, 1.0–5.3]) and lifetime number of female sex partners (FSPs) (OR for ≥21, 2.5 [95% CI, 1.3–4.6]), and factors significantly associated with oncogenic HPV were lifetime number of FSPs (OR for ≥21, 7.4 [95% CI, 3.4–16.3]) and condom use during the past 3 months (OR for more than half the time, 0.5 [95% CI, 0.3–0.8]). For nononcogenic HPV, a significant association was found for number of FSPs during the past 3 months (OR for ≥2, 2.9 [95% CI, 1.4–6.3]).

Conclusions—Lifetime and recent number of FSPs, condom use, and smoking were modifiable risk factors associated with HPV infection in men.

Human papillomavirus (HPV) infection is the most common sexually transmitted infection and is the necessary cause of cervical cancer. An estimated 6.2 million people in the United States acquired a genital HPV infection in 2000 [1]. Approximately 60 HPV genotypes are known to infect the genital tract, 13 of which are considered to be high risk, or oncogenic [2, 3]. Although infection is most often asymptomatic and transient, oncogenic genotypes of HPV are strongly associated with cervical cancer and are associated to varying degrees with other anogenital cancers in both men and women [4]. Nononcogenic HPV genotypes can

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cause genital warts and other benign lesions; however, many HPV infections are clinically inapparent [5].

Factors associated with prevalent HPV infection in men include current and past sexual behavior, circumcision status, lack of condom use, history of other sexually transmitted infections, race and ethnicity, and education level [6–16]. The strength and significance of the reported associations vary across the populations under examination and depend on whether the outcome analyzed is all HPV types, oncogenic types, or nononcogenic types.

The most consistently reported risk factor for HPV infection in men is a greater lifetime number of female sex partners [8–11, 13, 15], with some studies reporting an association with the recent number of female sex partners [8, 13]. Most studies that have evaluated the association between circumcision and HPV prevalence found a lower prevalence in circumcised men [6, 7, 11–14, 16].

Two studies have found younger age (e.g., 18–24 years old vs. ≥35 years old) to be associated with both oncogenic and nononcogenic HPV infection [13, 14]. A younger age at first sexual intercourse was associated with HPV infection in 1 of 4 studies that examined the association [6, 8–11]. When condom use was evaluated in male HPV prevalence studies, 5 studies found no association with HPV detection [9–12, 15], and 3 found a lower odds of detection associated with condom use [6, 10, 14].

Two prospective studies of HPV in men have reported factors associated with HPV acquisition and persistence. Risk factors for acquisition included anal intercourse with men and having had at least 3 sex partners, whereas protective factors were high socioeconomic status and condom use [11, 17]. Both studies reported that infection with multiple HPV types at baseline was a risk factor for persistent infection, and Lajous et al. reported a protective effect of circumcision on HPV persistence [11, 17].

The present study was conducted to determine the behavioral and health factors associated with HPV detection in the entire anogenital area among asymptomatic men in the United States.

SUBJECTS, MATERIALS, AND METHODS

Study design, clinical sampling, and HPV testing have been described in detail elsewhere [18]. Briefly, a cross-sectional study of HPV infection in 463 men—359 in Tucson, Arizona, and 104 in Tampa, Florida—was completed from 2003 to 2006. Men were eligible if they (1) were between 18 and 40 years old, (2) had had sexual intercourse with a woman within the past year, (3) had no previous diagnosis of genital warts or of penile or anal cancer, (4) had no current penile discharge or pain during urination, and (5) had no current diagnosis of a sexually transmitted disease (STD).

All participants gave written informed consent, and all procedures were approved by the University of Arizona Human Subjects Protection Program, the Centers for Disease Control and Prevention Institutional Review Board, the US Department of Defense, and the University of South Florida Institutional Review Board.

Participants completed a self-administered, scannable questionnaire that included questions on demographic factors (race, ethnicity, age, income, occupation, education, country of origin, and length of US residency); alcohol and tobacco use; age at first sexual intercourse; lifetime number of female sex partners; frequency of sexual intercourse; ever having had sex with a man or having been diagnosed with an STD; and condom use during the past 3 months.

Men collected a semen sample by masturbation 12–36 h before the clinical visit. The study clinician examined each participant's genital, abdominal, and anal areas and recorded the number and location of any lesions or warts. Lesions or warts were sampled by rubbing with a saline-wetted Dacron swab, and samples were stored separately. Because men were excluded if they had been given a diagnosis of genital warts or currently had a STD, very few lesions or warts were detected, and the HPV analysis of these samples is not included in this report. Acetowhitening was not done. The clinician also recorded the presence and location of any erythema, abrasions, rashes, inflammation, discharge, or piercings in the same regions and whether the participant was circumcised. The study clinician used a calcium alginate or Dacron urethral swab to sample the first 2 cm of the urethral epithelium. The clinician sampled other anogenital sites by rubbing separate saline-wetted Dacron swabs over the entire surface of the (1) glans penis/coronal sulcus, (2) penile shaft (including the prepuce, if present), (3) scrotum, and (4) perianal area. The anal canal up to the anal verge was sampled with another saline-wetted Dacron swab. The urethral sample was optional. The urethral and semen samples were eliminated in the third year of the study. Each specimen was evaluated separately for the presence of HPV DNA and human β-globin.

HPV DNA detection and genotyping

All samples were tested in a single laboratory at the H. Lee Moffitt Cancer Center and Research Institute. HPV testing of swabbed cellular material and semen was conducted by polymerase chain reaction (PCR) for amplification of a fragment of the L1 gene [19]. HPV genotyping was conducted using the reverse line blot method [20] on all samples, regardless of HPV PCR result. This detection method uses the HPV L1 consensus PCR products labeled with biotin to detect 37 HPV types. A trend toward increasing prevalence of HPV and increasing detection of β-globin was observed over the first half of the laboratory analysis period and is attributed to improvements in laboratory methods. Laboratory personnel were then cross-trained in a reference laboratory. This time trend was adjusted for by including a dichotomous variable—for before and after cross-training—in the statistical analyses. Between 83.7% and 99.7% of the samples, depending on the anatomic site or specimen sampled, were β-globin positive by PCR and/or genotyping [21].

Definition of HPV outcomes

The oncogenic HPV types associated with cervical dysplasia and cancer detected by the Roche line blot method include 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, and 66 [3]. The nononcogenic types detected by the Roche line blot method are 6, 11, 26, 40, 42, 53–55, 61, 62, 64, 67–73, 81–84, IS39, and CP6108. The presence of any HPV DNA was defined as a positive result by either PCR or genotyping. The absence of any HPV DNA was defined as a negative result by both PCR and genotyping in a sample positive for human β-globin. Samples without detection of β-globin or HPV were deemed to be inadequate for evaluation and were treated as missing. If the sample was positive for HPV by PCR but none of the 37 types was found in genotyping, the HPV type was classified as other or unknown.

A man was classified as having oncogenic infection if any of his samples contained 1 of the 13 oncogenic types, regardless of whether a nononcogenic type was also present. He was considered to have a nononcogenic infection if any of his samples were positive for 1 or more nononcogenic types only or for an unclassified type. The comparison group for all analyses was men who had no HPV detected at any site.

Statistical analysis

Frequencies and means of the responses to questionnaire items and the results from the clinical examination were calculated and compared between men who had no HPV infection at any site or specimen and those who had at least 1 positive HPV result. A *t* test was used to

compare continuous measures and a χ^2 test was used for categorical variables, with a *P* for trend calculated for those categories that were ordinal.

Logistic regression was used to model the associations between various reported or hypothesized risk factors and the outcomes (1) any HPV infection at any site, (2) an oncogenic HPV infection at any site (regardless of whether they also had a nononcogenic infection), and (3) nononcogenic HPV infection at any site (including men who had only nononcogenic infection and those who had unknown or other HPV types). Odds ratios (ORs) were first calculated using logistic regression for each potential risk factor, adjusting for date of laboratory analysis. Next, independent factors were determined by calculating adjusted ORs (AORs). Multivariate modeling used backward-selection logistic regression modeling, starting with the factors that had statistically significant ($P < .10$) ORs in the previous step.

To ensure that 2 or more variables were not included in a single multivariate model so as to cause multicollinearity [22], variance inflation factors (VIFs) were calculated for all variables in each of the 3 candidate multivariate models. A single VIF of 10 or more or a mean VIF of 6 or more for all variables in a model was the criterion used for multicollinearity [23]. No variables in the models presented here reached this criterion. Analyses were conducted using Intercooled Stata for Windows (version 9.1; StataCorp).

RESULTS

Results of recruitment and the demographic characteristics of the study population have been described elsewhere [18]. Three hundred three men (65.4%) were positive for any HPV type, 135 men (29.2%) were positive for at least 1 oncogenic HPV type, and 168 (36.3%) were positive for nononcogenic or unclassified types only. Of those positive for an oncogenic HPV type, 86 (63.7%) also had a nononcogenic HPV type detected. One hundred sixty men (34.6%) had no HPV detected at any site. HPV was more often detected in external genital sites (57.2%) than in anal sites (23.8%). Type-specific HPV prevalence by anatomic site for this study population has been reported elsewhere [18].

Factors associated with any HPV, oncogenic HPV, and nononcogenic HPV at any site in bivariate analyses are presented in tables 1–3. Notably, no sociodemographic characteristics were associated with HPV infection (table 1).

As shown in table 2, current smoking, compared with never smoking, was associated with the detection of any HPV (OR, 1.8 [95% confidence interval {CI}, 1.1–3.1]) and of oncogenic HPV (OR, 2.1 [95% CI, 1.2–3.9]). A similar magnitude of association was observed for detection of nononcogenic HPV (OR, 1.6 [95% CI, 0.9–2.8]), although the association was not statistically significant. A stronger association was observed between smoking 10 or more cigarettes per day (compared with smoking 0–9 cigarettes per day) and each of the 3 HPV outcomes: detection of any HPV (OR, 3.0 [95% CI, 1.4–6.4]), oncogenic HPV (OR, 3.7 [95% CI, 1.6–8.5]), and nononcogenic HPV (OR, 2.4 [95% CI, 1.1–5.6]) (table 2).

Table 2 also shows that, in bivariate analyses, several sexual behavior variables were associated with HPV detection. Factors statistically significantly associated with any HPV infection were increasing lifetime number of female sex partners, number of female sex partners during the past 3 months, and increased frequency of intercourse during the past month and during the past 3 months.

Sexual behavior factors that were associated with oncogenic HPV in bivariate analyses were similar to those associated with any HPV but also included condom use during the past 3

months (table 2). Having oncogenic HPV detected was associated with a higher lifetime number of female sex partners, a greater number of female partners during the past 3 months, and a higher frequency of intercourse during the past month and during the past 3 months. Using condoms at least half the time was associated with a reduced odds of HPV detection (OR, 0.5 [95% CI, 0.3–0.7]).

Table 3 shows the association between HPV detection and STD history, current genital warts, and partners' history of STD or abnormal Pap smear result. A history of STD infection was not associated with current HPV detection. Current presence of genital warts was, however, associated with any HPV (OR, 4.5 [95% CI, 1.0–20.0]) and oncogenic HPV (OR, 6.7 [95% CI, 1.4–31.3]). Also, having had a female sex partner with an abnormal Pap smear result was statistically significantly associated with having oncogenic HPV detected (OR 2.2 [95% CI, 1.1–4.1]).

Multivariate logistic regression modeling revealed that the set of variables that best explained the HPV outcome differed by the HPV category examined (table 4). Factors independently associated with any HPV were smoking 10 or more cigarettes per day (AOR vs. 0–9, 2.3 [95% CI, 1.0–5.3]; $P = .046$) and a greater lifetime number of female sex partners (AOR for ≥21 partners vs. 1–5 partners, 2.5 [95% CI, 1.3–4.6]). The factors independently associated with oncogenic HPV were lifetime number of female sex partners (AOR for ≥21 partners vs. 1–5 partners, 7.4 [95% CI, 3.4–16.3]) and using condoms during vaginal sex at least half the time during the past 3 months (AOR vs. using them less than half the time, 0.5 [95% CI, 0.3–0.8]). The factor independently associated with nononcogenic HPV was having 2 or more female sex partners during the past 3 months (AOR vs. none, 2.9 [95% CI, 1.4–6.3]).

DISCUSSION

Using complete anogenital sampling and HPV type detection, we found sexual history and tobacco use to be associated with HPV detection in asymptomatic men. Consistent condom use was associated with a lower prevalence of HPV.

Smoking was recently identified as a risk factor for HPV detection in men [14], and it has been reported to be associated with the persistence of HPV infection and with anal and penile cancer in men [24, 25]. Kjaer et al. [17] noted that current smoking along with having multiple HPV types or any highrisk HPV type at enrollment were the most important risk factors for HPV persistence in men. In 2 case-control studies, smoking was associated with penile cancer (OR, 4.5 [95% CI, 2.0–10.1]) [25] and anal cancer (OR, 3.9 [95% CI, 1.9–8.0]) [24]. In another case-control study, smoking 11 or more cigarettes per day (vs. not smoking) was associated with genital warts (OR, 1.9 [95% CI, 1.0–2.3]) [26]. Smoking among men has also been associated with their wives' cervical cancer risk in a case-control study: after adjustment for the wife's pack-years of smoking and other factors, the husband's smoking was moderately associated with cervical cancer (AOR for ≥26.2 pack-years vs. none, 2.5 [95% CI, 1.4–4.4]) [27]. It is possible that, in the present study, smoking is associated with unmeasured sex partner characteristics. Further study of the impact of smoking on HPV infection in men, a factor that may be important in preventing HPV-related diseases in both men and women, is recommended.

We have previously reported an ~60% lower adjusted odds of any HPV type and 80% lower adjusted odds of oncogenic HPV detection with always versus never using condoms during the past 3 months [6]. Similarly, others have reported that a lower prevalence of HPV was found for those who always used condoms (20.7%), compared with those who never used condoms (26.1%) [10]. A recent study found significantly lower adjusted odds of HPV

detection in men who used condoms with both regular sex partners and sex workers [14]. In the present study, men who had used condoms at least half the time during the past 3 months had significantly lower odds of oncogenic HPV detection (OR, 0.5) after adjustment for lifetime number of female sex partners; however, the association was not observed for nononcogenic HPV. We suggest that in studies in which only the glans penis/coronal sulcus, urethra, and/or penile shaft are sampled, an observed protective association with condom use might be stronger than in studies (such as the present one) in which the scrotum and anal sites are included.

We observed similarities in the magnitude of ORs across the 3 HPV outcomes for many of the health and behavioral factors measured. In bivariate analyses, associations with sexual factors— such as lifetime number of female sex partners and condom use during the past 3 months—were somewhat stronger for oncogenic HPV types than for the other 2 outcomes (table 3). These results might be explained by the inclusion of unclassified types, which may be false-positive result or HPV types not sexually transmitted, in the nononcogenic and any HPV type outcomes. Because we did not sequence unclassified types, we cannot determine the nature of the HPV DNA in the unclassified group. The consistency in the magnitude of ORs observed for the 3 multivariate models adds strength to the conclusion that smoking, lifetime and recent number of female sex partners, and condom use are associated with HPV detection in men (table 4).

Two other published multivariate models of risk factors for oncogenic, nononcogenic, and any HPV type infection in men reported somewhat different results [6, 13]. For example, Svare et al. [13] found that younger age (18–24 vs. ≥35 years) was associated with a greater odds of both oncogenic and nononcogenic HPV detection, whereas we and Baldwin et al. [6] found no association with age. Baldwin et al. [6] reported that lack of circumcision was a statistically significant independent risk factor for all 3 HPV outcomes, whereas Svare et al. [13] and we found no statistically significant association. Both previously published studies reported an association between nononcogenic HPV detection and genital warts. In the present study—perhaps because of our exclusion of men with such a history—the association was not statistically significant. Statistically significant factors the 3 studies had in common were lifetime and recent number of sex partners [6, 13].

It is of interest to determine whether risk factors differ by site. For example, although we did not observe a statistically significant association with circumcision at all sites combined, the effect of circumcision might be limited to certain penile sites. Similarly, condom use would logically be more strongly associated with HPV at the sites covered by condoms. These questions deserve further investigation.

The cross-sectional nature of the assessment of both exposures and HPV outcomes allowed us to detect associations between recent behaviors and current HPV detection. However, we are unable to assess causality or associations with infection duration. Analysis of sexual behaviors, including number of partners, smoking, and condom use, in a longitudinal cohort study of HPV in asymptomatic men is needed to provide evidence of factors that are related to viral acquisition and persistence.

Misclassification of potential risk behaviors is possible when participants fail to disclose accurate information about their sexual history or current practices. To limit this problem, we used a self-administered questionnaire. Prior research has shown the types of questions included in the present study should yield fairly reliable responses. One study of men found high reliability (≥90% agreement) between responses to questions on sexual activity reported for the previous 2 weeks and the previous 3 months but not between those shorter periods and the previous year [28]. In another study, test-retest agreement was also strong

for age at first intercourse (86%) and lifetime number of sex partners (82%) [29]. Because most questions included in the present study asked men to reflect on lifetime questions or activities during the past 3 months, confidence is increased for reliability of responses. Although misclassification of HPV outcomes is also a possibility, we have observed high replicability of HPV detection among male anogenital samples across laboratories [30].

In summary, the present study has allowed the identification of associations between current HPV infection and current smoking as well as confirmation of previously identified associations between HPV and lifetime and recent number of sex partners. Future longitudinal studies of HPV in men and sex partners that use complete anogenital sampling, including of the penile shaft, and that include detailed assessments of smoking habits and condom use to determine their effects on incidence, persistence, and transmission are under way.

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Table 1

Association between sociodemographic characteristics and human papillomavirus (HPV) status of men in the HPV Detection in Men Study.

		Any HPV			Oncogenic HPV			Nononcogenic HPV		
Category, parameter	**Subjects, total no.**	**Positive, no. (%)**	**OR[a] (95% CI)**	***P* for trend (χ^2)**	**Positive, no.**	**OR[a] (95% CI)**	***P* for trend (χ^2)**	**Positive, no.**	**OR[a] (95% CI)**	***P* for trend (χ^2)**
Residence										
Tucson, Arizona	359	228 (63.5)	Reference		101	Reference		127	Reference	
Tampa, Florida	104	75 (72.1)	1.2 (0.7–2.0)		34	1.1 (0.6–2.0)		41	1.3 (0.7–2.3)	
Age				.879			.529			.759
18–19 years	50	33 (66.0)	Reference		11	Reference		22	Reference	
20–24 years	181	113 (62.4)	0.8 (0.4–1.6)		52	1.1 (0.5–2.7)		61	0.7 (0.3–1.4)	
25–29 years	90	64 (71.1)	1.2 (0.6–2.6)		28	1.6 (0.6–4.0)		36	1.0 (0.5–2.3)	
30–34 years	63	44 (69.8)	1.2 (0.5–2.7)		20	1.6 (0.6–4.4)		24	1.0 (0.4–2.3)	
35–40 years	79	49 (62.0)	0.8 (0.4–1.7)		24	1.2 (0.5–3.0)		25	0.6 (0.3–1.4)	
Race										
White	324	210 (64.8)	Reference		89	Reference		121	Reference	
Black	33	20 (60.6)	0.8 (0.4–1.6)		10	0.9 (0.4–2.1)		10	0.7 (0.3–1.6)	
Asian/Pacific Islander	19	11 (57.9)	0.7 (0.4–1.6)		3	0.4 (0.1–1.6)		8	0.9 (0.3–2.4)	
American Indian/Alaska Native	9	5 (55.6)	0.7 (0.2–2.6)		4	1.3 (0.3–5.6)		1	0.2 (0.0–2.2)	
Other/unknown	78	57 (73.1)	1.4 (0.8–2.5)		29	1.7 (0.9–3.2)		28	1.2 (0.7–2.3)	
Ethnicity										
Non-Hispanic	384	240 (63.8)	Reference		103	Reference		137	Reference	
Hispanic	79	56 (70.9)	1.3 (0.8–2.3)		29	1.6 (0.9–3.0)		27	1.1 (0.6–2.1)	

Category, parameter	Subjects, total no.	Any HPV			Oncogenic HPV			Nononcogenic HPV		
		Positive, no. (%)	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)
Marital status										
Single, never married	327	220 (67.3)	Reference		100	Reference		120	Reference	
Married	59	36 (61.0)	0.8 (0.4–1.4)		12	0.6 (0.3–1.3)		24	1.0 (0.5–1.8)	
Cohabiting	29	17 (58.6)	0.8 (0.3–1.7)		8	0.8 (0.3–2.1)		9	0.7 (0.3–1.8)	
Divorced/separated	35	25 (71.4)	1.4 (0.6–3.0)		13	1.7 (0.7–4.0)		12	1.2 (0.5–2.8)	
Education				.255			.607			.750
<12 years	23	15 (65.2)	Reference		6	Reference		9	Reference	
High school graduate	94	63 (67.0)	1.1 (0.4–2.9)		27	1.2 (0.4–3.9)		36	1.0 (0.3–3.0)	
13–16 years	240	161 (67.1)	1.1 (0.4–2.6)		72	1.2 (0.4–3.6)		89	1.0 (0.4–2.7)	
≥17 years	101	59 (58.4)	0.7 (0.3–1.9)		27	0.9 (0.3–2.8)		32	0.7 (0.2–1.9)	

NOTE. The no. of subjects varies because of missing data. CI, confidence interval; OR, odds ratio.

[a]Adjusted for date of laboratory analysis.

Table 2

Association between human papillomavirus (HPV) status and sexual and health behaviors of men in the HPV Detection in Men Study.

Category, parameter	Subjects, total no.	Any HPV			Oncogenic HPV			Nononcogenic HPV		
		Positive, no. (%)	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)
Cigarette smoker										
Never	263	164 (62.4)	Reference		71	Reference		93	Reference	
Former	87	55 (63.2)	1.1 (0.6–1.8)		23	1.1 (0.6–2.0)		32	1.1 (0.6–1.9)	
Current	104	77 (74.0)	1.8 (1.1–3.1)		38	2.1 (1.2–3.9)		39	1.6 (0.9–2.8)	
No. of cigarettes currently smoked per day										
0–9	404	255 (63.1)	Reference		111	Reference		144	Reference	
≥10	51	42 (82.4)	3.0 (1.4–6.4)		22	3.7 (1.6–8.5)		20	2.4 (1.1–5.6)	
Monthly alcohol consumption				.187			.041			.617
0 drinks	79	50 (63.3)	Reference		21	Reference		29	Reference	
1–30 drinks	194	125 (64.4)	1.1 (0.6–1.8)		53	1.1 (0.5–2.1)		72	1.1 (0.6–2.0)	
31–60 drinks	66	42 (63.6)	1.0 (0.5–2.0)		16	0.9 (0.4–2.2)		26	1.1 (0.5–2.4)	
≥61 drinks	104	75 (72.1)	1.5 (0.8–2.9)		42	2.1 (1.0–4.4)		33	1.2 (0.6–2.5)	
Circumcised (clinician assessed)										
No	74	49 (66.2)	Reference		23	Reference		26	Reference	
Yes	389	254 (65.3)	1.0 (0.6–1.7)		112	0.9 (0.5–1.8)		142	1.0 (0.6–1.9)	
Age at first sexual intercourse										
<18 years	286	194 (67.8)	Reference		91	Reference		103	Reference	

Category, parameter	Subjects, total no.	Any HPV			Oncogenic HPV			Nononcogenic HPV		
		Positive, no. (%)	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)
≥18 years	177	109 (61.6)	0.8 (0.5–1.1)		44	0.7 (0.4–1.1)		65	0.9 (0.5–1.3)	
Lifetime no. of female sex partners				<.001			<.001			.044
1–5	158	83 (52.5)	Reference		26	Reference		57	Reference	
6–10	92	63 (68.5)	1.9 (1.1–3.2)		27	2.5 (1.3–5.1)		36	1.6 (0.9–2.9)	
11–20	105	76 (72.4)	2.4 (1.4–4.2)		35	3.7 (1.9–7.2)		41	1.9 (1.1–3.5)	
≥21	87	66 (75.9)	2.8 (1.5–4.9)		40	5.3 (2.6–10.6)		26	1.6 (0.8–3.1)	
No. of female sex partners during the past 3 months				.005			.007			.025
None	61	33 (54.1)	Reference		14	Reference		19	Reference	
1	274	175 (63.9)	1.5 (0.9–2.7)		76	1.6 (0.8–3.3)		99	1.5 (0.8–2.9)	
≥2	125	95 (74.2)	2.5 (1.3–4.7)		45	2.8 (1.1–4.7)		50	2.3 (1.1–4.7)	
New female sex partner during the past 3 months										
No	270	170 (63.0)	Reference		76	Reference		94	Reference	
Yes	193	133 (68.9)	1.3 (0.9–1.9)		59	1.2 (0.8–2.0)		74	1.3 (0.8–2.0)	
Frequency of sexual intercourse during the past month				.037			.029			.134
None	123	70 (56.9)	Reference		31	Reference		39	Reference	
1–10 times	235	159 (67.7)	1.6 (1.0–2.5)		66	1.5 (0.9–2.6)		93	1.7 (1.0–2.8)	
≥11 times	105	74 (70.5)	1.8 (1.0–3.1)		38	2.0 (1.1–3.9)		36	1.5 (0.8–2.9)	
Frequency of sexual intercourse during the past 3 months				.023			.005			.200

Category, parameter	Subjects, total no.	Any HPV			Oncogenic HPV			Nononcogenic HPV		
		Positive, no. (%)	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)	Positive, no.	OR[a] (95% CI)	*P* for trend (χ^2)
None	53	29 (54.7)	Reference		11	Reference	18		Reference	
1–25 times	277	180 (65.0)	1.5 (0.8–2.8)		76	1.7 (0.8–3.7)		104	1.4 (0.7–2.8)	
≥26 times	107	78 (72.9)	2.2 (1.1–4.5)		41	3.1 (1.3–7.3)		37	1.7 (0.8–3.7)	
Condom use with vaginal sex during the past 3 months										
Less than half the time	221	154 (69.7)	Reference		84	Reference		43	Reference	
At least half the time	187	119 (63.6)	0.7 (0.5–1.1)		39	0.4 (0.3–0.7)		18	1.1 (0.7–1.8)	

NOTE. The no. of subjects varies because of missing data. CI, confidence interval; OR, odds ratio.

[a] Adjusted for date of laboratory analysis.

Table 3

Association between human papillomavirus (HPV) status and history of sexually transmitted infection in the HPV Detection in Men Study.

Category, parameter	Subjects, total no.	Any HPV		Oncogenic HPV		Nononcogenic HPV	
		Positive, no. (%)	OR[a] (95% CI)	Positive, no.	OR[a] (95% CI)	Positive, no.	OR[a] (95% CI)
Ever diagnosed with any STD							
No	354	230 (65.0)	Reference	101	Reference	129	Reference
Yes	96	64 (66.7)	1.1 (0.7–1.7)	30	1.1 (0.6–2.0)	34	1.0 (0.6–1.7)
Genital wart(s) found during clinic visit							
No	445	287 (64.5)	Reference	125	Reference	162	Reference
Yes	18	16 (88.9)	4.5 (1.0–20.0)	10	6.7 (1.4–31.3)	6	3.0 (0.6–15.1)
Ever had sex partner with genital warts							
No	308	200 (64.9)	Reference	84	Reference	116	Reference
Yes	35	22 (62.9)	0.9 (0.4–1.8)	11	1.0 (0.4–2.4)	11	0.8 (0.3–1.8)
Don’t know	119	81 (68.1)	1.1 (0.7–1.7)	40	1.3 (0.7–2.1)	41	1.0 (0.6–1.6)
Ever had sex partner with abnormal Pap smear results							
No	153	100 (65.4)	Reference	32	Reference	68	Reference
Yes	107	75 (70.1)	1.3 (0.7–2.1)	41	2.2 (1.1–4.1)	34	0.8 (0.5–1.5)
Don’t know	203	128 (63.1)	0.9 (0.6–1.3)	62	1.3 (0.7–2.3)	66	0.7 (0.4–1.1)

NOTE. The no. of subjects varies because of missing data. CI, confidence interval; OR, odds ratio; STD, sexually transmitted disease.

[a]Adjusted for date of laboratory analysis.

Table 4

Independent risk factors for human papillomavirus (HPV) infection among men in the HPV Detection in Men Study.

	OR (95% CI)		
Category, parameter	**Any HPV**	**Oncogenic HPV**	**Nononcogenic HPV**
Smoke ≥10 cigarettes per day[a]	**2.3 (1.0–5.3)**	2.2 (0.8–5.8)	2.0 (0.8–4.6)
Lifetime no. of female sex partners			
1–5	**Reference**	**Reference**	Reference
6–10	**1.8 (1.0–3.1)**	**3.0 (1.4–6.7)**	1.4 (0.7–2.6)
11–20	**2.3 (1.3–4.0)**	**5.2 (2.4–11.4)**	1.6 (0.9–3.0)
≥21	**2.5 (1.3–4.6)**	**7.4 (3.4–16.3)**	1.3 (0.7–2.7)
Condom use with vaginal sex during the past 3 months			
Less than half the time	Reference	**Reference**	Reference
At least half the time	0.8 (0.5–1.2)	**0.5 (0.3–0.8)**	1.0 (0.6–1.6)
No. of female sex partners during the past 3 months			
None	Reference	Reference	**Reference**
1	2.2 (0.6–7.8)	1.6 (0.3–8.4)	**1.8 (0.9–3.6)**
≥2	2.8 (0.8–10.5)	2.8 (0.5–15.5)	**2.9 (1.4–6.3)**

NOTE. The no. of subjects varies because of missing data. Odds ratios (ORs) and 95% confidence intervals (CIs) in boldface indicate the variables that were included in the final model for each HPV outcome. ORs for other variables are included for comparison among the 3 outcomes. All ORs are adjusted for date of laboratory analysis.

[a] Reference category is <10 cigarettes per day.