

Barriers and facilitators of Pre-exposure Prophylaxis (PrEP) intention among Chinese men who have sex with men

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Abstract

Background

Despite strengthened efforts on HIV prevention and control, new HIV infections continue to increase among men who have sex with men (MSM) in China. Pre-exposure prophylaxis (PrEP), a highly effective HIV prevention tool, has recently been included in China's Action Plan of HIV Prevention and Control. To inform future PrEP implementation, this study aims to identify the barriers and facilitators of PrEP intention among MSM in China.

Methods

In 2018, a cross-sectional survey was conducted among 300 MSM in Nanjing, Jiangsu Province. Questions on demographics, sexual behavior (including a 7-item high-risk behavior index), PrEP use intention, PrEP-related awareness and accessibility, and a 7-item public HIV stigma scale were included in the questionnaire. Bivariate and multivariate logistic regression analyses were conducted to identify factors associated with PrEP intention.

Results

Overall, 44.67% had more than 2 male sexual partners and 5.56% had HIV-positive sexual partners. Just 57.00% had heard of PrEP and only 4 (1.33%) participants had used PrEP. However, 75.34% expressed a willingness to use oral PrEP if its efficacy was assured. Beliefs that 'PrEP can prevent HIV if taken as prescribed' (aOR=4.84, $p<0.001$), and 'PrEP can be scaled up in the community' (aOR=3.24, $p<0.001$), were positively associated with oral PrEP intention. Concerns of side effects were negatively associated with oral PrEP intention (aOR=0.32, $p=0.006$). Respectively 77.00% of the participants would choose injectable or implanted PrEP instead of oral PrEP. One of the PrEP stigma items, 'Not certain if doctors can prescribe PrEP if I go to the clinic' was positively associated with the intention to use injectable or implanted PrEP (aOR=3.03). Individuals who had heard of PrEP (aOR=2.74) and believed 'PrEP can prevent HIV if taken as prescribed' (aOR=2.65) were also positively related to the intention to use injectable or implanted PrEP. The most common concerns regarding PrEP use were efficacy (44.67%) and side effects (38.67%). The most common reasons for using injectable and implanted PrEP were adherence (81.94% and 77.86%, respectively) and privacy concerns (56.48% and 55.00%, respectively). Affordable price and coverage of health insurance are the driving factors for using PrEP.

Conclusions

Given the relatively low awareness of PrEP-related information in China, interventions on awareness and knowledge targeting high risk individuals and communities are needed. Furthermore, additional alternatives to prevent HIV, such as long-acting injectable or implanted PrEP, should be investigated to reduce the risk of HIV infection in at-risk MSM. Particularly, it is necessary to develop a more supportive social environment for MSM when implementing PrEP programs that are approved by China's FDA.

Introduction

Despite strengthened efforts on HIV prevention and control, new HIV infections continue to increase among men who have sex with men (MSM) in China due to the presence of multiple sex partners and unprotected sex. HIV prevalence among MSM populations ranged from 5.0–20%, while incidence was reported between 1.6–6.6% [1, 2]. Similar trends were also observed in other countries in South-East Asia [3].

Pre-exposure prophylaxis (PrEP), which involves individuals at high risk of HIV taking HIV anti-retrovirals such as Truvada (tenofovir/emtricitabine) (TDF/FTC), is highly effective at preventing HIV acquisition [4]. Clinical trials have demonstrated that taking oral TDF/FTC daily decreases HIV risk by up to 99% when adherence is high [4, 5]. In addition to evidence from clinical trials, a prospective cohort study in Australia showed that PrEP implementation was associated with a rapid decline of HIV incidence among MSM at the population level [6]. A mathematical modeling study of Chinese MSM demonstrated that PrEP would be an important and cost-effective biomedical intervention if added to the existing HIV prevention programs in China [7]. Therefore, as part of a combination prevention approach, PrEP implementation has been included in the latest Five-Year Action Plan of HIV Prevention and Control by the Chinese government.

Due to its robust efficacy in preventing HIV infection in high-risk men and women, oral TDF/FTC has been approved by the FDA in the US and other countries since 2012. However, the uptake rate among high-risk individuals is very low in some countries [8, 9]. Two strong cohort studies of MSM in the United States found that only 4% of the participants reported PrEP use [8, 9]. Meanwhile, previous studies have indicated that poor adherence to daily PrEP often leads to a dramatic compromising of its HIV prevention efficacy [10]. Furthermore, while some people with high risk behaviors in China have heard of PrEP, many may be uncertain about the efficacy of PrEP due to accessibility issues and insufficient knowledge, and thus do not intend to use it [11]. Individuals who engage in relatively high-risk behaviors are more likely to use PrEP [12]. However, a previous study has also demonstrated that some high-risk individuals are not willing to use PrEP [13]. It is hence important to explore the barriers to PrEP intention among these individuals. Meanwhile, to increase uptake and adherence, additional alternatives, including injectable and implanted PrEP, have been under investigation in recent years [14, 15]. Such alternatives include long-acting injectable drugs and sustained release implanted drugs [16, 17].

MSM and medical care workers are often concerned with the relationship between high risk sexual behaviors and PrEP use [18, 19]. In addition to barriers such as insufficient knowledge, lack of prescribing providers, and concerns about side effects, HIV-related stigma is still experienced by potential and current PrEP users. For example, since antiretrovirals are also used to treat HIV-infected people, PrEP users often have concerns that others may think that they are HIV positive or engage in socially stigmatized behaviors such as injection drug use, unprotected sex and multiple sex partners [20, 21]. They may also be concerned that others think they have an HIV-infected partner, which continues to be stigmatized by society [22, 23]. In addition, if assessing the risk of acquiring HIV is an indicator of prescribing PrEP by

medical care workers, stigmatization might be perceived by those desiring PrEP medicine at clinics. This is because those who are suggested to use PrEP by medical care workers are believed to have a greater risk of acquiring HIV infection. In other words, those who are suggested to use PrEP might be judged by others as being overtly promiscuous.

At present, Truvada is applying to the Chinese FDA to classify the drug as an HIV prevention tool. Once approved, PrEP programming and scale-up will likely be one of China's HIV prevention priorities. Therefore, in order to inform future PrEP prevention efforts, it is critical to identify factors associated with PrEP intention among Chinese MSM. The objective of this study is to identify the barriers and facilitators of PrEP intention among MSM in China.

Methods

Participants and procedures

From August to October 2018, study participants were recruited in Nanjing to complete a survey about PrEP use intention and related information. Prior to conducting the cross-sectional survey, a focus group of 15 MSM was conducted where we used an interview guide exploring PrEP knowledge, barriers and facilitators of using PrEP, sexual behavior and sexual risk. Findings from the focus group were used to develop and refine the survey measures.

We utilized a multifaceted sampling approach to recruit participants. This involved online advertising, social media, referrals from community-based organizations and clinics, and recruiting the peers of eligible participants who completed the survey. 300 individuals completed an on-line anonymous questionnaire survey. To meet the eligibility criteria, participants needed to be: 1) male sex at birth; 2) 18 years old or older; 3) sexually active with other men in the past year; 4) HIV-negative or unknown. An informed consent was displayed if the participants met the eligibility screening questions. Participants received a 50RMB pre-paid cellphone card for completing the survey. The study was approved by the Institutional Review Boards of Chinese Center for Disease Control and Prevention in Beijing.

Measures

Background characteristics

Participants were asked about their socio-demographic characteristics including age, educational background, marital status, employment, income, and sexual orientation. The time of their latest HIV test was also asked.

Awareness, knowledge, accessibility and intention to use PrEP

Participants were explained the definition of PrEP in the informed consent. They were asked whether they intended to use PrEP daily or before/after having sex to prevent HIV. Four questions assessed PrEP

awareness and knowledge. These questions asked participants if they had heard of PrEP, what the percentage of PrEP efficacy was, whether PrEP could prevent HIV if taken as prescribed, and whether PrEP could cause serious side effects. Another three questions assessed concerns of accessibility: I don't know where to get PrEP drugs, I don't know whether the doctors will prescribe PrEP drugs if I go to the clinic, and whether PrEP could be scaled up in China. Questions regarding intentions to use injectable and implanted PrEP instead of oral PrEP, and the reasons for using injectable and implanted PrEP were also asked. With exceptions for the questions on PrEP efficacy and the reasons for using injectable or implanted PrEP, all response options were either Yes or No.

Sexual behaviors in the last 6 months

We asked participants about their sexual behavior in their past 6 months. Questions included number of male partners, number of positive male partners, number of times having condomless receptive anal intercourse (CRAI) with partners of any HIV status, number of times having condomless insertive anal intercourse (CIAI) with positive partners, and whether they used amphetamines and poppers. With considerations of age, we used the 7-item screening index with a cutoff (if score is 10 or greater, prescribe PrEP or offer other intensive HIV prevention services; If score is 9 or less, provide standard HIV prevention services) developed in previous studies to prioritize individuals for intensive HIV prevention efforts, including PrEP [13]. Furthermore, participants were asked about their condom use with regular male sex partners, casual male sex partners, commercial male sex partners and female sex partners. Response options for these questions were always, frequently, occasionally and never use condom.

External HIV stigma

Public stigma is the attitudes and reactions that the general population has towards people who have a particular or undesirable attribute, such as homosexuality or HIV infection [24]. In this study, public HIV stigma was measured by the 7-item subscale from the Chinese version of HIV and homosexuality-related stigma scales [25]. The items included, 'HIV infected people should be ostracized by their spouse and family members', 'HIV infected people would lose their friends if they knew their HIV status', 'HIV infected people should be forced to leave their villages', etc. The Cronbach's coefficient alpha of the subscale was 0.86 in our sample. The scale was suggested to be used in developing countries and had been used among MSM populations in China [26].

Perceptions on barriers and facilitators of using PrEP

Participants were also asked about their reasons for not using PrEP, motivations to use PrEP, accessibility and affordability issues, opinions on promoting PrEP in China and willingness to use PrEP in the next 6 months.

Data Analysis

Descriptive statistics, including numbers and percentages, were calculated for all variables. Bivariate generalized linear modeling with a binary logistic distribution was conducted to examine background variables related to PrEP intention. Background variables that were significant at the bivariate level ($p < 0.05$) were adjusted in further multivariate analysis for factors related to PrEP intention. Results were reported as odds ratios (OR) and adjusted odds ratios (aOR).

Results

Background characteristics

Table 1 presents the background characteristics of the sample. A total of 300 individuals participated in the questionnaire survey. 55.67% of the sample were between the ages of 18-28, 70.67% completed some college or higher, 90.00% were single, 79.33% had a full-time job, 52.67% had a monthly income over 5000RMB (\$745), 77.67% self-identified as gay, 81.67% had been HIV tested in the past 6 months.

Table 1. Background characteristics of men who have sex with men (N=300)

	n	%
Age		
18-28	170	56.67
29+	130	43.33
Education		
High school or less and Technical School	88	29.33
College	156	52.00
Advanced degree	56	18.67
Marital status		
Married	30	10.00
Single	270	90.00
Employment		
Full-time	238	79.33
Other (part-time, no job)	62	20.67
Income		
≤2999	68	22.67
3000-4999	74	24.66
≥5000	158	52.67
Sexual orientation		
Gay	233	77.67
Bisexual and others	67	22.33
HIV test in previous 6 months		
Yes	245	81.67
No	55	18.33

Sexual behaviors in the last 6 months

Table 2 shows the sexual behaviors of the participants. Among 300 participants, 44.67% had more than 2 male sex partners, and 5.56% had HIV positive partners. 28.67% had CRAI with any HIV status partner, while 20.67% had CIAI with positive partners. Moreover, the consistent condom use rates were 56.95%, 56.43%, 65.55% and 65.33% when faced with regular and casual male sex partners as 1 or 0 respectively. Additionally, 3.00% had a commercial male sex partner, and 7.00% had a female sex partner. Amphetamines and rush poppers were used by 1.33% and 36.67% participants. 47.30% of participants' sexual risk index scores were 10 or greater.

Table 2. Sexual behaviors of MSM in the last 6 months (N=300)

	n	%
Number of male sex partners		
<2	166	55.33
≥2	134	44.67
Number of HIV positive partners (NA=66)		
<1	221	94.44
≥1	13	5.56
Unprotected as 0		
<1	214	71.33
≥1	86	28.67
Unprotected as 1 with HIV+		
<1	238	79.33
≥1	62	20.67
Number of male regular sex partners		
0	91	30.33
1	172	57.33
2-5	36	12.00
6+	1	0.33
Condom use for 1 with regular sex partners (n=151)		
Always	86	56.95
Frequently	30	19.87
Occasionally	21	13.91
Never	14	9.27
Condom use for 0 with regular sex partners (n=140)		
Always	79	56.43
Frequently	27	19.29
Occasionally	17	12.14
Never	17	12.14
Number of male casual sex partners		
0	177	59.00
1	50	16.67
2-5	60	20.00
6+	13	4.33

Condom use for 1 with casual sex partners (n=90)	
Always	59 65.55
Frequently	18 20.00
Occasionally	7 7.78
Never	6 6.67
Condom use for 0 with casual sex partners (n=75)	
Always	49 65.33
Frequently	15 20.00
Occasionally	7 9.33
Never	4 5.33
Ever have commercial partner	
Yes	9 3.00
Ever have female partner	
Yes	21 7.00
Amphetamines	
Yes	4 1.33
Rush poppers	
Yes	104 34.67
Sexual risk index score	
<10	158 52.67
≥10	142 47.33

Bivariate correlates of PrEP intention

Only 57.00% of the participants had heard about PrEP, while 75.34% were willing to use PrEP if efficacy of preventing HIV is assured. Background variables including education level, marital status, employment status, income, sexual orientation and the timing of the HIV test were not associated with the PrEP intention at the bivariate level. The 7-item risk behavior index was also not related to the PrEP intention.

1) Bivariate correlates of oral PrEP intention

The belief that 'PrEP can prevent HIV if take as prescribed' (OR=5.41, $p < 0.001$) was positively associated with oral PrEP intention, while 'PrEP may cause serious side effects' was negatively associated with oral PrEP intention (OR=0.31, $p = 0.003$). 'Don't know where to get PrEP' and 'Doctor may not prescribe PrEP if I

go to the clinic' were not associated with oral PrEP intention, while 'PrEP can be scaled up in the community' (aOR=3.41, $p<0.001$), was positively associated with oral PrEP intention.

2) Bivariate correlates of injectable or implanted PrEP intention

Age was associated with the injectable or implanted PrEP intention at the bivariate level (OR=1.88, $p=0.03$). Beliefs that 'PrEP can prevent HIV if take as prescribed' (OR=2.55, $p=0.025$), 'Heard of PrEP' (OR=2.57, $p<0.001$) and 'Doctor may not prescribe PrEP if I go to the clinic' (OR=2.55, $p<0.001$) were all positively associated with injectable or implanted PrEP intention.

Multivariate correlates of PrEP intention

A multivariate analysis controlling for all significant variables in bivariate analysis was also undertaken.

1) Multivariate correlates of oral PrEP intention

Beliefs that 'PrEP can prevent HIV if take as prescribed' (aOR=4.84, $p<0.001$), and 'PrEP can be scaled up in the community' (aOR=3.24, $p<0.001$) remained significantly associated with PrEP intention, while concerns of side effect were negatively associated with PrEP intention (aOR=0.32, $p=0.006$) (Table 4).

Table 4 Multivariate predictors of oral PrEP Intention (N=296)

	n(%)	aOR	95%CI	p
PrEP can be scaled up				
Disagree	52(17.57)	1		
Agree	244(82.43)	3.24	1.67,6.32	<0.001**
PrEP can prevent HIV if taken as requested				
No	27(9.12)	1		
Yes	269(90.88)	4.84	2.03,11.54	<0.001**
PrEP may cause serious side effects				
No	72(24.32)	1		
Yes	224(75.68)	0.32	0.14,0.73	0.006*

* $p<0.05$,** $p<0.001$

2) Multivariate correlates of injectable or implanted PrEP intention

Beliefs that 'PrEP can prevent HIV if taken as prescribed' (aOR=2.65, $p=0.027$), 'Heard of PrEP' (OR=2.74, $p=0.001$) and 'Doctor may not prescribe PrEP if I go to the clinic' (OR=3.03, $p<0.001$) remained

significantly associated with PrEP intention. Age was not related to the injectable or implanted PrEP intention at the multivariate level (Table 5).

Table 5 Multivariate predictors of injectable or implanted PrEP Intention (N=300)

	n(%)	aOR	95%CI	p
Age				
18-28	170(56.67)	1		
29+	130(83.08)	1.52	0.83,2.78	0.171
Heard of PrEP				
No	129(43.00)	1		
Yes	171(57.00)	2.74	1.53,4.93	0.001*
PrEP can prevent HIV if taken as requested				
No	27(9.00)	1		
Yes	273(91.00)	2.65	1.12,6.28	0.027*
Doctor may not prescribe the PrEP				
No	87(29.00)	1		
Yes	213(71.00)	3.03	1.66,5.55	<0.001**

*p<0.05,**p<0.001

Experience of PrEP use and perceptions on barriers and facilitators of using PrEP

Table 6 presents that only 4 participants (1.33%) reported having used PrEP before and that 129 participants (43.00%) had never heard of PrEP. After being briefed about the relevant information on PrEP use, the percentage of unwillingness to use daily oral PrEP was still as high as 24.33%. Reasons for not using PrEP included 'unsure where to find it' (40.00%), 'unsure of its effectiveness' (17.67%), 'worried about its side effects' (20.00%), 'have no high-risk sexual behavior' (15.67%) and 'price concerns' (20.67%).

Table 6 Perceptions on barriers and facilitators of using PrEP (N=300)

	n	%
Reasons for not using PrEP (n=300)		
Had used PrEP before		
Yes	4	1.33
No	167	55.67
Never heard of PrEP	129	43.00
Reasons for not using PrEP		
Unsure of where to find it	120	40.00
Unsure of its effectiveness	53	17.67
Worried about its side effects	60	20.00
No high-risk sexual behavior	47	15.67
Expensive	62	20.67
Never heard of PrEP	129	43.00
Motivation to use PrEP (n=223)		
Reasons for using PrEP		
With HIV positive sex partner	57	25.56
With HIV status unknown partner	172	77.13
Fond of partner	65	29.15
Frequent sexual behavior	107	47.98
Using condoms while using PrEP		
Yes	194	87.00
No	29	13.00
Accessibility and Affordability of PrEP (n=227)		
The most preferable way of getting PrEP		
Online shopping	65	28.63
Pharmacy	10	4.41
Hospital	23	10.13
Community	19	8.37
CDC	110	48.46

The highest price you can afford? (yuan/month)

<200	102 44.93
200-499	91 40.09
500-999	27 11.89
1000-2000	7 3.08

Reason for using generic drugs with lower price

Provided by qualified pharmacy in China	96 42.29
Brought back from developed countries	45 19.82
Brought back from abroad by friends	19 8.37
Light side effects	56 24.67
Unacceptable to generic drugs	113 49.78

Opinions on promoting PrEP (n=300)

The biggest concern about PrEP

Efficacy/effectiveness	134 44.67
Side effects	116 38.67
Drug resistance	22 7.33
How to access the drug	16 5.33

The barriers for promoting PrEP

Insufficient message from the government	235 78.33
No approved indication from FDA	137 45.67
Too expensive	168 56.00
Not covered by medical insurance	158 52.67
Privacy concerns during consultation and treatment	192 64.00
Insufficient experience of doctors	68 22.67
Discrimination when seeking treatment	152 50.67

How to promote PrEP

Improve doctor awareness	176 58.67
Media publicity	201 67.00
Convenient drug supply system	212 70.67
PrEP user manual	172 57.33
Available regular tests for HIV	185 61.67

Willingness to use PrEP in the next 6 months under different scenarios (n=300)

If the price is affordable

Yes	247 82.33
No	53 17.67

If the indication of PrEP got approval

Yes	273 91.00
No	27 9.00

The motivations for using PrEP included 'with HIV positive partner' (25.56%), 'with HIV status unknown partner' (77.13%), 'fond of the partner' (29.15%) and 'frequent sex behavior' (47.98%). 87.00% of participants would like to use condoms while using PrEP to ensure safety. The most preferable way of getting PrEP is from 'CDC' (48.46%), followed by 'online shopping' (28.63%), 'hospital' (10.13%), 'community' (8.37%) and 'pharmacy' (4.41%). In total, 85.02% of the participants' affordable price is less than 500 Yuan/month. Regarding using generic PrEP drugs, 49.78% stated this was unacceptable and 42.29% would use generics with a lower price if these drugs were provided by a qualified pharmacy in China.

Consistent with most foreign studies, the biggest concerns about PrEP were 'efficacy' (44.67%), 'side effects' (38.67%), 'drug resistance' (7.33%) and 'accessibility of the drug' (5.33%). Regarding the barriers for promoting PrEP, 'insufficient message from the government' (78.33%), 'privacy concerns during consultation and treatment' (64.00%), 'the high price' (56.00%), 'not being covered by medical insurance' (52.67%) and discrimination issues are major concerns. Each of the measures to promote PrEP use in China received more than 50% agreement with the participants, including 'doctors awareness' (58.67%), 'media publicity' (67.00%), 'convenient drug supply system' (70.67%), 'providing regular test of HIV' (61.67%), and 'availability of PrEP use manual' (57.63%).

The willingness to take PrEP increased to 82.33% and 91.00% if the price is affordable and if the indication of PrEP got approval, compared to the 75.34% willingness without any prerequisite.

Discussion

Improving uptake of oral PrEP as a prevention measure for individuals at high risk of HIV has been challenging since it was first approved in 2012 in the US and other countries. While daily dosing of PrEP could result in significant reduction in HIV incidence and has been widely promoted in developed countries [4], uptake of PrEP has been low despite increasing awareness [27]. In our study, nearly half of the participants never heard of PrEP as one of the approaches to prevent HIV. This estimate is much higher than that in the US where just 20% of MSM had never heard of PrEP [28]. In addition, compare to a

19.1% willingness to use oral PrEP in a study of MSM in Shanghai [29], acceptability of PrEP was much higher in our study. However, the real-world effectiveness of oral PrEP would be determined by pill-taking behavior of the population at high risk for HIV. Although intention to use PrEP has increased, it may not necessarily translate to actual PrEP uptake. In another word, self-reported intentions and actual behaviors can be more or less disconnected in various circumstances [22]. For example, in the clinical trial study in Shanghai, actual uptake was only 2.5% compared to 19.1% of participants who said they were willing to use oral PrEP [29]. Therefore, effective strategies to increase PrEP use should underscore the feasibility of promoting PrEP, including improving awareness of PrEP related knowledge, coverage of medical insurance or adjust the market pricing of PrEP to make it affordable to people who are really in need, and even the characteristics of the PrEP pills (color, size etc.)[30].

PrEP has been suggested as the most cost-effective and promising way to decrease HIV incidence among at-risk MSM in previous modeling studies [31]. The Clinical Screening Index had been developed to be used to prioritize individuals for PrEP use and used by US CDC [19]. It was found that individuals who had engaged in high risk behavior were more likely to find PrEP acceptable than those who had not [32]. Furthermore, willingness to use PrEP was also associated with perceived risk of acquiring HIV [33]. However, in a trial of PrEP use in the US, it was found that MSM with actual high risk behaviors reported low risk perception and declined to use PrEP [34]. Similarly in our study, while the percentage of participants with multiple male partners, inconsistent condom use and sexual risk index scores more than 10 were nearly 50%, high risk score was not significantly associated with PrEP intention. Therefore, to identify the gap between perceived high risk and actual high risk behaviors among MSM would be beneficial to future PrEP implementation. For example, regular targeted HIV and sex education, in combination with accessible PrEP counseling and support could be an effective strategy. Finally, a modified screening index of PrEP use specific to the MSM populations in China may also be needed to accurately identify individuals at high risk for HIV.

Similar to previous findings among MSM in the US and other countries, beliefs of efficacy was associated with the intention of PrEP use [32, 35]. To maximize acceptability of PrEP, awareness, correct knowledge and information on PrEP are critical to improving willingness of PrEP use among MSM. Sufficient information distribution and marketing of PrEP from various sources such as CDC, HIV clinics, community organizations and social media has the potential to increase PrEP uptake once PrEP is approved in China.

From this study, nearly 85% of the participants can afford the price no more than 500 yuan a month and 70% can accept the generic drugs with lower price from various sources. Meanwhile, insufficient message, lack of relevant experience by doctors, the privacy concerns and coverage of medical insurance are major barriers of promoting PrEP in China. Consequently, to develop PrEP use manuals suitable for doctors and potential PrEP users, to set up an efficient drug supply system and to carry out appropriate media publicity measures would be beneficial in promoting PrEP among MSM population, and thus make the prevention roles of PrEP truly effective in preventing HIV.

Concerns of side effects have been identified as one of the major reasons of not willing to use oral PrEP among study participants, this was consistent with previous studies among Chinese MSM [36, 37] and MSM in other countries [38]. While there are some side effects when first starting the medication, such as nausea and frequent vomiting, they usually abate after two months into the regimen [4, 39]. However, kidney function decline and bone mineral density decrease were also reported among long-term PrEP users in clinical trials [40, 41]. In addition, traditional Chinese beliefs that medicine is somewhat toxic, would also be a barrier for MSM to take medicine before illness occurs. As a part of China's national HIV/AIDS prevention strategy, PrEP is expected to be scaled up in the coming years. Therefore, in addition to disseminate correct knowledge on the efficacy of PrEP, accurate drug safety information of potential short-term and long-term side effects as well as benefits of using PrEP, which may outweigh side effects, may improve uptake and adherence in the future.

77% of the participants intended to try injectable or implanted PrEP compare to oral PrEP, which suggests us the necessity of studying or introducing some additional alternatives for PrEP, such as injectable PrEP with a cycle of 2-3 months or long-acting sustained release implanted PrEP, in order to increase PrEP adherence and meet the different needs for MSM to uptake PrEP [14, 15]. Concerns that doctor may not prescribe PrEP have been identified as one of the major reasons of willing to try injectable or implanted PrEP among study MSM. Since there are prejudice and discrimination against MSM or people living with HIV/AIDS, MSM would not disclose their sexual orientation to physicians due to privacy or discrimination concerns in the course of seeking medical treatment, which will seriously affect the promotion of oral PrEP. Accordingly, apart from the developing new regimen of injectable or implanted PrEP, a more supportive social environment needs to be created to promote the use of PrEP among the target population.

Conclusion

Given the low awareness of PrEP-related information in China, a comprehensive package in delivering PrEP, including regular HIV and PrEP education, and further development of feasible intervention strategies targeting high risk individuals and communities would benefit the scale up of oral PrEP. Furthermore, injectable or implanted PrEP should be investigated as additional alternatives to improve uptake and adherence of PrEP. These findings also highlight the importance of a more supportive social environment for MSM when implementing PrEP programs that are approved by China's FDA.

Declarations

Ethical Approval and consent to participate The study protocol was reviewed and approved by the Institutional Review Boards of Chinese Center for Disease Control and Prevention in Beijing, and informed consent signed by the investigator after the participant's verbal consent was obtained from all individual participants included in the study.

Consent for publication Not applicable.

Availability of data and materials The original data generated from this study and the analyzed results will be available from the corresponding author upon reasonable request.

Competing interests The co-author Chongyi Wei (name initial: CYW) is an associate editor of this journal, and all other authors declare that they have no competing interests.

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Authors' contributions XYS, CYW, HJY and LY designed the study. HJY and LY implemented the cross-sectional survey in Nanjing. XYS, MYS, CYW and HJY analyzed the data, interpreted the results and drafted the manuscript. YJ and YLL interpreted the data. All authors revised and approved the final version of the manuscript submitted to the journal.

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Abbreviations

MSM: Men who have sex with men

HIV: Human immunodeficiency virus

AIDS: Acquired immunodeficiency syndrome

PrEP: Pre-exposure prophylaxis

OR: Odds ratio

aOR: Adjusted odds ratios

P: Probability

FDA: Food and Drug Administration

CRAI: Condomless receptive anal intercourse

CIAI: Condomless insertive anal intercourse

References

1. [Chen Q, Sun Y, Sun W, Hao M, Li G, Su X, et al.](#) Trends of HIV incidence and prevalence among men who have sex with men in Beijing, China: Nine consecutive cross-sectional surveys, 2008-2016. *Plos One*. 2018;13(8). doi: 10.1371/journal.pone.0201953

2. Zhang Y, Chen P, Lu R, Liu L, Wu Y, Liu X, et al. Prevalence of HIV among men who have sex with men in Chongqing, China, 2006-2009: cross-sectional biological and behavioural surveys. *Sexually transmitted infections*. 2012;88(6):444-50. doi: 10.1136/sextrans-2011-050295.
3. Van Griensven F, van Wijngaarden JWD. A review of the epidemiology of HIV infection and prevention responses among MSM in Asia. *Aids*. 2010;24:S30-S40. doi: 10.1097/01.aids.0000390087.22565.b4.
4. Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, et al. Preexposure Chemoprophylaxis for HIV Prevention in Men Who Have Sex with Men. *New England Journal of Medicine*. 2010;363(27):2587-99. doi: 10.1056/NEJMoa1011205.
5. Baeten JM, Donnell D, Ndase P, Mugo NR, Campbell JD, Wangisi J, et al. Antiretroviral Prophylaxis for HIV Prevention in Heterosexual Men and Women. *New England Journal of Medicine*. 2012;367(5):399-410. doi: 10.1056/NEJMoa1108524.
6. Grulich AE, Guy R, Amin J, Jin F, Selvey C, Holden J, et al. Population-level effectiveness of rapid, targeted, high-coverage roll-out of HIV pre-exposure prophylaxis in men who have sex with men: the EPIC-NSW prospective cohort study. *Lancet Hiv*. 2018;5(11):E629-E37. doi: 10.1016/S2352-3018(18)30215-7.
7. Zhang L, Peng P, Wu Y, Ma X, Soe NN, Huang X, et al. Modelling the Epidemiological Impact and Cost-Effectiveness of PrEP for HIV Transmission in MSM in China. *Aids and Behavior*. 2019;23(2):523-33. doi: 10.1007/s10461-018-2205-3.
8. Hoots BE, Lewis FM, Anschuetz G, Schillinger JA, Blank S, Foskey T, et al. Would targeting increase efficiency of syphilis partner services programs?—Data from New York City, Philadelphia, Texas, and Virginia. *Sex Transm Dis*. 2014 Jun;41(6):407-12. doi: 10.1097/OLQ.000000000000130.
9. Parsons JT, Rendina HJ, Lassiter JM, Whitfield TH, Starks TJ, Grov C. Uptake of HIV Pre-Exposure Prophylaxis (PrEP) in a National Cohort of Gay and Bisexual Men in the United States. *J Acquir Immune Defic Syndr*. 2017 Mar 1;74(3):285-292. doi: 10.1097/QAI.0000000000001251.
10. Marrazzo JM, Ramjee G, Richardson BA, Gomez K, Mgodhi N, Nair G, et al. Tenofovir-based preexposure prophylaxis for HIV infection among African women. *N Engl J Med*. 2015 Feb 5;372(6):509-18. doi: 10.1056/NEJMoa1402269.
11. Han J, Bouey JZ, Wang L, Mi G, Chen Z, He Y, et al. PrEP uptake preferences among men who have sex with men in China: results from a National Internet Survey. *Journal of the International Aids Society*. 2019;22(2) . doi: 10.1002/jia2.25242.
12. Bull L, Dimitrijevic P, Beverley S, Scarborough A, Mandalia S, Dosekun O, et al. Perceived need of, and interest in, HIV pre-exposure prophylaxis amongst men who have sex with men attending three sexual health clinics in London, UK. *International Journal of Std & Aids*. 2018;29(5):435-42. doi: 10.1177/0956462417730259.
13. Beymer MR, Gildner JL, Holloway IW, Landovitz RJ. Acceptability of Injectable and On-Demand Pre-Exposure Prophylaxis Among an Online Sample of Young Men Who Have Sex with Men in California. *Lgbt Health*. 2018;5(6):341-9. doi: 10.1089/lgbt.2017.0244.

14. Markowitz M, Frank I, Grant RM, Mayer KH, Elion R, Goldstein D, et al. Safety and tolerability of long-acting cabotegravir injections in HIV-uninfected men (ECLAIR): a multicentre, double-blind, randomised, placebo-controlled, phase 2a trial. *Lancet HIV*. 2017 Aug;4(8):e331-e340. doi: 10.1016/S2352-3018(17)30068-1.
15. Schlesinger E, Johengen D, Luecke E, Rothrock G, McGowan I, van der Straten A, et al. A Tunable, Biodegradable, Thin-Film Polymer Device as a Long-Acting Implant Delivering Tenofovir Alafenamide Fumarate for HIV Pre-exposure Prophylaxis. *Pharm Res*. 2016 Jul;33(7):1649-56. doi: 10.1007/s11095-016-1904-6.
16. Spreen W, Williams P, Margolis D, Ford SL, Crauwels H, Lou Y, et al. Pharmacokinetics, safety, and tolerability with repeat doses of GSK1265744 and rilpivirine (TMC278) long-acting nanosuspensions in healthy adults. *J Acquir Immune Defic Syndr*. 2014 Dec 15;67(5):487-92. doi: 10.1097/QAI.0000000000000365.
17. Gunawardana M, Remedios-Chan M, Miller CS, Fanter R, Yang F, Marzinke MA, et al. Pharmacokinetics of long-acting tenofovir alafenamide (GS-7340) subdermal implant for HIV prophylaxis. *Antimicrob Agents Chemother*. 2015 Jul;59(7):3913-9. doi: 10.1128/AAC.00656-15.
18. Lockard A, Rosenberg ES, Sullivan PS, Kelley CF, Serota DP, Rolle CM, et al. Contrasting Self-Perceived Need and Guideline-Based Indication for HIV Pre-Exposure Prophylaxis Among Young, Black Men Who Have Sex with Men Offered Pre-Exposure Prophylaxis in Atlanta, Georgia. *Aids Patient Care and Stds*. 2019;33(3):112-9. doi: 10.1089/apc.2018.0135.
19. Smith DK, Pals SL, Herbst JH, Shinde S, Carey JW. Development of a Clinical Screening Index Predictive of Incident HIV Infection Among Men Who Have Sex With Men in the United States. *J AIDS-Journal of Acquired Immune Deficiency Syndromes*. 2012;60(4):421-7. doi: 10.1097/QAI.0b013e318256b2f6.
20. Golub SA, Gamarel KE, Surace A. Demographic Differences in PrEP-Related Stereotypes: Implications for Implementation. *Aids and Behavior*. 2017;21(5):1229-35. doi: 10.1007/s10461-015-1129-4.
21. Biello KB, Oldenburg CE, Mitty JA, Closson EF, Mayer KH, Safren SA, et al. The "Safe Sex" Conundrum: Anticipated Stigma From Sexual Partners as a Barrier to PrEP Use Among Substance Using MSM Engaging in Transactional Sex. *Aids and Behavior*. 2017;21(1):300-6. doi: 10.1007/s10461-016-1466-y.
22. Van der Elst EM, Mbogua J, Operario D, Mutua G, Kuo C, Mugo P, et al. High Acceptability of HIV Pre-exposure Prophylaxis but Challenges in Adherence and Use: Qualitative Insights from a Phase I Trial of Intermittent and Daily PrEP in At-Risk Populations in Kenya. *Aids and Behavior*. 2013;17(6):2162-72. doi: 10.1007/s10461-012-0317-8.
23. Eaton LA. What Can We Do or Change to Encourage People to Seek Out Preexposure Prophylaxis? *American Journal of Public Health*. 2017;107(12):1862-4. doi: 10.2105/AJPH.2017.304149. doi: 10.2105/AJPH.2017.304149.
24. Scambler G. Stigma and disease: changing paradigms. *Lancet*. 1998;352(9133):1054-5. doi: 10.1016/S0140-6736(98)08068-4.

25. Liu H, Feng T, Rhodes AG, Liu H. Assessment of the Chinese version of HIV and homosexuality related stigma scales. *Sexually transmitted infections*. 2009;85(1):65-9. doi: 10.1136/sti.2008.032714.
26. Wei CY, Yan L, Li JJ, Su XY, Lippman S, Yan HJ. Which user errors matter during HIV self-testing? A qualitative participant observation study of men who have sex with men (MSM) in China. *Bmc Public Health*. 2018;18. doi: 10.1186/s12889-018-6007-3.
27. John SA, Rendina HJ, Grov C, Parsons JT. Home-based pre-exposure prophylaxis (PrEP) services for gay and bisexual men: An opportunity to address barriers to PrEP uptake and persistence. *Plos One*. 2017;12(12) . doi: 10.1371/journal.pone.0189794.
28. Rao DW, Carr J, Naismith K, Hood JE, Hughes JP, Morris M, et al. Monitoring HIV Preexposure Prophylaxis Use Among Men Who Have Sex With Men in Washington State: Findings From an Internet-Based Survey. *Sexually Transmitted Diseases*. 2019;46(4):221-8. doi: 10.1097/OLQ.0000000000000965.
29. Ding Y, Yan H, Ning Z, Cai X, Yang Y, Pan R, et al. Low willingness and actual uptake of pre-exposure prophylaxis for HIV-1 prevention among men who have sex with men in Shanghai, China. *Bioscience Trends*. 2016;10(2):113-9. doi: 10.5582/bst.2016.01035.
30. Wang ZX, Lau JTF, Fang Y, Mary I, Gross DL. Prevalence of actual uptake and willingness to use pre-exposure prophylaxis to prevent HIV acquisition among men who have sex with men in Hong Kong, China. *Plos One*. 2018;13(2). doi:10.1371/journal.pone.0191671.
31. Paltiel AD, Freedberg KA, Scott CA, Schackman BR, Losina E, Wang B, et al. HIV Preexposure Prophylaxis in the United States: Impact on Lifetime Infection Risk, Clinical Outcomes, and Cost-Effectiveness. *Clinical Infectious Diseases*. 2009;48(6):806-15. doi: 10.1086/597095.
32. Galea JT, Kinsler JJ, Salazar X, Lee SJ, Giron M, Sayles JN, et al. Acceptability of pre-exposure prophylaxis as an HIV prevention strategy: barriers and facilitators to pre-exposure prophylaxis uptake among at-risk Peruvian populations. *International Journal of Std & Aids*. 2011;22(5):256-62. doi: 10.1258/ijsa.2009.009255.
33. Underhill K, Guthrie KM, Collieran C, Calabrese SK, Operario D, Mayer KH. Temporal Fluctuations in Behavior, Perceived HIV Risk, and Willingness to Use Pre-Exposure Prophylaxis (PrEP). *Archives of Sexual Behavior*. 2018;47(7):2109-21. doi: 10.1007/s10508-017-1100-8.
34. King HL, Keller SB, Giancola MA, Rodriguez DA, Chau JJ, Young JA, et al. Pre-Exposure Prophylaxis Accessibility Research and Evaluation (PrEPARE Study). *Aids and Behavior*. 2014;18(9):1722-5. doi: 10.1007/s10461-014-0845-5.
35. Mimiaga MJ, Case P, Johnson CV, Safren SA, Mayer KH. Preexposure Antiretroviral Prophylaxis Attitudes in High-Risk Boston Area Men Who Report Having Sex With Men: Limited Knowledge and Experience but Potential for Increased Utilization After Education. *J aids-Journal of Acquired Immune Deficiency Syndromes*. 2009;50(1):77-83. doi: 10.1097/QAI.0b013e31818d5a27.
36. Liu C, Ding Y, Ning Z, Gao M, Liu X, Wong FY, et al. Factors influencing uptake of pre-exposure prophylaxis: some qualitative insights from an intervention study of men who have sex with men in

- China. *Sexual Health*. 2018;15(1):39-45. doi: 10.1071/SH17075.
37. Wang X, Bourne A, Liu P, Sun J, Cai T, Mburu G, et al. Understanding willingness to use oral pre-exposure prophylaxis for HIV prevention among men who have sex with men in China. *Plos One*. 2018;13(6) . doi: 10.1371/journal.pone.0199525.
38. Holloway IW, Dougherty R, Gildner J, Beougher SC, Pulsipher C, Montoya JA, et al. PrEP Uptake, Adherence, and Discontinuation Among California YMSM Using Geosocial Networking Applications. *Jaids-Journal of Acquired Immune Deficiency Syndromes*. 2017;74(1):15-20. doi: 10.1097/QAI.0000000000001164.
39. Thigpen MC, Kebaabetswe PM, Paxton LA, Smith DK, Rose CE, Segolodi TM, et al. Antiretroviral Preexposure Prophylaxis for Heterosexual HIV Transmission in Botswana. *New England Journal of Medicine*. 2012;367(5):423-34. doi: 10.1056/NEJMoa1110711.
40. Touret J, Deray G, Isnard-Bagnis C. Tenofovir Effect on the Kidneys of HIV-Infected Patients: A Double-Edged Sword? *Journal of the American Society of Nephrology*. 2013;24(10):1519-27. doi: 10.1681/ASN.2012080857.
41. Stellbrink HJ, Orkin C, Arribas JR, Compston J, Gerstoft J, Van Wijngaerden E, et al. Comparison of Changes in Bone Density and Turnover with Abacavir-Lamivudine versus Tenofovir-Emtricitabine in HIV-Infected Adults: 48-Week Results from the ASSERT Study. *Clinical Infectious Diseases*. 2010;51(8):963-72. doi: 10.1086/656417.