Awareness and acceptance of HPV vaccination for condyloma acuminata among men who have sex with men in China

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ABSTRACT
The dissemination of the fact that the human papillomavirus (HPV) vaccine can protect females as well as males is greatly beneficial for the control of condyloma acuminata (CA). We aimed to investigate the acceptance of the HPV vaccine for CA among men who have sex with men (MSM) in China. A cross-sectional online survey in the adult MSM population from 31 regions in China was carried out via WeChat in May 2017. Information on demographic characteristics, sexual behaviors, history of HIV and HPV infection, awareness of CA and HPV/CA vaccines, acceptance of CA vaccination, and behavioral intentions for vaccination were collected through a self-administered questionnaire. In total, 902 questionnaires were analyzed; the prevalence of CA was 13.3% (120/902), the HIV positivity rate was 15.1% (136/902), and the coinfection rate of HIV and CA was 3.9% (35/902). In the MSM population, the knowledge of CA and HPV/CA vaccines was poor, but the acceptance rate of the CA vaccine was high (85.1%, 768/902). Data indicated that MSM who had a history of anal intercourse (OR = 1.9), had heard of CA (OR = 2.9), knew the treatments for CA (OR = 2.0), had heard of HPV vaccines/cervical cancer vaccines (OR = 1.9), and received education about CA (OR = 1.9) were associated with the intention to use CA vaccines. With current moderate levels of CA and HPV/CA vaccine awareness, more emphasis should be placed on improving education and other behavioral interventions for high-risk populations such as MSM in China.

KEYWORDS
Condyloma acuminata; HPV; vaccine; MSM; awareness; acceptance

Introduction
Human papillomavirus (HPV) types 6 and 11 cause more than 90% of condyloma acuminata (CA) cases. CA are highly contagious, with a transmission rate of approximately 65% from an infected person to a susceptible partner within a sexual partnership. The annual incidence of CA in the general adult population is 1.6 to 1.8 per 1,000 persons, whereas it is over 10 per 1,000 persons among men who have sex with men (MSM) and human immunodeficiency virus (HIV)-infected individuals. Furthermore, the treatment of CA does not eradicate HPV infection. HPV DNA may remain latent after initial infection and recur months or even years later. The recurrence rates of CA are high, ranging from 6% to 77%, further increasing the direct economic burden of medical costs and psychosocial impact. CA gives patients pain, while it was previously considered a nonlife-threatening disease; however, mounting evidence suggests that individuals with CA have a strongly increased risk of cancers of the penis and anogenital region.

MSM have been considered one of the most at-risk populations for HPV and HIV infection. MSM have an enhanced risk of HPV infection and persistence, carrying multiple HPV types and HPV-related disease with even more rapid progression to malignancies. To date, 2 licensed vaccines, a quadrivalent HPV vaccine (4vHPV, Gardasil®) and nonavalent HPV vaccine (9vHPV, Gardasil 9°), can prevent HPV-6 and HPV-11 infection with high effectiveness. Real-world data show that five years after the national HPV vaccination program was implemented in Australia, the proportion of MSM diagnosed with CA declined from 8.5% in 2007 to 6.4% in 2011. The Advisory Committee on Immunization Practices (ACIP) recommends either 9vHPV or 4vHPV vaccination for MSM and HIV carriers. However, only a few countries recommend existing HPV vaccines for males. By October 2020, 110 countries worldwide had added the HPV vaccine to national immunization programs for females; nevertheless, only 11 countries have included it for males. The insufficient supply of HPV vaccines even for females further impedes the control of CA.

Therefore, one vital barrier to the control of CA is the lack of an HPV vaccine for males. To address this issue, an HPV vaccine for males containing only HPV 6 and 11 strains has completed phase 1 (NCT02405520) and phase 2 clinical trials (NCT02710851). The phase 1 clinical trial showed that the candidate HPV-6/11 vaccine is well tolerated and has robust immunogenicity. Nevertheless, the dissemination of the fact that the HPV vaccine can protect females as well as males is of great benefit to the control of CA.
There are currently several HPV vaccine acceptability studies among Chinese MSM, reporting HPV awareness ranging from 18.4% to 47.6%, acceptance of free HPV vaccination ranging from 26.2% to 97.6%, and acceptability of market price HPV vaccination ranging from 2.5% to 29.2%. In addition, although HPV and HIV infections often occur together, studies on HPV knowledge and vaccination intentions among HIV-infected MSM are scarce. It is critical to investigate awareness and acceptability of the HPV vaccine for CA (CA vaccine), the relationship between HIV infection status and acceptability of the HPV vaccine, and develop a practical vaccination strategy for men and even MSM populations in mainland China. This study aims to investigate the awareness of CA and acceptance of the HPV vaccine for CA among MSM aged 18–55 years in China.

Materials and methods

Design and participants

This study was a cross-sectional online survey in the MSM population from 31 regions in China, including 22 provinces, 3 autonomous regions, 4 municipalities, and the special administrative regions of Hong Kong and Macau. A self-administered questionnaire was designed by the research team, including skin venereal disease physicians, epidemiologists and site investigators who are leaders of local organizations that serve the MSM population. A presurvey of the questionnaire was carried out in the target population in January 2017, and the research team revised and finalized the questionnaire according to the results of the presurvey. The final online electronic questionnaire was designed through Questionnaire Star software, taking into account the social invisibility and social characteristics of the MSM population.

The MSM participants were recruited through local influential MSM population-related community organizations (Lingnan Partners). A total of 902 MSM older than 18 years were successfully invited to complete the questionnaire under the guidance of the investigators, and all the retrieved questionnaires met the requirements and were included in the analysis. The study protocol was reviewed and approved by the Ethics Committees of Guangdong Provincial Dermatology Hospital, Guangzhou, China (GDDHLS -2016-112102).

Data collection

The electronic questionnaire collected information on demographic characteristics (e.g., age, education, marital status, sexual orientation), sexual behaviors (e.g., HIV status, fixed or temporary male sexual partner behaviors, and condom use in the past 12 months), history of HPV and HIV, CA and HPV/CA vaccine knowledge, HPV/CA vaccine acceptance and behavioral intentions for vaccination. The electronic questionnaire was disseminated to the MSM population via WeChat in May 2017, and the required number of questionnaires was finished within 48 hours. Only one questionnaire was allowed per respondent based on the IP address recorded by Questionnaire Star. The respondents received an allowance of 10 RMB for one successful questionnaire submission.

Statistical analysis

The main outcome variables for these analyses were the risk factors for CA vaccine knowledge and acceptance among MSM. The chi-square test was used to compare categorical variables. The crude odds ratio (ORc) was first proposed in a univariate analysis. A multistep regression model was then fitted using significant univariate background variables as candidate variables, and adjusted odds ratios (ORAs) were derived. In addition, the 95% confidence intervals (CIs) of the odds ratios were corrected. A P value <0.05 was considered statistically significant. HIV status was entered into a multiple logistic regression model as a fixed effect. Other variables with a P value <0.05 and a dummy variable P value <0.2 in univariate models were entered into a multivariate logistic regression model to explore factors associated with CA vaccine acceptance. Statistical analyses were conducted using SAS 9.4.

Result

Demographic characteristics and sexual behaviors

A total of 902 MSM older than 18 years from 31 regions in China were included in this study. The demographic characteristics and sexual behaviors of the participants are summarized in Tables 1 and 2, respectively. The median age of the 902 participants was 25 years (interquartile range: 22–30). Overall, 768 (85.1%) of the 902 participants were willing to be vaccinated with the CA vaccine. CA vaccination intention varied with monthly salary and sexual orientation, with statistically significant differences. MSM with an income over 10,000 RMB showed the highest intention to receive CA vaccination (94.2%, 768/800).

Table 1. Vaccination willingness of MSM with different demographic characteristics.

| Variable                          | N   | %    | Willing to be vaccinated | P     |
|----------------------------------|-----|------|--------------------------|-------|
| Total                            | 902 | -    | 768 (85.1%)              | -     |
| Demographic characteristics      |     |      |                          |       |
| Age                              |     |      |                          |       |
| 18–25 years                      | 458 | 50.8%| 376 (82.1%)              | 0.068 |
| 26–30 years                      | 258 | 28.6%| 226 (87.6%)              |       |
| 31–39 years                      | 153 | 17.0%| 137 (89.5%)              |       |
| ≥41 years                        | 33  | 3.7% | 29 (87.9%)               |       |
| Highest education level attained |     |      |                          |       |
| Senior high school or lower      | 179 | 19.8%| 147 (82.1%)              | 0.420 |
| Bachelor’s degree                | 667 | 74.0%| 572 (85.8%)              |       |
| Master’s degree and higher       | 56  | 6.2% | 49 (87.5%)               |       |
| Marital status                   |     |      |                          |       |
| Single                           | 573 | 63.5%| 497 (86.7%)              | 0.206 |
| Married                          | 294 | 32.6%| 242 (82.3%)              |       |
| Separated/Divorced               | 35  | 3.9% | 29 (82.9%)               |       |
| Monthly salary (RMB)             |     |      |                          |       |
| <3000                            | 136 | 15.1%| 98 (72.1%)               | <0.001|
| 2000–4999                        | 379 | 42.0%| 325 (85.8%)              |       |
| 5000–9999                        | 301 | 33.4%| 264 (87.7%)              |       |
| ≥10,000                          | 86  | 9.5% | 81 (94.2%)               |       |
| Self-identified sexual orientation|     |      |                          | 0.025 |
| Homosexual                       | 781 | 86.6%| 671 (85.9%)              |       |
| Heterosexual                     | 0   | -    | 0 (0%)                   |       |
| Bisexual                         | 85  | 9.4% | 72 (84.7%)               |       |
| Unsure                           | 36  | 4.0% | 25 (69.4%)               |       |
Bisexual and homosexual MSM were also more willing to receive the CA vaccine than those unsure of their sexual orientation.

Additionally, MSM who had a history of anal intercourse and the experience of sex with fixed or temporary male sexual partners in the past 12 months had higher vaccination intentions. However, the willingness to be vaccinated was not associated with either the number of fixed or temporary sexual partners or the use of condoms in this analysis.

### History of HIV and HPV

Table 3 shows that the prevalence of CA was 13.3% (120/902), and the proportion of MSM with previous or current CA was 21.8% (197/902), and the recurrence rate was 61.9% (122/197) among individuals with CA. Furthermore, 15.1% (136/902) of participants self-reported having tested positive for HIV. In addition, 3.9% (35/902) of MSM were coinfected with HIV and HPV (data not shown). In addition, MSM who had a history of CA and a history of HIV infection had higher vaccination intentions, and the differences were statistically significant.

### Behavioral intentions for vaccination

Behavioral intentions were also strongly associated with vaccination intention. MSM who had friends or family members who had received the HPV vaccine or who knew about HPV or discussed HPV with other people had significantly higher intentions to be vaccinated (Table 5). Regrettably, only 34.8% (314/902) of MSM had friends or family members who had ever received the HPV vaccine in this study. A total of 46.2% to 60.9% of MSM had learned about HPV or discussed HPV with others, which led to poor behavioral intentions among them to receive the HPV/CA vaccine.
Table 4. Vaccination willingness of MSM with different perceptions of condyloma acuminata and HPV/CA vaccines.

| Variable                                    | N  | %    | n (%) | P   |
|---------------------------------------------|----|------|-------|-----|
| **Perceptions of CA**                       |    |      |       |     |
| Ever heard of CA                            |    |      |       |     |
| No                                         | 153| 17.0 | 95 (62.1%) | <0.001 |
| Yes                                        | 749| 83.0 | 673 (89.9%) |       |
| Know the route of CA transmission           |    |      |       |     |
| No                                         | 372| 41.2 | 282 (75.8%) | <0.001 |
| Yes                                        | 530| 58.8 | 486 (91.7%) |       |
| Know the symptoms of CA                    |    |      |       |     |
| No                                         | 363| 40.2 | 271 (74.7%) | <0.001 |
| Yes                                        | 539| 59.8 | 497 (92.2%) |       |
| Know the endangersments of CA              |    |      |       |     |
| No                                         | 405| 44.9 | 320 (79%) | <0.001 |
| Yes                                        | 497| 55.1 | 448 (90.1%) |       |
| Know the treatments of CA                  |    |      |       |     |
| No                                         | 580| 64.3 | 465 (80.2%) |       |
| Yes                                        | 322| 35.7 | 303 (94.1%) |       |
| **Perceptions of HPV/CA vaccines**          |    |      |       |     |
| Ever heard of HPV vaccine/cervical cancer  |    |      |       |     |
| Yes                                        | 397| 44.0 | 304 (76.6%) | <0.001 |
| Know the HPV/CA vaccine prevent CA? †      |    |      |       | 0.059 |
| Yes                                        | 432| 85.5 | 401 (92.8%) |       |
| Do you think the HPV/CA vaccine is safe? ‡  |    |      |       | <0.001 |
| Not very safe/not safe                     | 71 | 7.9  | 49 (69%) |       |
| Neutral                                    | 259| 28.7 | 215 (83%) |       |
| Very safe/safe                             | 371| 41.1 | 351 (94.6%) |       |
| Uncertain                                  | 201| 22.3 | 153 (76.1%) |       |
| Do you think the HPV/CA vaccine is effective in preventing CA? † |    |      |       | <0.001 |
| Not very efficacious/not efficacious       | 28 | 3.1  | 19 (67.9%) |       |
| Neutral                                    | 215| 23.8 | 179 (83.3%) |       |
| Very efficacious/efficient                 | 483| 53.6 | 444 (91.9%) |       |
| Uncertain                                  | 176| 19.5 | 126 (71.6%) |       |

†Statistics were calculated based on 505 MSM who had ever heard of HPV or cervical cancer vaccines. CA: condyloma acuminata.

**Table 5.** Vaccination willingness of MSM with different behavioral intentions for vaccination.

| Variable                                    | N  | %    | n (%) | P   |
|---------------------------------------------|----|------|-------|-----|
| **Behavioral intentions to take HPV/CA vaccines** |    |      |       |     |
| Have any of your friends or family members received the HPV vaccine? |    |      |       | <0.001 |
| No                                         | 588| 65.2 | 490 (83.3%) |       |
| Yes                                        | 314| 34.8 | 278 (88.5%) |       |
| Have you proactively learned CA?            |    |      |       | <0.001 |
| No                                         | 353| 39.1 | 273 (73.3%) |       |
| Yes                                        | 549| 60.9 | 495 (90.2%) |       |
| Have you proactively learned HPV vaccine?   |    |      |       | <0.001 |
| No                                         | 451| 50.0 | 358 (79.4%) |       |
| Yes                                        | 451| 50.0 | 410 (90.9%) |       |
| Have you received education about CA?       |    |      |       | <0.001 |
| No                                         | 479| 53.1 | 384 (80.2%) |       |
| Yes                                        | 423| 46.9 | 384 (90.8%) |       |
| Have you proactively discussed CA or the vaccine with others? |    |      |       | 0.001 |
| No                                         | 485| 53.8 | 395 (81.4%) |       |
| Yes                                        | 417| 46.2 | 373 (89.5%) |       |

CA: condyloma acuminata.

**Factors associated with intention to receive the CA vaccine**

The results of the univariate and multivariate logistic regression model analyses are shown in Table 6. Multivariate logistic regression model analysis indicated that MSM who had a history of anal intercourse (OR = 1.9), had heard of CA (OR = 2.9), knew the treatment for CA (OR = 2.0), had heard of the HPV vaccine/cervical cancer vaccine (OR = 1.9) and received education about CA were factors associated with intention to receive the CA vaccine.

**Discussion**

This study investigated self-reported CA and HIV infection status, as well as HPV awareness and vaccination intention and relative impact factors among MSM from 31 regions in China. Males deserve the protection conferred by the HPV vaccine as much as females, especially MSM and HIV-positive individuals. We aimed to provide evidence for the acceptance of an HPV-6/11 vaccine against CA in the MSM population of China.

The increasing prevalence of HIV and HPV-6/11 infection among MSM in China is of growing concern. The overall HIV prevalence among MSM in China was estimated to be 5.7% from 2005 to 2018, with an upward annual trend. The overall HPV-6/11 prevalence among MSM in China was estimated to be 16.2% to 26.8% among HIV-positive MSM, higher than that of 8.5% to 13.1% among HIV-negative MSM. HPV and HIV infections are tightly correlated, and HIV-positive individuals are at higher risk of HPV infection and vice versa. The combination of HPV vaccination and HIV prevention and promotion of condom use reinforce each other. The potential use of HPV vaccination as a means of reducing HIV infection was reported, but there is no direct evidence thus far.

In this study, 83.0% (749/902) of MSM stated that they had heard of CA, but only 35.7%-59.8% of them knew about the transmission routes, symptoms, risks and treatment of CA. Our data coincide with several studies indicating that most men are unaware that genital warts are caused by HPV infection. Forty-six percent of MSM from the US, 25% of MSM from Haiti, 43.0% of MSM from Liberia and 40.4%-63.7% of MSM from China stated that HPV infection is the cause of genital warts. In addition, 56.0% (505/902) of MSM in this study stated that they had heard of the HPV vaccine. In other Chinese studies of MSM, HPV vaccine awareness rates varied considerably, from low rates (4.8%-10.2%) to high rates (69.7%-78.0%), which may be related to the economic situation of the different study sites. Inadequate knowledge of HPV infection and related diseases will be a great impediment for prevention and early diagnosis. Poor knowledge of CA suggests that it is necessary to further strengthen publicity and education about HPV and CA in the MSM population.

In this study, 85.1% (768/902) of MSM from 31 regions in China were willing to be vaccinated against CA. Another similar study reported that 82.8% (736/889) of MSM from 31 regions in China were willing to be vaccinated against HPV. In a meta-analysis of 78 studies mainly from the US, the average HPV vaccine acceptability among MSM was 63% (range from 30% to 97%). In this study, history of anal intercourse, knowledge of CA, knowledge of the treatments for CA, knowledge of the HPV vaccine/cervical cancer vaccine, and having received education about CA were factors...
### Table 6. Factors associated with intention to receive the CA vaccine among MSM in China.

| Variable                                           | % (number of those willing to receive CA vaccination/number of MSM) | Crude odds ratio | Adjusted odds ratio |
|----------------------------------------------------|---------------------------------------------------------------|-----------------|-------------------|
| **Demographic Characteristics**                    |                                                               |                 |                   |
| Monthly salary (RMB)                               |                                                               |                 |                   |
| ≤2000                                              | 72.1% (98/136)                                                | ref             |                   |
| 2000–4999                                          | 85.8% (325/379)                                               | 2.3 (1.5, 3.7)  | <0.001            |
| 5000–9999                                          | 87.7% (264/301)                                               | 2.8 (1.7, 4.6)  | <0.001            |
| ≥ 10,000                                          | 94.2% (81/86)                                                 | 6.3 (2.4, 16.7) | <0.001            |
| Self-identified sexual orientation                 |                                                               |                 |                   |
| Heterosexual/Unsure                                | 69.4% (25/36)                                                 | ref             |                   |
| Bisexual                                           | 84.7% (72/85)                                                 | 2.4 (1.0, 6.1)  | 0.059             |
| Homosexual                                         | 85.9% (671/781)                                               | 2.7 (1.3, 5.6)  | 0.009             |
| **Sexual behaviors**                               |                                                               |                 |                   |
| History of anal intercourse                        |                                                               |                 |                   |
| No                                                 | 73.4% (94/128)                                                | ref             | ref               |
| Yes                                                | 87.1% (674/774)                                               | 2.4 (1.6, 3.8)  | <0.001            |
| Experience of sex with fixed male sexual partners in the past 12 months | | | |
| No                                                 | 80.1% (265/331)                                               | ref             |                   |
| Yes                                                | 88.1% (503/571)                                               | 1.8 (1.3, 2.7)  | 0.001             |
| Experience of sex with temporary male sexual partners in the past 12 months | | | |
| No                                                 | 81.6% (369/452)                                               | ref             |                   |
| Yes                                                | 88.7% (399/450)                                               | 1.8 (1.2, 2.6)  | 0.003             |
| **History of HIV**                                 |                                                               |                 |                   |
| HIV testing status                                 |                                                               |                 |                   |
| Have never tested before                           | 79.2% (244/308)                                               | ref             | ref               |
| HIV negative                                       | 88.9% (407/458)                                               | 2.1 (1.4, 3.1)  | <0.001            |
| HIV positive                                       | 86.0% (117/136)                                               | 1.6 (0.9, 2.8)  | 0.092             |
| **History of HPV**                                 |                                                               |                 |                   |
| History of CA                                      |                                                               |                 |                   |
| No                                                 | 83.3% (587/705)                                               | ref             |                   |
| Yes                                                | 91.9% (181/197)                                               | 2.3 (1.3, 3.9)  | 0.003             |
| **Perceptions of CA**                              |                                                               |                 |                   |
| Ever heard of CA                                   |                                                               |                 |                   |
| No                                                 | 62.1% (95/153)                                                | ref             | ref               |
| Yes                                                | 89.9% (673/749)                                               | 5.4 (3.6, 8.1)  | <0.001            |
| Know the routes of transmission of CA              |                                                               |                 |                   |
| No                                                 | 75.8% (282/372)                                               | ref             |                   |
| Yes                                                | 91.7% (486/530)                                               | 3.5 (2.4, 5.2)  | <0.001            |
| Know the symptoms of CA                            |                                                               |                 |                   |
| No                                                 | 74.7% (271/363)                                               | ref             |                   |
| Yes                                                | 92.2% (497/539)                                               | 4.0 (2.7, 6.0)  | <0.001            |
| Know the risks of CA                               |                                                               |                 |                   |
| No                                                 | 79.0% (320/405)                                               | ref             |                   |
| Yes                                                | 90.1% (448/497)                                               | 2.4 (1.7, 3.6)  | <0.001            |
| Know the treatments for CA                         |                                                               |                 |                   |
| No                                                 | 80.2% (465/580)                                               | ref             | ref               |
| Yes                                                | 94.1% (303/322)                                               | 3.9 (2.4, 6.5)  | <0.001            |
| **Perceptions of HPV/CA vaccines**                 |                                                               |                 |                   |
| Ever heard of available HPV vaccine/cervical cancer vaccine abroad? | | | |
| No                                                 | 76.6% (304/397)                                               | ref             | ref               |
| Yes                                                | 91.9% (464/505)                                               | 3.5 (2.3, 5.1)  | <0.001            |
| Behavioral intention to take up HPV/CA vaccine     |                                                               |                 |                   |
| Have any of your friends or family members received the HPV vaccine? | | | |
| No                                                 | 83.3% (490/588)                                               | ref             |                   |
| Yes                                                | 88.5% (278/314)                                               | 1.5 (1.0, 2.3)  | 0.036             |
| Have you proactively learned about CA?             |                                                               |                 |                   |
| No                                                 | 77.3% (273/353)                                               | ref             |                   |
| Yes                                                | 90.2% (495/549)                                               | 2.7 (1.8, 3.9)  | <0.001            |
| Have you proactively learned about HPV vaccine?    |                                                               |                 |                   |
| No                                                 | 79.4% (358/451)                                               | ref             |                   |
| Yes                                                | 90.9% (410/451)                                               | 2.6 (1.8, 3.9)  | <0.001            |
| Have you received education about CA?              |                                                               |                 |                   |
| No                                                 | 80.2% (384/479)                                               | ref             | ref               |
| Yes                                                | 90.8% (384/423)                                               | 2.4 (1.6, 3.6)  | <0.001            |
| Have you proactively discussed CA or the vaccine with others? | | | |
| No                                                 | 81.4% (395/485)                                               | ref             |                   |
| Yes                                                | 89.5% (373/417)                                               | 1.9 (1.3, 2.8)  | 0.001             |

CA – condyloma acuminata.
associated with CA vaccine acceptability. This implies that knowledge and education about CA and HPV vaccines were the primary factors impacting CA vaccine acceptability. The findings of our study are consistent with those of previous studies, and they also reinforce the importance of promoting CA and HPV vaccine awareness and education in the MSM population. To form a positive attitude toward HPV vaccination, media promotion and the popularization of health science are very effective methods for raising awareness of HPV infection and vaccines among MSM.

As previously mentioned, we have emphasized the strong association between HPV and HIV. However, there was no statistical relationship between HIV infection status and acceptability of the CA vaccine in this study, which was unexpected. Our initial hypothesis was that HIV-positive status would increase awareness of self-care, which would make MSM more concerned about their health and would increase the uptake of the CA vaccine. We found that this conclusion was not reached by all studies. Several studies described that HIV-infected MSM displayed higher acceptability, whereas there was no statistical correlation in some other studies. The negative result of our study may be due to the unbalanced distribution of the number of HIV-positive and HIV-negative participants. Although not statistically significant in this study, the correlation between HIV status and acceptability of the HPV vaccine was of high practical importance, which warrants further research.

HPV infection is extremely common in both females and males. Several studies have reported that males, especially MSM, may have higher rates of HPV-6/11 infection than females. Although national HPV vaccination programs have been implemented in 110 countries worldwide, due to insufficient vaccine supply and uneven distribution, only 11 countries have included males in their national vaccination programs. Developing countries with high cervical cancer disease burdens still regard women as the only target population. Therefore, if an HPV-6/11 vaccine against CA can be developed and universally used in males, especially MSM, it will be substantial in reducing the disease burden of CA.

There are some limitations to this study. First, we employed a self-administered electronic questionnaire. Potential bias caused by self-reporting and inaccurate responses cannot be ruled out.

Second, our questionnaire was completed through social media platforms by participants, and caution should be exercised in the interpretation of the results. Finally, our study participants may not be representative of the general MSM population.

Nonetheless, our study raised serious concerns about HPV and HIV infection in MSM. With current moderate levels of CA and HPV vaccine awareness and acceptance, more emphasis should be placed on improving behavioral interventions for high-risk populations in China. Further announcements and education are necessary so that people at high risk for CA can gain more knowledge about HPV and related diseases and the benefits of the HPV vaccine. In addition, if an HPV-6/11 vaccine against CA is universally available, it would alleviate the insufficiency of the cervical cancer vaccine supply and be greatly beneficial for the prevention and control of CA in high-risk populations, such as MSM.

**Abbreviations**

**Abbreviations**  
Human papillomavirus  
CA: condyloma acuminata  
MSM: men who have sex with men  
HIV: human immunodeficiency virus  
STDs: sexually transmitted diseases  
OR: odds ratio  
CI: confidence interval

**Acknowledgements**

We are hugely greatly to all those who helped to design the self-administered questionnaire. We thank the employees of Xiamen Innovax for their help in the design of the project and the Lingnan Partners of MSM population organization for their help in the implementation of the project. We also thank you for the financial support from Xiamen Innovax Biotech Co., Ltd. (XNBH00030740). The funder had no role in the implementation of the project, data collection and analysis, and decision to publish.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**Funding**

The work was supported by the Xiamen Innovax Biotech Co., Ltd. [XNBH00030740].

**Authors’ contributions**

XQ-R, AQ-L, WJ-K, TW, and HC-Z designed and coordinated the study. XQ-R monitored the implementation of the project and the collection of the data. LX-Q analyze the data and prepared the manuscript. All authors critically reviewed the manuscript and approved the final version.

**Data availability statement**

Authorization to access the data may be considered by the authors upon reasonable requests. Requests to access these datasets should be directed to the corresponding author, xuqi-ren@ntu.edu.cn.

**References**

1. Lacey CJ, Lowndes CM, Shah KV. Chapter 4: burden and management of non-cancerous HPV-related conditions: HPV-6/11 disease. Vaccine. 2006;24:35/35–41.
2. Patel H, Wagner M, Singhal P, Kothari S. Systematic review of the incidence and prevalence of genital warts. BMC Infect Dis. 2013;13:39.
3. Jin F, Prestage GP, Kippax SC, Pell CM, Donovan B, Templeton DJ, Kaldor JM, Grulich AE. Risk factors for genital and anal warts in a prospective cohort of HIV-negative homosexual men: the HIM study. Sex Transm Dis. 2007;34:488–493.
4. Banura C, Mirembe FM, Orem J, Mboeye AK, Kasasa S, Mbide EK. Prevalence, incidence and risk factors for anogenital warts in sub-Saharan Africa: a systematic review and meta-analysis. Infect Agent Cancer. 2013;8:27.
5. Machalek DA, Poynten M, Jin F, Fairley CK, Farnsworth A, Garland SM, Hillman RJ, Petoumenos K, Roberts J, Tabrizi SN, et al. Anal human papillomavirus infection and associated neo-plastic lesions in men who have sex with men: a systematic review and meta-analysis. Lancet Oncol. 2012;13(5):487–500.

6. Wei F, Guo M, Huang S, Li M, Cui X, Su Y, et al. Sex differences in the Incidence and clearance of anogenital human papillomavirus infection in Liuzhou, China: an observational cohort study. Clin Infect Dis. 2020;70(1):82–89.

7. Nordenvall C, Chang ET, Adami HO, Ye W. Cancer risk among patients with condylomata acuminata. Int J Cancer. 2006;119:888–893.

8. Blomberg M, Friis S, Munk C, Bautz A, Kjaer SK. Genital warts and risk of cancer: A Danish study of nearly 50,000 patients with genital warts. J Infect Dis. 2012;205:1544–1553.

9. Li YZ, Xu JJ, Qian HZ, You BX, Zhang J, Zhang JM, Hu QH, Chu ZX, Liu SY, Jiang YJ, et al. High prevalence of HPV infection and unprotected anal intercourse among older men who have sex with men in China: a systematic review and meta-analysis. BMC Infect Dis. 2014;14(1):531.

10. Geretti AM, Brook G, Cameron C, Chadwick D, French N, Heyderman R, Ho A, Hunter M, Ladhani S, Lawton M, et al. British HIV association guidelines on the use of vaccines in HIV-positive adults 2015. HIV Med. 2016;17(Suppl 3):s2–81.

11. Ali H, Donovan B, Wand H, Read TR, Regan DG, Grulich AE, Fairley CK, Guy RJ. Genital warts in young Australians five years into national human papillomavirus vaccination programme: national surveillance data. Bmj. 2013;346:f2032.

12. Petrosky E, Bocchini JA Jr., Hariri S, Chesson H, Curtis CR, Saraiya M, Unger ER, Markowitz LE. Use of 9-valent human papillomavirus (HPV) vaccine: updated HPV vaccination recommendations of the advisory committee on immunization practices. MMWR Morb Mortal Wkly Rep. 2015;64:300–304.

13. Human papillomavirus vaccines: WHO position paper , May 2017. Releve epidemiologique hebdomadaire. World Health Organ. 2017;92:241–268. doi:10.1016/j.vaccine.2017.05.069.

14. World Health Organization. Vaccine in national immunization programme update[EB/OL]. [2021-03-08]. http://www.who.int/immunization/monitoring_surveillance/VaccineIntroStatus.pptx?ua=1.

15. Mo ZJ, Bi ZF, Sheng W, Chen Q, Huang T, Li MQ, et al. Safety and immunogenicity of an Escherichia coli-produced bivalent human papillomavirus type 6/11 vaccine: a dose-escalation, randomized, double-blind, placebo-controlled phase 1 trial. Hum Vaccines Immuno. 2022;2092363.

16. Li X, Cao X, Li Z, Yang Y, Li M, Feng B, Xin H, Zhang H, Gao L. Human papillomavirus awareness and vaccine acceptability among men who have sex with men from mainland China. Sci Rep. 2019;9:8763.

17. Tian T, Wang D, Papamichael C, Yan Z, Guoyao S, Zhanlin Z, Mahan Y, Xiaojing T, Zheng G, Jianghong D, et al. HPV vaccination acceptability among men who have sex with men in Urumqi, China. Hum Vaccines Immuno. 2019;15(4):1005–1012.

18. Zou H, Meng X, Jia T, Zhu C, Chen X, Li X, Xu J, Ma W, Zhang X. Awareness and acceptance of human papillomavirus (HPV) vaccination among males attending a major sexual health clinic in Wuxi, China: a cross-sectional study. Hum Vaccin Immunother. 2016;12:1551–1559.

19. Lau JT, Wang Z, Kim JH, Lau M, Lai CH, Mo PK, Gray CM. Acceptability of HPV vaccines and associations with perceptions related to HPV and HPV vaccines among men who have sex with men in Hong Kong. PLoS One. 2013;8:e57204.

20. Wang Z, Mo PK, Lau JT, Lau M, Lai CH. Acceptability of HPV vaccines and perceptions related to genital warts and penile/anal cancers among men who have sex with men in Hong Kong. Vaccine. 2013;31:4675–4681.

21. He W, Pan H, Lin B, Zhong X. Analysis of HPV vaccination willingness amongst HIV-negative men who have sex with men in China. Vaccines (Basel). 2021;9(49):1069.

22. Pan H, He W, Lin B, Zhong X. Factors influencing HPV vaccination willingness among men who have sex with men in China: a structural equation modeling analysis. Hum Vaccines & Immuno. 2022;18:2038504.

23. Dong MJ, Peng B, Liu ZF, Ye QN, Liu H, Lu XL, Zhang B, Chen JN. The prevalence of HIV among MSM in China: a large-scale systematic analysis. BMC Infect Dis. 2019;19:1000.

24. Zhou Y, Lin YF, Gao L, Dai J, Luo G, Li L, Yuan T, Li P, Zhan Y, Gao Y, et al. Human papillomavirus prevalence among men who have sex with men in China: a systematic review and meta-analysis. Eur J Clin Microbiol Infect Dis. 2021;40(7):1357–1367.

25. van der Loeff MF, Nittayag AG, Giuliano AR. HPV vaccination to prevent HIV infection: time for randomized controlled trials. Sex Transm Dis. 2011;38:640–643.

26. Nadarzynski T, Smith H, Richardson D, Jones CJ, Llewellyn CD. Human papillomavirus and vaccine-related perceptions among men who have sex with men: a systematic review. Sex Transm Infect. 2014;90:515–523.

27. Reiter PL, Brewer NT, McRee AL, Gilbert P, Smith JS. Acceptability of HPV vaccine among a national sample of gay and bisexual men. Sex Transm Dis. 2010;37:197–203.

28. Gichane MW, Calo WA, McCarthy SH, Walmer KA, Boggan JC, Brewer NT. Human papillomavirus awareness in Haiti: preparing for a national HPV vaccination program. J Pediatr Adolesc Gynecol. 2017;30:96–101.

29. Lieber M, Reynolds CW, Lieb W, McGill S, Beddoo AM. Human papillomavirus knowledge, attitudes, practices, and prevalence among men who have sex with men in Monrovia, Liberia. J Low Genit Tract Dis. 2018;22:326–332.

30. Nadarzynski T, Frost M, Miller D, Wheldon CW, Wiernik BM, Zou H, Richardson D, Marlow LAV, Smith H, Jones CJ, et al. Vaccine acceptability, uptake and completion amongst men who have sex with men: a systematic review, meta-analysis and theoretical framework. Vaccine. 2021;39(27):3565–3581.

31. Gerend MA, Madkins K, Phillips G, Mustanski B. Predictors of human papillomavirus vaccination among young men who have sex with men. Sex Transm Dis. 2016;43:185–191.

32. Rank C, Gilbert M, Ogilvie G, Jayaraman GC, Marchand R, Trussler T, Hogg RS, Gustafson R, Wong T. Acceptability of human papillomavirus vaccination and sexual experience prior to disclosure to health care providers among men who have sex with men in Vancouver, Canada: implications for targeted vaccination programs. Vaccine. 2012;30:5753–5760.

33. Zhao Y, Xin X, Deng H, Xu J, Weng W, Zhang M, Li J, Gao Y, Huang X, Liu C, et al. Improving the acceptability of human papillomavirus vaccines among men who have sex with men according to the associated factors: a systematic review and meta-analysis. Front Pharmacol. 2021;12:600273.

34. Giuliano AR, Nyitray AG, Kreimer AR, Pierce Campbell CM, Goodman MT, Sudenga SL, Monsonego J, Franceschi S. EUROGIN 2014 roadmap: differences in human papillomavirus infection natural history, transmission and human papillomavirus-related cancer incidence by gender and anatomic site of infection. Int J Cancer. 2015;136:2752–2760.

35. Bruni L, Saurazano A, Montolivo A, Brotos M, Alemany L, Diallo MS, Afsar OZ, LaMontagne DS, Mosina L, Contreras M, et al. HPV vaccination introduction worldwide and WHO and UNICEF estimates of national HPV immunization coverage 2010-2019. Prev Med. 2021;144:106399.