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HIV Status Differentially Associated with Genital and Anal Human Papillomavirus Infection among Chinese Men Who Have Sex with Men: A Cross-Sectional Survey

Han-Zhu Qian, MD, PhD[1,2], **Yifei Hu, MD, PhD**[3], **James G. Carlucci, MD**[1,4], **Lu Yin, PhD**[1], **Xiangwei Li, PhD**[5], **Anna R. Giuliano, PhD**[6], **Dongliang Li, MD**[7], **Lei Gao, PhD**[5], **Yiming Shao, MD, PhD**[8], and **Sten H. Vermund, MD, PhD**[1,4]

[1]Vanderbilt Institute for Global Health, Vanderbilt University School of Medicine, Nashville, Tennessee, USA

[2]Division of Epidemiology, Department of Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, USA

[3]Department of Child and Adolescent Health and Maternal Care, School of Public Health, Capital Medical University, Beijing, China

[4]Division of Pediatric Infectious Diseases, Department of Pediatrics, Vanderbilt University Medical Center, Nashville, Tennessee, USA

[5]Institute of Pathogen Biology, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China

[6]Center for Infection Research in Cancer, Moffitt Cancer Center, Tampa, Florida, USA

[7]Chaoyang Center for Disease Control and Prevention, Beijing, China

[8]State Key Laboratory of Infectious Disease Prevention and Control, National Center for AIDS/STD Control and Prevention, Chinese Center for Disease Control and Prevention, Collaborative Innovation Center for Diagnosis and Treatment of Infectious Diseases, Beijing, China

Abstract

Background—Little is known about human papillomavirus (HPV) infection and genotypes when considering both anatomic site and HIV status among men who have sex with men (MSM) in low- and middle-income countries.

Methods—A cross-sectional study was conducted among MSM in Beijing, China. HIV status was determined, and genital and anal HPV genotyping were performed from respective swabs.

Corresponding author: Dr. Han-Zhu Qian, 2525 West End Avenue, Suite 725, Nashville, Tennessee, USA, 37203; Tel: (615) 343-3159; lqz2@cdc.gov.

New affiliation: Dr. Qian is currently with U.S. Centers for Disease Control and Prevention, Atlanta, USA (lqz2@cdc.gov).

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Results—Of 1,155 MSM, 817 (70.7%) had testing for genital (611; 52.9%) and/or anal (671; 58.1%) HPV. Preference for insertive anal sex (adjusted odds ratio [aOR], 2.60; 95% confidence interval [CI], 1.42–4.75) and syphilis (aOR, 1.50; 95% CI, 1.01–2.23) were associated with genital HPV. Inconsistent condom use during receptive anal sex (aOR, 1.82; 95% CI, 1.17–2.84), and HIV seropositivity (aOR, 2.90; 95% CI, 1.91–4.42) were associated with anal HPV. Among 465 (40.3%) MSM with specimens from both anatomic sites, anal HPV (68%) was more common than genital HPV (37.8%). Prevalence of anal HPV was higher among HIV-infected than uninfected MSM ($P<0.01$). Some oncogenic HPV types were more commonly found at the anal site of HIV-infected MSM ($P<0.01$).

Conclusions—HPV is highly prevalent among Chinese MSM. Anal HPV was more common than genital HPV, and HIV seropositivity was associated with oncogenic HPV types at the anal site.

Keywords

Human papillomavirus; genotype; anogenital; HIV; men who have sex with men; China

INTRODUCTION

Human papillomavirus (HPV) is a common sexually transmitted infection (STI) among men, but its prevalence varies widely from 1% to 99% depending on the study population, sampling method, and anatomic site [1, 2]. The risk of HPV among men who have sex with men (MSM) is higher than among heterosexual men [3, 4]. HIV-infected MSM have an even higher risk [5–7]. Among MSM, HPV infection also varies by anatomic site: more common in the perineal/perianal region and anal canal than in the penile urethra or scrotum. Preferred sex position/role and differences in epithelium type may present different exposure opportunities and differential susceptibility in genital and perianal areas [4, 8–10].

There have been >30 genotypes of HPV identified infecting anogenital areas. Similar to the pathogenic relationship between HPV and cervical cancer, there is also a relationship between HPV and anal cancer; approximately80% of anal cancer cases are associated with HPV infection [11]. HPV genotypes are categorized into oncogenic types (higher risk for anal intraepithelial neoplasia [AIN] and anogenital cancers such as cervical and anal), and non-oncogenic types [5].

HPV-associated genital and anal cancers occur more often among HIV-infected men compared to HIV-negative men [12, 13]. Co-infection with oncogenic HPV types and HIV is of special concern for MSM; HIV infection increases HPV prevalence, incidence and persistence[14], and HIV-infected men who live longer on antiretroviral therapy may be at ongoing risk of anogenital cancers [5]. There is a growing focus on HPV infection and associated cancers among MSM in recent years [4, 13, 15]; however, few studies included both HIV-negative and positive MSM and sampled multiple anatomic sites [16, 17]. The aims of this study were to compare HPV prevalence and type distribution at genital and anal anatomic sites among MSM in China, and to assess the effect of HIV status on HPV prevalence at these anatomic sites.

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METHODS

Study population

Through local gay-friendly community based organizations in Beijing, China, we recruited MSM to participate in a study of circumcision and HIV/STIs, into which this study was nested, using multiple approaches: gay website advertisements, outreach to MSM-frequented venues, snowball sampling, and referrals from an ongoing epidemiological study of HIV-infected men. Eligibility criteria included men self-reporting anal sex with men in the past 3 months, age ≥18 years, living in Beijing City at the time of the survey, and giving written informed consent to complete study procedures including a genital exam, HPV swabs, and providing blood for HIV and *T. pallidum* testing. Participants were compensated 50 Chinese yuan (approximately 7 US dollars). To include more HIV-infected MSM in the study sample, we also recruited participants with known HIV-positive status from a prospective study in Beijing, where MSM were enrolled using the same approaches as for the community participants [18]. This study was approved by the institutional review boards from the National Center for AIDS/STD Control and Prevention (NCAIDS), the Chinese Center for Disease Control and Prevention (China CDC) (NCAIDS IRB FWA00002958), and Vanderbilt University (VU IRB FWA00005756).

Questionnaire interview

A questionnaire interview was conducted by a trained interviewer in a private room at HIV voluntary counseling and testing clinics. The questionnaire included questions on socio-demographic characteristics, alcohol and drug use, sexual behaviors (e.g., number of male and female sexual partners, frequency of partner change, pattern of homosexual activities, condom use, preferred anal sex role/position, forced sex), experience of STI, and history of circumcision.

Specimen collection and laboratory tests

Blood samples were collected from each participant and were tested for HIV and syphilitic infections following the Chinese national testing algorithms. HIV infection status was determined by an enzyme immunoassay (Wantai Biological Medicine Company, Beijing, China), and was confirmed by HIV-1/2 Western blot assay (HIV Blot 2.2 WB; Genelabs Diagnostics, Singapore, Singapore). Syphilitic infection was determined through rapid plasma reagin (RPR, Shanghai Kehua Biotechnology Ltd., Shanghai, China) and confirmed by the *Treponema pallidum* particle assay (TPPA) (Fujirebio Inc., Tokyo, Japan).

Trained physicians collected an anal sample by rotating a saline moistened nylon flocked swab for 2 minutes in the anal canal, and collected a genital swab from the coronal sulcus of the glans penis using a saline moistened swab. Backward and forward swab movements were performed at each site. The swabs were then kept in 3 mL of sample transport medium for Tellgenplex™ HPV DNA Test (Tellgen Life Science, Shanghai, China).

The Tellgenplex™ HPV DNA test is based on the suspension bead array method to identify HPV types [7], and was approved by the State Drug and Food Administration of China (SFDA). This method can detect 26 common types of HPV. Of them, 13 types are

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considered oncogenic (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, or 68), and the other 13 types are considered non-oncogenic (6, 11, 26, 40, 42, 44, 53, 55, 61, 66, 73, 82, and 83) [19]. In order to minimize possible non-specific competition between partial probes, the manufacturer suggests reporting the following types combined: 26/55, 40/42/44, and 61/73. Study participants with genotype positive results for any HPV type were categorized as positive for "any genotype".

Specimens were tested for the presence of HPV using TellgenplexTM HPV DNA Test (Tellgen Life Science, Shanghai, China), and only samples that tested positive for β-globin were judged to be adequate and included. We implemented two quality control procedures in HPV testing. First, we added one negative control and one positive control to every 96-pore test plate. The controls were included throughout all steps of testing. Second, we randomly selected 1% of the specimens for repeat testing. All of the repeat test results were consistent with the initial test results.

Statistical analysis

Data for questionnaire responses, physical examinations, and laboratory tests were entered independently by two study staff and verified with EpiData software (EpiData 3.1 for Windows, The EpiData Association Odense, Denmark). Completed databases were then analyzed with Statistical Analysis System (SAS 9.3 for Windows; SAS Institute Inc., NC, USA) software.

The analyses included three parts: (1) Both univariate and multivariate logistic regression analyses were conducted to evaluate factors associated with genital and anal HPV infection, separately. Variables at a significance level of $P<.10$ in univariate analyses were included in the multivariate regression model, and those significant at $P<.05$ were retained in the final model using backward stepwise elimination (Table 1). (2) For the subgroup with both usable genital and anal swabs in which human β-globin gene were detectable (Figure 1), the detection rates of each HPV genotype and each category of genotypes (i.e., oncogenic and non-oncogenic) from the genital and anal sites were compared between HIV-infected and uninfected MSM using Chi-square, Fischer's Exact, or McNemar tests (Table 2). (3) For the subgroup with both usable genital and anal swabs, the agreement of detecting individual and categorical HPV genotypes from two anatomic sites was assessed using *Kappa* values [20] (Table 3).

RESULTS

Demographics of study participants

Of 1,155 participating MSM, 822 (71%) provided genital swab specimens and 834 (72%) provided anal swab specimens; 611 (53%) had successful HPV testing for genital, 671 (58%) for anal, and 465 (40%) for both sites [7] (Figure 1).

The median age of the 817 participants with usable specimens was 29 years (interquartile range 25–34), 27% were ever married, 51% received post high school education (>12 years), and 58% had a full-time job. There were no statistically significant demographic differences between 611 men with genital swabs and 671 men with anal swabs (not shown).

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Risk factors for genital and anal HPV infection

Factors associated with genital HPV infection were assessed among 611 participants who provided usable genital specimens (Figure 1). Of 16 demographic, sexual, behavioral, or co-infection factors assessed for their relationship with detection of HPV DNA at the genital site, four were associated (P<0.1) with HPV infection in univariate analyses: alcohol consumption, preferred anal sex role, condom use during insertive anal sex, and presence of syphilis. These variables were then included in the multivariate logistic regression models developed to assess factors independently associated with genital HPV infection. Only two variables were retained in final models (preference for insertive anal sex and presence of syphilis). Compared with men who preferred receptive anal sex, those who preferred insertive anal sex (adjusted odds ratio [aOR], 2.60; 95% confidence interval [CI], 1.47–4.75) or versatile anal sex role (aOR, 1.70; 95% CI, 1.01–2.85) were more likely to have HPV DNA detection at the genital site. MSM with syphilis were also more likely to have HPV DNA detection at the genital site (aOR, 1.50; 95% CI, 1.01–2.23) (Table 1).

Factors associated with anal HPV infection were assessed among 671 participants who provided usable anal specimens (Figure 1). Of the same 16 factors assessed for their relationship with detection of HPV DNA at the anal site, three were independently associated with anal HPV infection: no full-time job, inconsistent condom use during receptive anal sex, and HIV infection. Men without a full-time job were more likely to have anal HPV infection than those with a full-time job (aOR, 1.58; 95% CI, 1.10–2.28). MSM with inconsistent condom use during receptive anal sex had a higher anal HPV risk (aOR, 1.82; 95% CI, 1.17–2.84). Men who were HIV-positive were also more likely to have anal HPV infection (aOR, 2.90; 95% CI, 1.91–4.42) (Table 1).

HPV prevalence and genotype distribution comparing HIV-infected and uninfected MSM

Among 465 MSM from whom usable specimens were obtained from both genital and anal sites, anal HPV infection (68%) was more common than genital infection (37.8%). This anatomic difference, with anal HPV infection being more common than genital HPV infection, was also observed in HIV-positive and negative subgroups (Table 2).

At the genital site, 37.8% of MSM were infected with at least one HPV type and 14.6% were infected with multiple HPV types. The most commonly detected oncogenic types (>4%) at the genital site included HPV 16 and 18, and the most commonly detected non-oncogenic type was HPV 6. The prevalence of genital HPV infection with any HPV type did not significantly differ between HIV-infected (39.8%) and uninfected MSM (36.7%). There were no statistically significant differences of individual HPV type prevalence at the genital site between HIV-positive and negative MSM, except for HPV 51 which was more prevalent in HIV-negative MSM (Table 2).

At the anal site, 68% of MSM were infected with at least one HPV type and 34.8% were infected with multiple HPV types. The prevalence of anal HPV infection with any HPV type was higher among HIV-infected (81.2%) than uninfected MSM (59.9%) (P<.01). HIV-infected MSM were significantly more likely than HIV-uninfected MSM to have oncogenic

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HPV types 18, 31, 39, 56, 68 and non-oncogenic HPV types 6, 66, 40/42/44 and 26/55 (Table 2).

Agreement for HPV genotypes detection at genital and anal sites

Overall, there was little agreement between detecting HPV genotypes at the genital and anal sites. Only for HPV 18 was there fair agreement (*Kappa* value >0.20). For all other genotypes, the *Kappa* values were either <0 indicating no agreement, or between 0–0.20 indicating slight agreement (Table 3).

DISCUSSION

Our study is one of the largest investigations into prevalence and type distribution of HPV infection at multiple anatomic sites and among HIV-positive and HIV-negative MSM. This is the first study of this kind among Chinese MSM, and it compliments other studies of HPV infection among Chinese MSM [2, 6, 7]. Additionally, this study provides genotypic and anatomic site specific findings, and highlights the need for individual and public health interventions for prevention of HPV in this and similar high-risk populations.

Our key findings include that over one-third of MSM had genital HPV infection, but this did not vary significantly based on HIV status. Prevalence of anal HPV infection was even higher, affecting almost 60% of HIV-negative MSM and more than 80% of HIV-positive MSM. Consistent with this finding, our multivariate logistic regression model identified HIV infection as being independently associated with increased odds of anal HPV infection. This relationship may be because HIV and HPV share the transmission route, such as unprotected sex, and it may also be because HIV-infected individuals with compromised immunity are less likely to eliminate HPV infection and therefore have higher HPV persistence [14]. Furthermore, anal HPV infection with oncogenic types 18, 31, 39, 56, and 68 were significantly more common among HIV-positive MSM compared to HIV-negative MSM. HPV types 16 and 18 were the most commonly detected oncogenic HPV types found at the genital site, but this did not vary significantly based on HIV status.

Similar studies conducted among MSM in Europe have yielded results consistent with our findings. Van Aar, et al., similarly found that high-risk anal and penile HPV infections were highly prevalent among MSM and that anal HPV was more prevalent than penile HPV. They found that HIV infection was associated with both anal and penile HPV infection, but the association was stronger for anal HPV infection. They also found that infection with multiple HPV types was common, more so at the anal site, but they did not comment as to whether there was concordance between HPV genotypes at different anatomic sites [17].

Others have also noted that HPV infection was more common among HIV-positive MSM and that HPV infection was most prevalent at the anal site [5, 16, 21–24]. Van Rijn et al. noted that high-risk HPV types were concordant at multiple anatomic sites in more than 10% of MSM, that the distribution of high-risk HPV types from oral specimens differed from that found in anal and penile specimens, and that concordant infections at multiple anatomical sites were associated with type-specific seropositivity. However, in cases of concordance, they did not specify which high-risk HPV types were identified [21].

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Infection with multiple HPV types may contribute to persistent infection [25], and infection with multiple oncogenic HPV types may increase the risk for developing HPV associated cancers. We found that despite about 15% of MSM being infected with multiple HPV types at the genital site, and about 35% of MSM being infected with multiple HPV types at the anal site, there was little concordance between HPV genotypes at different anatomical sites. This lack of agreement could be due to: different sources of HPV infections, having different sexual partners when practicing insertive and receptive sex, difference in infection duration at anal versus genital sites [16, 26], differential limitations of genital versus anal specimen collection, differential failure to detect HPV from genital versus anal specimens, or difference in tissue structure and virus tropism between the two anatomic sites – one is a mucosal epithelium while the other is keratinized. If this is not simply artefactual, our observation of low agreement of HPV genotypes identified between genital and anal areas may imply that there are very common HPV infections, as well as differing infection opportunities at different anatomic sites even in the same individuals.

It should also be noted, that while anal HPV infection was more prevalent than genital HPV infection overall, preferred receptive anal sex role was a risk factor for anatomic site of HPV infection. We found that MSM with inconsistent condom use during receptive anal sex had increased odds of anal HPV infection. Van Aar et al. also noted that receptive anal intercourse was associated with anal HPV infection [17]. On the other hand, preference for insertive anal sex was associated with genital HPV infection in our study. In heterosexual men, genital HPV infection is more common than anal HPV infection [27]. These findings might suggest that the genital area may be a major transmission route of HPV infection compared to the anal area as major reservoir. This would be consistent with other work which has noted that risk of HPV infection may be increased with particular sexual behaviors [4, 28, 29], and reinforces the importance of condom use and HPV vaccination for adolescent boys. While a majority of MSM practice both receptive and insertive anal intercourse and may be at risk for HPV infections at multiple anogenital sites [7], these findings reinforce that MSM are a diverse group with variable risk dependent on an individual's behaviors.

Syphilis was independently associated genital HPV infection, while ever having had an STI was associated with anal HPV infection in the univariate analysis but not in the multivariate model. It is likely that this is because syphilis and HPV are associated with risky sexual behaviours. Clearly prevention strategies including reducing number of sexual partners, promotion of condom use, and vaccination against HPV stand to reduce the risk of HPV infection in this population.

An important strength of our study is that a full spectrum of detection of HPV genotypes was performed among MSM with and without HIV infection. This degree of genotyping is seldom conducted in low- and middle-income countries (LMIC). Most studies on HPV in MSM have been conducted in high-income countries, and there is limited literature from LMIC [5]. This study contributes to the clinical and public health data needed to understand HPV issues among MSM in LMIC, where the HIV epidemic increases rapidly in this population [30].

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A limitation of this study is that the penile samples were only obtained from the coronal sulcus of the glans penis, instead of from multiple genital sites including the urethral orifice, foreskin, and penile shaft [27]. As such, our sampling method might underestimate the true prevalence of genital HPV. Another limitation is that not all participants had successful HPV DNA results in two anatomic sites, leading to a smaller than desired sample size, and resulting in insufficient statistical power to perform age disaggregated analyses. However, despite these issues, the sample size was still substantial and included a diverse population including 48.6% with a college education, 51.4% with less than a high school education, with 78.4% immigrants versus 21.6% being permanent Beijing residents. Lastly, MSM were recruited through multiple approaches: most from snowball sampling and peer referrals and some from ongoing epidemiological study and other routes. This convenience sampling may limit the representativeness of the study sample and generalizability of the study findings.

HPV is widespread, and may facilitate transmission of HIV amongst MSM and their sexual partners. HIV-infected MSM with high prevalence of oncogenic HPV types might also be at increased risk of developing HPV associated anogenital cancers. Presently, HPV vaccine has been available and is recommended by the US CDC for all boys aged 11–21 years. It is also recommended for high-risk populations including MSM and men with compromised immune systems, including those with HIV-infection through age 26 [31]. Our study supports the use of currently available HPV vaccines and should also help inform which HPV types to include in future HPV vaccine development. Even though HPV vaccine is usually recommended for individuals who have not initiated sex, considering the high burden of HIV and HPV in this population, an intervention approach with any efficacy such as HPV vaccination for MSM with sexual experience should be considered in the public health programs.

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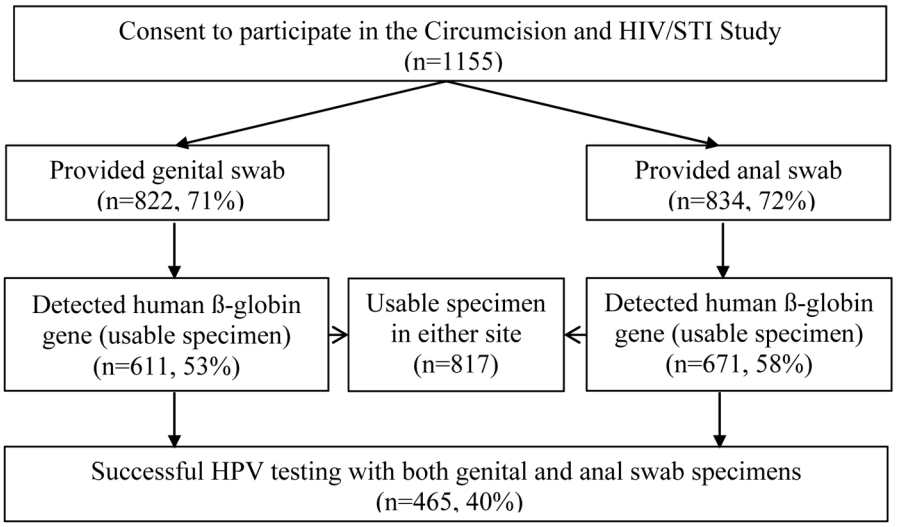

Figure 1.
Flowchart of specimen collection and HPV testing in genital and anal sites

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Table 1

Factors Associated with Genital and Anal Human Papillomavirus Infections among 817 Chinese Men Who Have Sex with Men

Factor	Genital HPV (n=611)			Anal HPV (n=671)		
	No of positives/total (%) #	Crude OR (95% CI)	Adjusted OR (95% CI)	No. of positives/total (%) #	Crude OR (95% CI)	Adjusted OR (95% CI)
Age (every 1 year increase)						
	227/611 (37.1)	1.01 (0.99–1.03)		438/671 (65.3)	0.98 (0.96–1.00)	
Ever married						
No	162/450 (36.0)	1.00		316/481 (65.7)	1.00	
Yes	63/154 (40.9)	1.23 (0.85–1.79)		118/184 (64.1)	0.93 (0.65–1.33)	
Education, year						
≤ 12	117/296 (39.5)	1.00		227/329 (69.0)	1.00	
> 12	110/315 (34.9)	0.82 (0.59–1.14)		211/342 (61.7)	0.72 (0.53–1.00) †	
Current employment						
Full-time	122/343 (35.6)	1.00		229/385 (58.0)	1.00	
Non full-time	105/268 (39.2)	1.17 (0.84–1.62)		209/286 (73.1)	1.85 (1.33–2.58) ‡	1.58 (1.10–2.28) †
Alcohol consumption in the past 4 weeks						
No	165/467 (35.3)	1.00		330/503 (65.6)	1.00	
Yes	60/137 (43.8)	1.43 (0.97–2.10) *		104/162 (64.2)	0.94 (0.65–1.36)	
Total number of lifetime male sexual partners (every 1 increase)						
	n/a	1.00 (0.99–1.00)			1.00 (0.99–1.00)	
Preferred anal sex role						
Mainly receptive	24/95 (25.3)	1.00		78/112 (69.6)	1.00	
Mainly insertive	55/119 (46.2)	2.54 (1.41–4.57) ‡	2.60 (1.42–4.75) ‡	65/122 (53.3)	0.59 (0.29–0.85) †	

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Factor	Genital HPV (n=611)			Anal HPV (n=671)		
	No of positives/total (%) #	Crude OR (95% CI)	Adjusted OR (95% CI)	No. of positives/total (%) #	Crude OR (95% CI)	Adjusted OR (95% CI)
Versatile	136/371 (36.7)	1.71 (1.03–2.85) †	1.70 (1.01–2.85) †	274/409 (67.0)	0.89 (0.56–1.39)	
Condom use during insertive anal intercourse in the past 6 months						
No sex	70/221 (31.7)	1.00				
Consistent use	91/230 (39.6)	1.41 (0.95–2.08) *				
Inconsistent use	64/158 (40.5)	1.47 (0.96–2.25) *				
Condom use during receptive anal intercourse in the past 6 months						
No sex				176/290 (60.7)	1.00	
Consistent use				144/217 (66.4)	1.28 (0.89–1.85)	1.35 (0.90–2.02)
Inconsistent use				118/164 (72.0)	1.66 (1.10–2.51) †	1.82 (1.17–2.84) ‡
Number of male partners to have insertive anal sex with in the past 6 months						
≤1	160/427 (37.5)	1.00		332/468 (70.9)	1.00	
≥2	72/184 (39.1)	1.08 (0.72–1.63)		123/202 (60.9)	0.63 (0.42–0.96) †	
Number of male partners to have receptive anal sex with in the past 6 months						
≤1	172/430 (40.0)	1.00		302/466 (64.8)	1.00	
≥2	57/177 (32.3)	0.69 (0.45–1.05)		152/200 (76.0)	1.70 (1.08–2.68) †	
Had forced sex with male partners in the previous year						
No	216/572 (37.8)	1.00		406/632 (64.2)	1.00	
Yes	8/28 (28.6)	0.66 (0.29–1.52)		26/31 (83.9)	2.89 (1.10–7.64) †	
Ever had sexually transmitted infections						
No	144/400 (36.0)	1.00		272/443 (61.4)	1.00	
Yes	72/187 (38.5)	1.11 (0.78–1.59)		147/202 (72.8)	1.68 (1.17–2.42) †	
Ever had circumcision						

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Factor	Genital HPV (n=611)			Anal HPV (n=671)		
	No of positives/total (%) [#]	Crude OR (95% CI)	Adjusted OR (95% CI)	No. of positives/total (%) [#]	Crude OR (95% CI)	Adjusted OR (95% CI)
No	206/584 (37.6)	1.00		394/603 (65.3)	1.00	
Yes	17/43 (39.5)	1.09 (0.58–2.05)		29/47 (61.7)	0.86 (0.46–1.58)	
HIV seropositivity						
No	148/409 (36.2)	1.00		264/459 (57.5)	1.00	
Yes	79/202 (39.1)	1.13 (0.80–1.60)		174/212 (82.1)	3.38 (2.27–5.03) [‡]	2.90 (1.91–4.42) [‡]
Syphilis seropositivity						
No	155/436 (35.6)	1.00		286/472 (60.6)	1.00	
Yes	70/167 (41.9)	1.31 (0.91–1.88) [*]	1.50 (1.01–2.23) [†]	148/192 (77.1)	2.19 (1.49–3.21) [‡]	

OR: odds ratio; CI: confidence interval.

[#] Sum may not always add up to the total due to mission data;

[*] $P<.1$;

[†] $P<.05$;

[‡] $P<.01$.

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Table 2

Comparison of the Prevalence of Human Papillomavirus Genotypes by HIV Status and Anatomic Site among 465 Chinese Men Who Have Sex with Men

HPV type	Genital			Anal			*P* value [b]	
	HIV(−) n=289 (%) (a1)	HIV(+) N=176 (%) (a2)	*P* value [a] a1 vs. a2	HIV(−) n=289 (%) (b1)	HIV(+) n=176 (%) (b2)	*P* value [a] b1 vs. b2	a1 vs. b1	a2 vs. b2
Any type	106 (36.7)	70 (39.8)	.50	173 (59.9)	143 (81.2)	<.01	<.01	<.01
0	183 (63.3)	106 (60.2)		116 (40.1)	33 (18.8)			
1	67 (23.2)	41 (23.3)		95 (32.9)	59 (33.5)			
2	30 (10.4)	17 (9.7)		58 (20.1)	41 (23.3)			
3	8 (2.8)	9 (5.1)		11 (3.8)	26 (14.8)			
≥4	1 (0.4)	3 (1.7)		9 (3.1)	17 (9.7)			
Oncogenic								
HPV 16	13 (4.5)	8 (4.6)	.98	37 (12.8)	27 (15.3)	.44	<.01	<.01
HPV 18	12 (4.2)	9 (5.1)	.63	13 (4.5)	21 (11.9)	<.01	.82	<.01
HPV 31	1 (0.4)	4 (2.3)	.07	0 (0)	6 (3.4)	<.01	—	.53
HPV 33	3 (1.0)	4 (2.3)	.43	11 (3.8)	8 (4.6)	.70	.03	.21
HPV 35	0 (0)	3 (1.7)	.05	0 (0)	2 (1.14)	.14	—	.65
HPV 39	5(1.7)	1 (0.6)	.42	15 (5.2)	19 (10.8)	.02	.03	<.01
HPV 45	6 (2.1)	6 (3.4)	.38	19 (6.6)	16 (9.1)	.32	.01	.03
HPV 51	14 (4.8)	1 (0.6)	.01	13 (4.5)	11 (6.3)	.41	.83	<.01
HPV 52	6 (2.1)	9 (5.1)	.07	17 (5.9)	14 (8.0)	.38	.02	.28
HPV 56	1 (0.4)	2 (1.1)	.56	4 (1.4)	17 (9.7)	<.01	.18	<.01

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HPV type	Genital			Anal			*P* value [b]	
	HIV(−) n=289 (%) (a1)	HIV(+) N=176 (%) (a2)	*P* value [a] a1 vs. a2	HIV(−) n=289 (%) (b1)	HIV(+) n=176 (%) (b2)	*P* value [a] b1 vs. b2	a1 vs. b1	a2 vs. b2
HPV 58	6 (2.1)	7 (4.0)	.25	19 (6.6)	10 (5.7)	.70	.01	.47
HPV 59	9 (3.1)	3 (1.7)	.55	12 (4.2)	13 (7.4)	.13	.47	.01
HPV 68	7 (2.4)	5 (2.8)	.77	11 (3.8)	14 (8.0)	.05	.35	.02
Non-oncogenic								
HPV 6	19 (6.6)	18 (10.2)	.16	45 (15.6)	47 (26.7)	<.01	<.01	<.01
HPV 11	9 (3.1)	6 (3.4)	.86	16 (5.5)	17 (9.7)	.09	.13	.02
HPV 53	0 (0)	2 (1.1)	.14	0 (0)	0 (0)	—	—	—
HPV 66	3 (1.0)	4 (2.3)	.43	2 (0.7)	7 (4.0)	.03	.65	.37
HPV 82	12 (4.2)	6 (3.4)	.69	10 (3.5)	10 (5.7)	.25	.65	.29
HPV 83	3 (1.0)	2 (1.1)	1.00	7 (2.4)	2 (1.1)	.49	.21	1.00
HPV 40/42/44	10 (3.5)	5 (2.8)	.71	5 (1.7)	10 (5.7)	.02	.20	.17
HPV 26/55	10 (3.5)	5 (2.8)	.71	7 (2.4)	13 (7.4)	.01	.41	.05
HPV 61/73	6 (2.1)	6 (3.4)	.38	22 (7.6)	9 (5.1)	.29	.01	.41

[a] Chi-square test or Fisher's Exact test;

[b] McNemar test

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Table 3

Agreement of Detecting Genital and Anal Human Papillomavirus Genotypes among 465 HIV-infected and Uninfected Chinese Men who Have Sex with Men

HPV type	HIV(+) MSM (n=176)					HIV(−) MSM (n=289)					Total sample (n=465)				
	Genital Only (+)	Anal only (+)	Both (+)	Both (−)	*Kappa* value [a]	Genital only (+)	Anal Only (+)	Both (+)	Both (−)	*Kappa* value [a]	Genital only (+)	Anal only (+)	Both (+)	Both (−)	*Kappa* value [a]
Oncogenic	**16**	**81**	**30**	**49**	**0.02**	**29**	**88**	**39**	**133**	**0.13**	**45**	**169**	**69**	**182**	**0.09**
HPV 16	6	25	2	143	0.05	11	35	2	241	0.01	17	60	4	384	0.03
HPV 18	4	16	5	151	0.28	9	10	3	267	0.21	13	26	8	418	0.25
HPV 31	4	6	0	166	−0.03	1	0	0	288	0.00	5	6	0	454	−0.01
HPV 33	3	7	1	165	0.14	3	11	0	275	−0.02	6	18	1	440	0.06
HPV 35	3	2	0	171	−0.01	0	0	0	289	--	3	2	0	460	−0.01
HPV 39	0	18	1	157	0.09	5	15	0	269	−0.03	5	33	1	426	0.03
HPV 45	5	15	1	155	0.04	5	18	1	265	0.05	10	33	2	420	0.05
HPV 51	1	11	0	164	−0.01	12	11	2	264	0.11	13	22	2	428	0.07
HPV 52	8	13	1	154	0.03	5	16	1	267	0.06	13	29	2	421	0.05
HPV 56	2	17	0	157	−0.02	1	4	0	284	−0.01	3	21	0	157	−0.03
HPV 58	7	10	0	159	−0.05	5	18	1	265	0.05	12	28	1	424	0.01
HPV 59	2	12	1	161	0.10	7	10	2	270	0.16	9	22	3	431	0.13
HPV 68	3	12	2	159	0.18	7	11	0	271	−0.03	10	23	2	430	0.08
Non-oncogenic	**21**	**29**	**3**	**123**	**−0.06**	**26**	**34**	**12**	**217**	**0.17**	**47**	**63**	**15**	**340**	**0.08**
HPV 6	10	39	8	119	0.12	12	38	7	232	0.14	22	77	15	351	0.13
HPV 11	5	16	1	154	0.04	7	14	2	266	0.13	12	30	3	420	0.08
HPV 53	2	0	0	174	0.00	0	0	0	289	--	2	0	0	463	0.00

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HPV type	HIV(+) MSM (n=176)					HIV(−) MSM (n=289)					Total sample (n=465)				
	Genital Only (+)	Anal only (+)	Both (+)	Both (−)	*Kappa* value [a]	Genital only (+)	Anal Only (+)	Both (+)	Both (−)	*Kappa* value [a]	Genital only (+)	Anal only (+)	Both (+)	Both (−)	*Kappa* value [a]
HPV 66	4	7	0	165	−0.03	3	2	0	284	−0.01	7	9	0	449	−0.02
HPV 82	5	9	1	161	0.09	11	9	1	268	0.06	16	18	2	429	0.07
HPV 83	2	2	0	172	−0.01	3	7	0	279	−0.01	5	9	0	451	−0.01
HPV 40/42/44	4	9	1	162	0.10	10	5	0	274	−0.02	14	14	1	436	0.04
HPV 26/55	4	12	1	159	0.07	8	5	2	274	0.21	12	17	3	433	0.14
HPV 61/73	5	8	1	162	0.10	5	21	1	262	0.04	10	29	2	424	0.06

[a] *Kappa* values range from −1 to 1: <0 indicating no agreement; 0–0.20 indicating slight agreement; 0.21–0.40 indicating fair agreement; 0.41–0.60 indicating moderate agreement; 0.61–0.80 indicating substantial agreement; and 0.81–1 indicating almost perfect agreement.