

RESEARCH PAPER



# Factors influencing HPV vaccination willingness among men who have sex with men in China: a structural equation modeling analysis

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## ABSTRACT

Men who have sex with men (MSM) are at high risk of infection with human papillomavirus (HPV). Some countries have incorporated MSM into their HPV vaccination strategies. The acceptance of the HPV vaccine is an important factor affecting vaccine promotion in MSM. This study aims to analyze the factors influencing HPV vaccination willingness among MSM in China. Non-probability sampling was used to recruit MSM in China in June 2021. The information collected included demographic characteristics, HPV knowledge, attitude, behavior, history of sexually transmitted diseases (STDs), and HPV vaccination intention. A structural equation model was used to analyze the data based on the theory of knowledge-attitude-behavior. Among 889 participants, 736 (82.79%) of the MSM were willing to receive the HPV vaccine. The results of the structural equation model showed that knowledge, attitude, behavior, and STD history influenced the vaccination intention, of which knowledge (total effect of .36) and attitude (total effect of .31) had the greatest influence. Since most MSM in China were willing to be vaccinated against HPV, they should be considered for inclusion in the HPV vaccination program. Enhancing HPV awareness and improving risk awareness may be useful in increasing the vaccination willingness of MSM in China.

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## Introduction

Human papillomavirus (HPV) is the most common sexually transmitted virus worldwide, causing the majority of cervical, oropharyngeal, anal, and vulvar cancers. Research evidence suggests that more than 9000 cases of HPV-related cancers occur in men in the United States annually, accounting for 63% of penile, 91% of anal, and 72% of oropharyngeal cancers.<sup>1</sup> HPV-associated oropharyngeal squamous cell cancer is a disease that primarily affects men and has one of the most rapidly rising incidences in high-income countries. The incidence of oropharyngeal squamous cell cancer in men surpassed that of cervical cancer in the UK for the first time in 2016,<sup>2</sup> as was the case in the USA in 2015.<sup>3</sup> Men who have sex with men (MSM) are at high risk of HPV infection. The overall prevalence of HPV infection is very high among MSM internationally (63.9% in HIV-negative MSM and 92.6% in HIV-infected MSM).<sup>4</sup> Numerous studies have reported that MSM have higher oral and anal HPV prevalence than women and heterosexual men.<sup>5–7</sup> HPV is far more prevalent among MSM (the prevalence of anal HPV infection is 59.2%), compared with heterosexual men (the overall HPV prevalence is 14.5%) and women (the overall HPV prevalence is 15.6%) in China.<sup>6–8</sup> HIV-positive MSM are more likely to be infected with HPV than HIV-negative MSM, and tend to be infected with multiple HPV genotypes.<sup>9–11</sup>

The HPV vaccine is intended to prevent HPV infection. Three prophylactic HPV vaccines are currently available for the prevention of HPV-related diseases; the 2-valent vaccine is recommended for females, while the 4-valent and 9-valent

vaccines are recommended for both males and females.<sup>12–15</sup> Several studies have shown that HPV vaccination effectively prevents preventing anal, penile, and oral HPV infection in MSM.<sup>16–18</sup> The HPV vaccine is promoted only in women in most countries. Therefore, MSM who do not receive indirect protection from vaccination can only be protected by being vaccinated.<sup>19,20</sup> The HPV vaccine is effective even after the first sexual encounter.<sup>21,22</sup> Increasing vaccination coverage in the MSM population will ultimately have an important impact on reducing HPV infection in MSM.<sup>17,23,24</sup> Therefore, an increasing number of countries, such as Spain, the United Kingdom, the United States, and Australia, are incorporating MSM (aged up to 26 and 45 years in the USA and the UK, respectively) into their HPV vaccination strategies.<sup>15,24–26</sup> The HPV vaccine, which was introduced to mainland China in 2016, is promoted only in women. Two types of HPV vaccines (4-valent and 9-valent) are provided to males aged 9 years or more by private physicians in Hong Kong, China.<sup>13</sup> However, HPV vaccination rates among MSM are well below the target in some countries where HPV vaccination is recommended for MSM, such as in the USA and France.<sup>27,28</sup> The main factors influencing HPV vaccination among MSM include provider recommendation, age, HPV vaccine attitudes, and HPV knowledge.<sup>27–30</sup> Therefore, HPV vaccination willingness is an important factor affecting vaccine promotion in MSM,<sup>31</sup> and a topic worth studying.

There are few studies on the HPV vaccination willingness of MSM in China. Previous studies on the willingness of women to be vaccinated against HPV showed that 67.25% of women were willing to be vaccinated in China.<sup>32</sup> The vaccine acceptance

among MSM reported by region varies greatly, ranging from 34.9% to 94.9%.<sup>33,34</sup> The factors influencing vaccination willingness mainly include HPV and HPV vaccination knowledge, attitude, sexual behavior, history of sexually transmitted diseases (STDs), and HIV-related services.<sup>33–35</sup> HPV knowledge, attitude, and behavior are correlated, but no studies have taken this into account. The knowledge-attitude-behavior (KAB) model is the most commonly used model to explain how individual knowledge and attitudes affect health behavior. It explains that a person's knowledge directly affects his/her attitude, and indirectly affects behavior through his/her attitude.<sup>36</sup> Therefore, in this study, we applied the KAB model and analyzed the influence of knowledge, attitude, and behavior on HPV vaccination willingness using a structural equation model. The results of this study will be useful in providing recommendations for the future promotion of the HPV vaccine in MSM.

## Methods

### Subjects and recruitment

In June 2021, MSM were recruited from various cities in China using non-probability sampling. The participants were self-identified gay or bisexual MSM aged 16–45; women and heterosexual men were excluded. In this study, we employed a cross-sectional online survey. Some of the participants were recruited from existing MSM groups (the cohort of “National Science and Technology Major Project 2018ZX10721102-005”), while others were recruited from three nongovernmental organizations (NGOs) through core members of NGOs who were in the existing cohort. Acquired immunodeficiency syndrome (AIDS) voluntary counseling, testing clinic staff and NGOs sent questionnaires to MSM through WeChat. The participants could decide whether to participate in the survey after understanding the purpose, confidentiality, time spent and reward [10 RMB (approximately \$1.56)]. The participants had the right to withdraw from the investigation at any time. All of the participants' responses were confidential. This study was approved by the Ethics Committee of Chongqing Medical University (2,019,001).

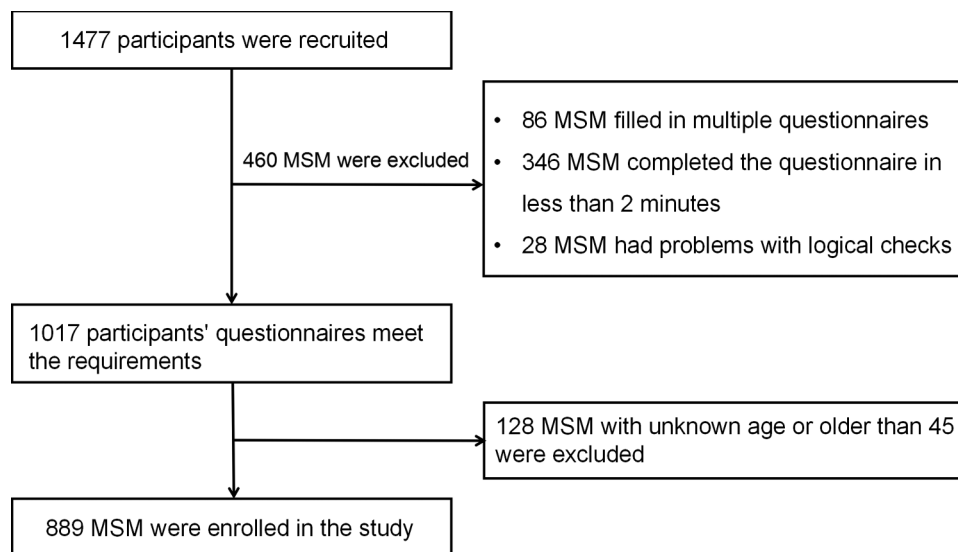
A total of 1,477 participants were recruited. A total of 558 individuals (39.81%) were excluded: those who were of unknown age or older than 45, filled in multiple questionnaires, had problems with logical checks or took less than 2 min to complete the questionnaire (after testing, we assessed that it should have taken participants at least 2 min to complete the questionnaire). The flow chart of the enrollment of participants is shown in [Figure 1](#). The remaining 889 participants met the requirements. The regional distribution of participants was as follows: 283 (31.83%) from Chongqing, 102 (11.471%) from Guangdong, 88 (9.90%) from Sichuan, 65 (7.31%) from Beijing and 351 (39.48%) from 27 other cities. The regional distribution of participants is shown in [Figure 2](#).

### Measurements

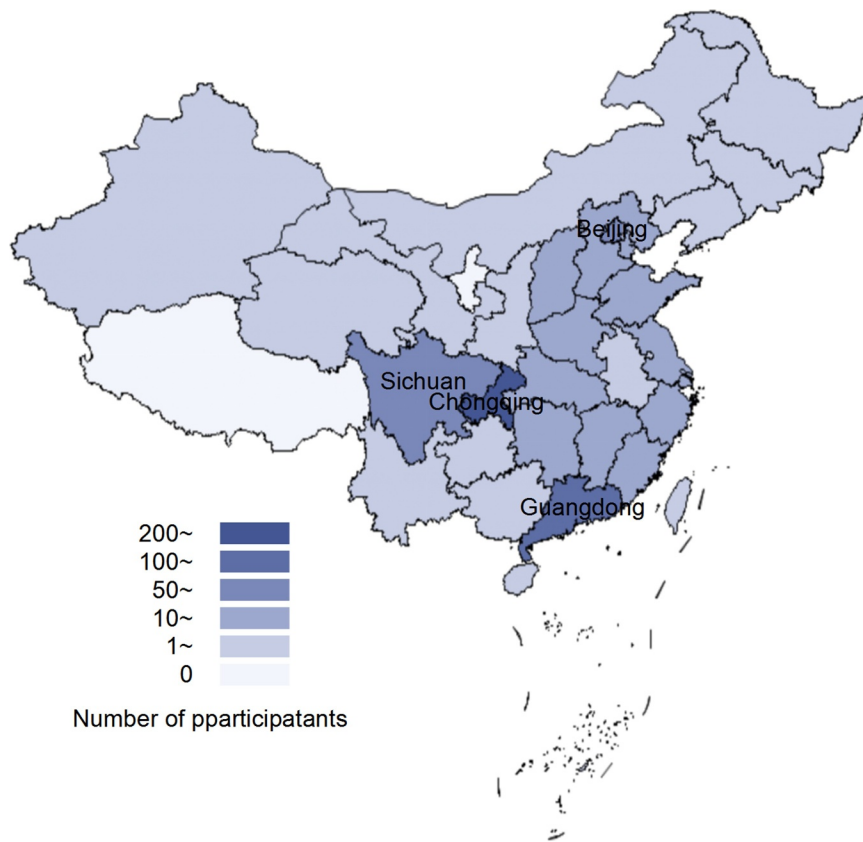
The social demographic characteristics included date of birth, household registration, ethnic groups, educational level, employment status, legal marital status (marriage with women), and personal monthly disposable income. Knowledge, attitude and behavior are latent variables that are difficult to measure directly and need to be measured by observed variables. Based on previous literature, 12 observed variables were identified to measure the knowledge of HPV and HPV vaccines.<sup>37–39</sup> Attitude was measured using two observed variables: perceived possibility and perceived severity. Seven variables were observed in behavior: the number of male sexual partners, the number of times MSM had sexual intercourse with men, condom use, STD counseling, HIV counseling, STD testing, and HIV testing in the past six months. The initial structural equation model is shown in [Figure 3](#).

### Statistical analysis

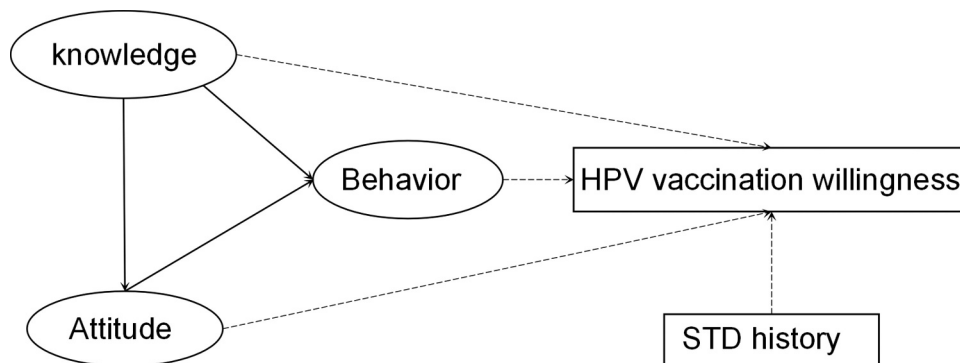
Data collation and univariate analysis were performed using SAS version 9.4. Categorical data were described in frequencies and percentages. The chi-squared test was used to compare variables between groups. Mplus version 8.3 (Asparouhov & Muthén,



**Figure 1.** Flow chart of the enrollment of participants.



**Figure 2.** Regional distribution of participants.



**Figure 3.** Initial structural equation model. Note: The solid line represents the theoretical model of knowledge, belief, and behavior. The dotted lines represent the four paths added in this study.

2019) was used for structural equation modeling and analysis. All the variables used in this study were categorical; thus, a weighted least squares mean and variance adjusted estimator was used to estimate the parameters. The commonly used model-fit indices include the chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). The chi-square test is easily affected by other factors (such as degree of freedom and sample size), so this study did not use it as a model fit index. We mainly adopted the suggestions of Hu and Bentler in this study.<sup>40</sup> CFI >.95, TLI >.95, SRMR <.08 and RMSEA <.06 indicated that the model was reasonable. The critical values of the model fit index were given by researchers

through a simulation study or experience, as there is no consensus on the acceptable levels of these critical values. Therefore, the aforementioned critical values are only for reference.

## Results

### *Sociodemographic characteristics*

A total of 889 MSM were eligible for this study. The median age of the participants was 28 years (interquartile range: 23–33), and none of the participants had been vaccinated against HPV. A total of 736 (82.79%) MSM were willing to be vaccinated against HPV. The HPV vaccination willingness varied with

education and marital status: MSM with a bachelor's degree or higher educational level exhibited the highest willingness (86.21%) to be vaccinated against HPV. Compared with married, divorced or widowed MSM, unmarried MSM were more willing to be vaccinated (84.78%). There was no significant difference in vaccination willingness among MSM of different ages, household registrations, ethnic groups, employment status, and income levels ( $p > .05$ ) (Table 1).

### Knowledge, attitude and behavior

The vaccination willingness of MSM with different knowledge, attitudes, behaviors and STD histories is shown in Table 2.

#### Knowledge of HPV and HPV vaccines

Most MSM had heard of HPV (71.43%), HPV-related diseases (70.98%) and the HPV vaccine (77.95%). MSM who had heard about HPV, HPV-related diseases and the HPV vaccine had a significantly higher willingness to be vaccinated ( $p < .05$ ). A total of 50.28% of MSM answered incorrectly when presented with the statement "most HPV infections have no visible symptoms." A total of 40.61% of MSM answered incorrectly when asked if "the HPV vaccine protects against all types of HPV infection;" the MSM who answered incorrectly were more likely to be vaccinated. In terms of other knowledge, the MSM who answered correctly had a higher willingness to be vaccinated than those who answered incorrectly.

**Table 1.** Vaccination willingness of MSM with different demographic characteristics ( $n = 889$ ).

Variable	Willing to be vaccinated			<i>p</i>
	All	<i>n</i>	%	
N	889	736	82.79	
Age				0.8539
16 ~ 26	372	309	83.06	
27 ~ 45	517	427	82.59	
Household registration#				0.1638
Urban areas	527	444	84.25	
Rural areas	362	292	80.66	
Ethnic groups				0.9452
Han nationality	855	708	82.81	
Other ethnic minorities	34	28	82.35	
Highest education level				0.0324
Junior high and below	68	53	77.94	
High school	140	114	81.43	
Junior college	217	169	77.88	
College and above	464	400	86.21	
Employment status				0.3894
Employed	655	546	83.36	
Students	160	133	83.13	
Retired or unemployed	74	57	77.03	
Marital status*				0.0337
Unmarried	644	546	84.78	
Married	209	161	77.03	
Divorced/widowed	36	29	80.56	
Monthly disposable income				0.5494
1000 RMB or less	65	50	76.92	
1001 ~ 3000 RMB	197	162	82.23	
3001 ~ 5000 RMB	231	197	85.28	
5001 ~ 10,000 RMB	280	229	81.79	
10,000 RMB or more	116	98	84.48	

Note: The Chi-square test was used for comparison between groups. \* Only heterosexual marriage is currently legally allowed in China. Some MSM ever married women due to pressure from family and society. Married MSM were not excluded because they still had sex with men. # Household registration usually indicates the place of birth. Many people with rural household registration came to live in cities when they grew up.

### Attitude

Only 17.66% of MSM thought they had a high chance of being infected with HPV and 37.80% of MSM thought that HPV posed a great or particularly great threat to them. MSM who thought they were more likely to be infected were more likely to be vaccinated. MSM who perceived a high threat were more willing to be vaccinated than those who perceived a low threat; the difference was statistically significant ( $p < .05$ ).

### Behavior

MSM who had one or more male partners, had sex with men, received STD counseling and testing, or received AIDS counseling and testing within the last six months had higher vaccination willingness. A total of 46.23% of MSM had been tested for STDs. A total of 11.47% of MSM had been diagnosed with STDs in the last sex months. MSM who had been diagnosed with STDs were more likely to be vaccinated. There were significant differences in the aforementioned behaviors between the two groups ( $p < .05$ ).

### Structural equation model

#### Testing the measurement model

The initial measurement model was tested. The degrees of freedom were 207 ( $df \geq 0$ ), which satisfied the t-rule, and the model could be identified. The model fit indices were as follows: CFI = .961, TLI = .957, SRMR = .087, and RMSEA = .068. These model fit indices either reached or were close to the recommended values, making the model acceptable. The factor loading of K12 (whether the HPV vaccine protects against all types of HPV infection) was less than .5, which was lower than the acceptable level; thus, it was deleted. The factor loading of other items was at an acceptable level, and the significance was  $p < .01$ .

#### Structural equation model of HPV vaccination willingness

After deleting the K12 item, the structural equation model of HPV vaccination willingness was constructed. The degrees of freedom were 204 ( $\geq 0$ ), which satisfied the t-rule, and the model could be identified. The model-fit indices were as follows: CFI = .959, TLI = .953, SRMR = .084, and RMSEA = .071. The standardized path coefficients of the initial structural equation model of HPV vaccination willingness are shown in Table 3. Except for the path from knowledge to behavior, all standardized path coefficients were statistically significant ( $p < .01$ ). Thus, the model was modified by removing the path from knowledge to behavior.

The modified model then fit better, and the improved model fit indices were as follows: CFI = .962, TLI = .957, SRMR = .087, and RMSEA = .068. The standardized path coefficients are shown in Figure 4. The path coefficients of the model were statistically significant ( $p < .01$ ). A standardized total effect of knowledge on vaccination willingness was .36, with a direct effect of .26 and an indirect effect of .10. A standardized total effect of attitude on vaccination willingness was .31, with a direct effect of .23 and an indirect effect of .08. The direct effect of behavior on vaccination willingness was .17. The direct effect of STD history in the last six months on vaccination willingness was .16.

**Table 2.** Vaccination willingness of MSM with different knowledge, attitude, behavior, and STD history (n = 889).

Variable	All	Willing to be vaccinated		p
		n	%	
<b>Knowledge</b>				
K1: Have you ever heard of HPV?				<.0001
Yes#	635	555	87.40	
No	254	181	71.26	
K2: Have you ever heard of HPV-related diseases?				<.0001
Yes#	631	547	86.69	
No	258	189	73.26	
K3: Using condoms can reduce HPV infection.				0.0008
Yes#	695	591	85.04	
No or don't know	194	145	74.74	
K4: HPV can infect both men and women.				<.0001
Yes#	722	618	85.60	
No or don't know	167	118	70.66	
K5: HPV can cause <i>condyloma acuminatum</i> and cervical/penile/skin cancer.				<.0001
Yes#	635	546	85.98	
No or don't know	254	190	74.80	
K6: HPV is spread mainly through sexual contact.				0.0035
Yes#	664	564	84.94	
No or don't know	225	172	76.44	
K7: Most HPV infections have no visible symptoms.				0.0320
Yes#	442	378	85.52	
No or don't know	447	358	80.09	
K8: Have you ever heard of the HPV vaccine?				<.0001
Yes#	693	605	87.30	
No	196	131	66.84	
K9: Do you know that HPV vaccines are effective in preventing cervical/anal/genital warts?				<.0001
Yes#	621	545	87.76	
No	268	191	71.27	
K10: What is the best time to get the HPV vaccine?				<.0001
Before first sex#	558	495	88.71	
Other answers	331	241	72.81	
K11: Who can be vaccinated against HPV?				<.0001
Both men and women#	689	607	88.10	
Other answers	200	129	64.50	
K12: Does the HPV vaccine protect against all types of HPV infection?				0.0019
No#	528	420	79.55	
Yes	361	316	87.53	
<b>Attitude</b>				
A1: How likely do you think you are to be infected with HPV?				<.0001
very low	292	212	72.60	
low	165	140	84.85	
average	275	234	85.09	
high	86	85	98.84	
very high	71	65	91.55	
A2: How much of a threat do you consider HPV to be for you?				<.0001
very small	166	110	66.27	
small	108	86	79.63	
average	279	232	83.15	
large	146	134	91.78	
very large	190	174	91.58	
<b>Behavior (last 6 months)</b>				
B1: Number of male sexual partners				<.0001
None	445	338	75.96	
1	285	255	89.47	
2 or more	159	143	89.94	
B2: Number of sexual encounters with men*				<.0001
1 or more	391	354	90.54	
None	474	361	76.16	
B3: Were condoms used throughout sex?*				0.0003
No sex	323	247	76.47	
No	148	121	81.76	
Yes	405	356	87.90	
B4: STD testing				<.0001
done	411	364	88.56	
Never	478	372	77.82	
B5: STD counseling				<.0001
done	348	313	89.94	
Never	541	423	78.19	
B6: HIV testing				<.0001
done	471	419	88.96	
Never	418	317	75.84	
B7: AIDS counseling				<.0001
done	413	370	89.59	

(Continued)

Table 2. (Continued).

Variable	Willing to be vaccinated			p
	All	n	%	
Never	476	366	76.89	
<b>History of STD</b>				
Have you ever been diagnosed with an STD in the last six months?				0.0077
Yes	102	94	92.16	
No	787	642	81.58	

Note: The Chi-square test was used for comparison between groups. \* indicates that the variable has missing values. The option with the # symbol is the correct response.

Table 3. Hypothesis test results (path coefficient) of the initial structural equation model of HPV vaccination willingness.

Path	Path coefficient	Standard error	p
Knowledge → Attitude	0.24	0.05	<.001
Knowledge → Behavior	0.10	0.04	0.022
Attitude → Behavior	0.39	0.04	<.001
Knowledge → HPV vaccination willingness	0.27	0.05	<.001
Attitude → HPV vaccination willingness	0.24	0.07	<.001
Behavior → HPV vaccination willingness	0.17	0.06	0.002
STD history → HPV vaccination willingness	0.16	0.06	0.005

Note: The weighted least squares mean and variance adjusted estimator (WLSMV) was used to estimate the parameters

## Discussion

### Recommendation of HPV vaccination in MSM

MSM are at high risk of being infected with HPV, as the estimated prevalence of anal HPV among MSM in China is 59.2%.<sup>8</sup> However, the HPV vaccine has not been introduced among MSM in China. In 2019, the Chinese National Medical Products Administration approved the first Chinese 2-valent HPV vaccine.<sup>41</sup> A previous study in China suggested that the Chinese 2-valent HPV vaccine was more cost-effective for MSM than other imported vaccines.<sup>42</sup> In addition, our study showed that 82.79% of MSM were willing to be vaccinated against HPV. This rate was higher than the corresponding rate for women before the HPV vaccine was recommended in China (67.25%) and higher than the international average rate for MSM (50.0%) reported in a 2021 systematic review.<sup>32,43</sup> Most MSM would accept to be vaccinated against HPV. Based

on the low cost of the Chinese 2-valent HPV vaccine and the high vaccination willingness of MSM, it is important and feasible to include MSM in the HPV vaccine project in China.

### Factors influencing HPV vaccination willingness

The structural equation model constructed in this study showed that HPV and HPV vaccine knowledge affected attitude (perceived possibility and perceived threat) and that attitude affected MSM behavior. These results were consistent with the theory of KAB.<sup>36</sup> Knowledge, attitude, and behavior influenced the vaccination intention of MSM; knowledge had the greatest impact on inoculation willingness. This was consistent with previous studies, which showed that knowledge has an important impact on vaccination willingness in women, heterosexual men, and MSM.<sup>43–45</sup> However, previous studies have not explained exactly how knowledge affects the intent to be vaccinated. The structural equation model showed that knowledge of HPV and HPV vaccines could help MSM establish correct HPV risk awareness and make them aware of the benefits of HPV vaccination, thereby increasing MSM vaccination willingness. Approximately 30% of the study participants had not heard of HPV prior to being questioned in the context of the present study, thereby indicating a low level of HPV knowledge. HPV-related knowledge can be promoted through the internet, WeChat, social media, and other platforms. At the same time, rigorous fact-checking is necessary as misinformation/disinformation can spread easily through media channels. It is worth noting that a total of 40.61% of MSM thought that the HPV vaccine could prevent all types of HPV infection, and that they were more likely to be vaccinated (87.53%). They had high expectations for the effectiveness of the

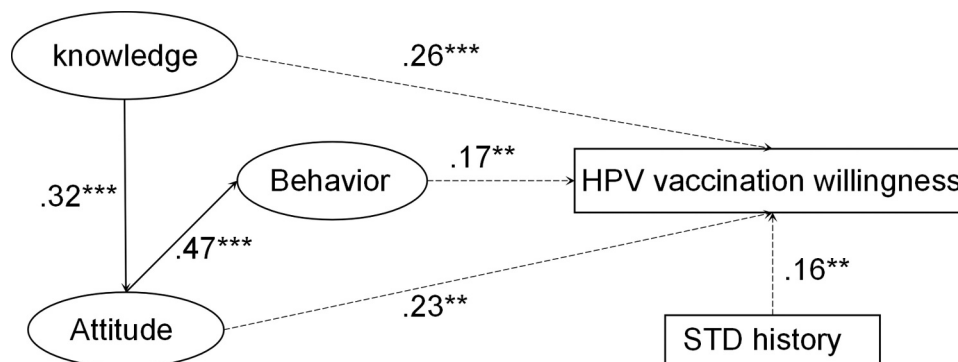


Figure 4. Modified structural equation model of HPV vaccination willingness. Note: \*\*indicate statistical significance with  $p < 0.01$ . \*\*\*indicate statistical significance with  $p < 0.001$ . The weighted least squares mean and variance adjusted estimator (WLSMV) was used to estimate the parameters.

HPV vaccine. They may be reluctant to get vaccinated after learning that the HPV vaccine only prevents most HPV infections. Therefore, the acceptance of the HPV vaccine in this study may be higher than its true acceptance.

Attitude (perceived possibility and perceived threat) was also an important factor affecting vaccination willingness. MSM with high perceived possibility and high perceived threat were more likely to reduce their risk of HPV infection through vaccination. As mentioned in the protective motivation theory, improving individual awareness in terms of disease severity and susceptibility can enhance individual protective motivation and promote the intention of behavior change.<sup>46</sup> When carrying out HPV education, there is a need to emphasize the high incidence and severity of HPV-related diseases to improve the recipients' risk perception.

Behavior affected vaccination intention. MSM with high-risk sexual behavior were more likely to be infected with HPV.<sup>47</sup> MSM with high-risk sexual behaviors, including having multiple sexual partners ( $\geq 2$ ), having sex with men in the past six months, or not using condoms throughout the course of having sex with other men, were more likely to be vaccinated against HPV. MSM exhibiting high-risk sexual behaviors have a high risk of HPV infection and high acceptance rates of the HPV vaccine; thus, they can be an important target group for HPV vaccination. MSM who underwent STD or HIV counseling and testing were more receptive to the HPV vaccine. This may be because they are exposed to STDs and have a higher risk of infection. It is difficult to reach MSM groups effectively. Hence, bundling HPV vaccination with services related to MSM, such as STDs and HIV counseling and testing, may increase the vaccination rates.

## Limitations

The present findings should be interpreted with caution, owing to several limitations. First, convenience sampling was used in this study. We used WeChat to send the questionnaires. MSM who were interested in health-related topics were more likely to complete the questionnaire. Therefore, the acceptance of the HPV vaccine in this study may be higher than its true acceptance, and our results are representative of the MSM population status to a certain extent. Second, we included sensitive topics in this study (such as the number of sexual partners, sexual behaviors, and STD history), which may lead to report bias; hence, participants may not truthfully report this sensitive information. Third, this study did not ask MSM if they found the price of the HPV vaccine to be acceptable or from which institution or organization they would like to be vaccinated against HPV. If the HPV vaccine is to be provided to MSM in the future, the price and the method of access may be important factors affecting the actual vaccination rate of MSM.<sup>33,35,48</sup> Therefore, before making the HPV vaccine available to MSM, we need to study the influence of the HPV vaccine price and acquisition method on the acceptance of the vaccine by MSM.

## Conclusion

MSM are at high risk of being infected with HPV. In this study, most MSM were willing to be vaccinated against HPV. Therefore, MSM should be considered for inclusion in the HPV vaccination program in China. Knowledge and attitude are important factors influencing the willingness of HPV vaccination in MSM. We should focus on promoting HPV and HPV vaccine knowledge and increasing risk perception to increase vaccination willingness among MSM. HPV vaccination can be bundled with MSM-related services (such as STD counseling and testing) to increase vaccination rates.

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## Disclosure statement

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

## Data availability statement

The data presented in this study are available on request from the corresponding authors. The data are not publicly available as they contain sensitive personal behaviors.

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