

Original research

Identifying patterns of sexual behaviors and PrEP uptake characteristics among MSM who were eligible for PrEP: A national cross-section study

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ABSTRACT

Men who have sex with men (MSM) are at a high risk of HIV infection and should be offered effective preventive measures, such as pre-exposure prophylaxis (PrEP). However, PrEP uptake among eligible MSM was not as high as desired. Diverse research findings on how risky sexual behaviors affect PrEP uptake highlight the necessity for a comprehensive investigation. Understanding the interconnectedness of different sexual behaviors is crucial for evaluating their impact on PrEP uptake among eligible MSM.

Using a proportional sampling method, we recruited 5877 MSM aged 16 years and above in mainland China according to PrEP eligibility criteria. Through latent class analysis (LCA), three distinct sexual behavior patterns were identified among eligible MSM. Demographic variances and PrEP uptake among the three distinct sexual behavior patterns were examined using chi-squared tests and multinomial logistic regression.

LCA revealed three patterns: low-risk (4,815 MSM), medium-risk (516 MSM), and high-risk (546 MSM). MSM aged 25 years or older with a monthly income of \geq ¥8,000 were more likely to be in the medium-risk group. Those from areas with high HIV prevalence and engaging as "top" in anal sex were more likely to be in the medium- and high-risk groups. The medium- and high-risk groups had a higher willingness, uptake, and adherence rates for PrEP than the low-risk group.

LCA is effective in identifying diverse sexual behavior patterns among MSM, aiding targeted interventions to enhance PrEP uptake. Addressing demographic variations and tailoring interventions for specific risk groups are crucial for promoting PrEP dissemination and reducing HIV infection risk in eligible MSM.

1. Introduction

By the end of 2022, there were 1.223 million surviving acquired immune deficiency syndrome (AIDS) cases in China, of which approximately 107,000 were newly infected, and 30,000 died of AIDS-related diseases in one year.¹ Men who have sex with men (MSM) are at high risk of human immunodeficiency virus (HIV) infection, more than 27 times higher than that of the general male population. In 2021, MSM

accounted for 21 % of new HIV infections, meaning that one in every five new HIV infections were in MSM.² Despite strategies such as safer sex advocacy, voluntary HIV counseling and testing, and peer interventions for this population in China, it has not been possible to end the HIV epidemic in this population.³ Hence, there is a need to improve prevention strategies, especially for those targeting high-risk populations.

In 2014, the World Health Organization (WHO) recommended

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providing pre-exposure prophylaxis (PrEP) to MSM as a supplemental prevention measure in combination with comprehensive HIV prevention strategies.⁴ PrEP is a biomedical prevention method for HIV-negative individuals to prevent HIV infection by taking antiretroviral transcriptional drugs before or during HIV exposure.⁵ Clinical trials have shown that the uptake of PrEP before and after sexual intercourse reduces the risk of HIV infection in MSM by 86 %, and the risk of HIV infection is reduced by approximately 99 % if PrEP is taken daily or consistently (at least four times per week).⁶ It should be emphasized that not all HIV-negative individuals are eligible for PrEP to prevent HIV infection, and only those at high risk of HIV exposure are eligible for PrEP. As outlined in the "China Expert Consensus on Pre-Exposure Prophylaxis" which guides the selection of individuals based on their HIV exposure risk and medical suitability, ensuring that PrEP is reserved for those at the highest risk of HIV infection.⁷

The uptake of PrEP varies considerably among MSM who are eligible for PrEP uptake, with some studies indicating associations between engaging in unprotected anal intercourse,⁸ having multiple sexual partners,^{9,10} engaging in group sex,¹¹ and PrEP uptake. A study in the United States examined PrEP uptake among MSM involved in commercial sex work and identified barriers due to concerns about negative reactions from sexual partners upon learning about their PrEP uptake.¹² Risky sexual behaviors such as inconsistent condom use, having multiple partners, engaging in commercial sex work, and group sex heighten the risk of HIV and sexually transmitted diseases (STDs) transmission.¹³ Previous research has demonstrated that patterns of risky sexual behavior affect PrEP uptake among MSM. However, these have typically focused on individual sexual behaviors, but considering the high correlation among various behaviors suggests the need to assess them collectively to better understand sexual risk. First, examining multiple sexual behaviors in combination allows for a more comprehensive understanding of sexual risks. Research has shown that individual behaviors often occur within specific contexts and are influenced by a myriad of factors. By identifying patterns of sexual behavior, we aimed to capture the complexity of sexual risk more accurately. Second, understanding the different patterns of sexual behavior is crucial for designing effective PrEP intervention programs. Simply targeting individual behaviors may overlook synergistic effects and miss opportunities for tailored preventive strategies. The existing literature suggests that comprehensively considering multiple risk factors is more effective in interventions.¹⁴ Currently, there is limited knowledge about the patterns of sexual behavior among MSM and their relationship with willingness and uptake of PrEP. This information is necessary for designing effective prevention programs.

Latent class analysis (LCA) is a statistical method used to classify individuals and identify group heterogeneity based on different response patterns of latent categorical variables.¹⁵ The theoretical assumption of LCA is that individuals simultaneously share latent and observed categorical variables, and membership in unobserved classes can account for or explain patterns in the score measures. In contrast to more traditional variable-centered approaches such as multiple regression analysis, LCA is a person-centered approach. It has been used to identify HIV risk patterns based on gender identity and sexual orientation,¹⁶ aiding in defining and targeting various populations. However, it is not widely used to explain the relationship between PrEP uptake and sexual behavior patterns.

In summary, this study used LCA to cluster individual behaviors into latent categories, unveiling the complex patterns of sexual behaviors among eligible MSM in mainland China for PrEP uptake. It also delves into the interplay between various risky sexual behaviors, demographic details, high-risk regions, pilot cities, and sexual roles. Additionally, we investigated the willingness, uptake, and adherence to PrEP among different patterns of risky sexual behaviors and analyzed barriers to uptake. By identifying MSM engaging in diverse risky sexual behaviors, we offer valuable data to support future PrEP campaigns and uptake among MSM communities. We aimed to develop tailored PrEP

intervention strategies for MSM exhibiting different sexual behavior patterns, foster PrEP acceptance and use within the MSM population, and contribute to HIV prevention efforts in China and globally. Our ultimate goal is to combat the AIDS epidemic and work towards its eradication.

2. Materials and methods

2.1. Study design and participants selection

A cross-sectional survey was conducted among MSM residing in 31 provinces, municipalities, and autonomous regions of mainland China between October 20 and December 20, 2021. The project was sponsored by the WHO Representative Office in China and organized by the Shenlan Public Health Consultation Service Center in Tianjin. The PrEP electronic questionnaire was distributed to MSM community organizations in northern, northeastern, eastern, southern, southwestern, northwestern, and other regions through the mobilization of PrEP project members. For participant recruitment, a combined approach of online and offline methods was employed, utilizing convenience sampling and snowball sampling. The online approach involved community workers promoting and recruiting participants through WeChat Moments and groups. Offline methods included staff visiting bars and bathhouses frequented by the gay community to recruit participants.

Study eligibility criteria: Chinese mainland male residents aged 16 years and above, self-reported as HIV-negative or unknown HIV status, had engaged in gay sex in the past six months, and eligible for PrEP uptake,^{7,17} namely: (1) engaged in unprotected anal intercourse in the past six months; (2) diagnosed with STDs, such as syphilis, gonorrhoea, or chlamydia, in the past six months; (3) used sexualized substance during sex in the past six months; (4) HIV-positive partner in the past six months; and (5) expressed willingness to take up PrEP. Meeting any one of the five criteria qualifies an individual for PrEP uptake. The detailed exclusion and inclusion criteria for the participants are shown in Fig. 1.

2.2. Sampling method

This study used proportional sampling to calculate the sample size, based on previous surveys conducted in China, which indicated a PrEP uptake rate of 15 % with the following assumptions: 2.0 % margin of error and 95 % level of confidence. Proportional sampling was calculated based on the number of males aged 16 and above in each province, as recorded in the "2021 China Statistical Yearbook".¹⁸ Considering a disqualification rate of 20 % in the survey responses, the sample size was adjusted to 5877. Equation (1) represents the formula for calculating the sample size,

$$n = \frac{u_g^2 \pi (1 - \pi)}{\delta^2} \quad (1)$$

The large sample size (N = 5877) and sampling method ensured representative data and scientific results. The number of questionnaires was allocated based on population density and study design.

2.3. Study variables

Participants completed a questionnaire, either online or offline, which included information on social demographics, sexual behavior, and PrEP-related details.

Sociodemographic information collected included age, education level, occupation, monthly income, economic level region, and whether participants resided in a high HIV prevalence area and a PrEP pilot city. The age groups were referenced from previous studies¹⁹ and categorized based on the actual circumstances of this survey, specifically adjusted as 16–24 years old, 25–44 years old, and 45 years and above. Educational level was junior high school education or lower, senior high

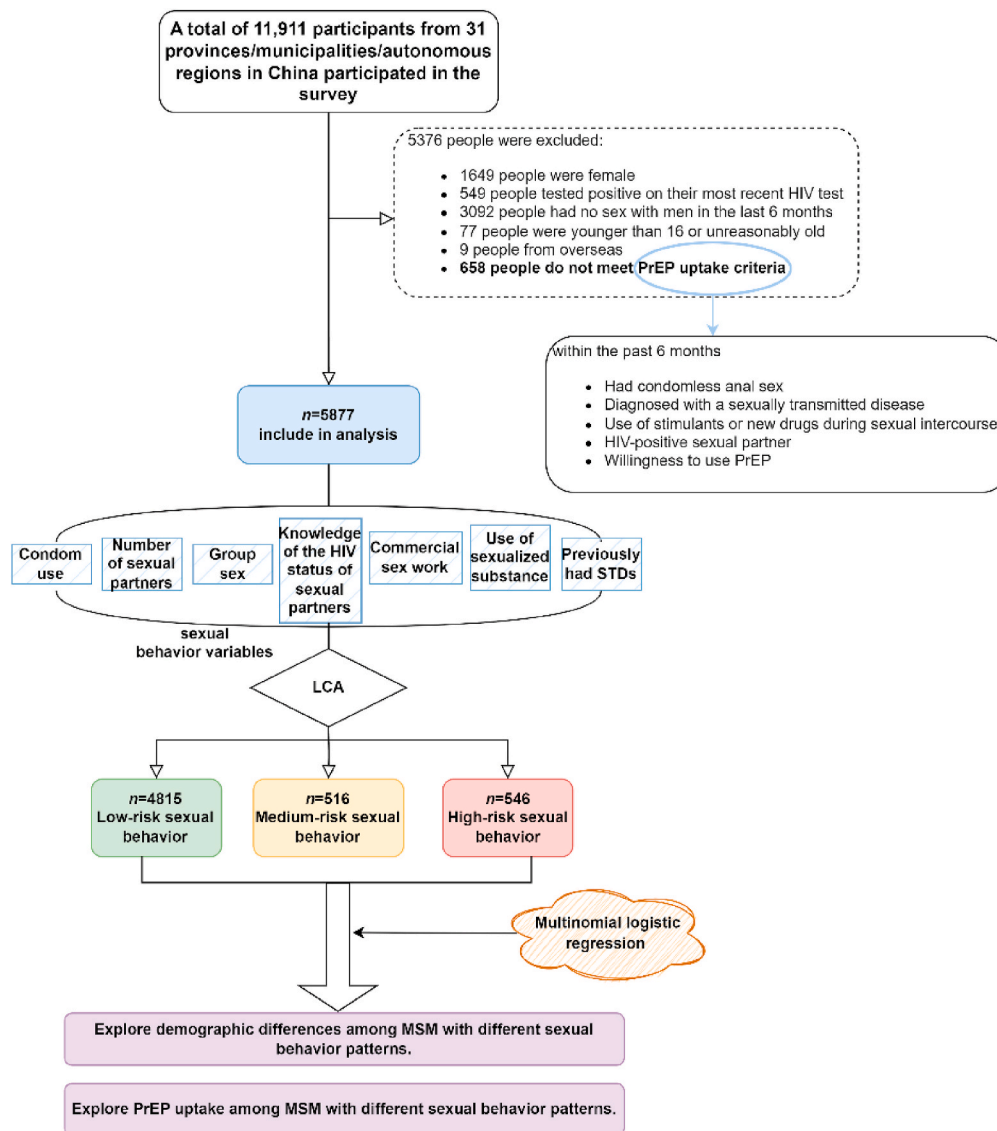


Fig. 1. Flowchart of sexual behavior patterns for MSM who were eligible for PrEP; MSM: men who have sex with men.

school education or professional qualification, junior college or college graduate, or graduate degree or higher. Occupations were categorized as company employees or civil servants, factory workers, farmers, students, freelancers, and unemployed. Income monthly was categorized as <¥3000, ¥3000–5000, ¥5000–8000, and ≥¥8000. Gross domestic product (GDP) served as a measure of the economic situation and the level of development of a region. According to the National Bureau of Statistics 2021 annual report, provinces and cities ranking in the top ten in terms of per capita GDP are classified as high-GDP regions, those ranked in the bottom ten are classified as low-GDP regions, and the remaining areas are classified as moderate-GDP regions.²⁰ According to previous studies,^{21,22} Yunnan, Sichuan, Guangxi, Guangdong, and Henan were classified as high-risk areas, and Shenyang, Beijing, Shenzhen, and Chongqing as pilot cities.

Information on sexual behavior in the last six months included the role of anal sex (top/bottom/versatile), frequency of condom use (low/high), number of sexual partners (≤6/>6), group sex (yes/no), knowledge of HIV status of sexual partners (fully understand/not fully understand), commercial sex work (yes/no), use of sexualized substance during sex (yes/no), and history of STDs in the past year (yes/no). The roles of anal sex include tops, bottoms, versatiles, and oral sex. Tops preferred insertive anal intercourse; bottoms, receptive anal intercourse;

and versatiles, both types. In the questionnaire, statistical analysis was conducted to categorize individuals based on their frequency of condom use during the most recent anal intercourse experience. The original categories include "Never" "Occasionally," "Frequently," and "Always." For the analysis, this variable was reclassified as follows: Low frequency will include those who "Never" and "Occasionally," while high frequency will encompass "Frequently" and "Always." The level of understanding regarding the HIV infection status of sexual partners was divided into two categories: fully understand and not fully understand. STDs included gonorrhea, syphilis, condyloma acuminatum, genital herpes, genital chlamydia trachomatis infection, and others. Sexualized substances included Viagra, Rush, capsules Zero, G-spot liquid, and methamphetamine.

Additionally, participants were surveyed on their awareness of PrEP, willingness to take PrEP, PrEP uptake, adherence to PrEP, and barriers to each link. The uptake of PrEP was evaluated through a single-item measure: "Have you ever used 'PrEP'?" Participants who responded positively were recognized as having used it, whereas those who responded negatively were regarded as non-users. PrEP adherence: Based on self-reported data, daily PrEP defined adherence was taking four or more doses per week consistently. Event-driven PrEP was defined as adherence to an on-demand regimen.

2.4. Ethical approval

This study was approved by the Institutional Review Board of Tianjin Medical University (approval number: TMUUhMEC2021010). All participants were informed that their participation was voluntary and anonymous by reading an online consent form. Those who voluntarily agreed to participate in the survey were directed to the online questionnaire by clicking on a button.

2.5. Statistical analyses

Descriptive statistics were used to present sociodemographic and sexual behavior information of MSM who were eligible for PrEP uptake, represented as n(%). LCA was then performed to distinguish MSM with different sexual behavior risks. Seven binary variables included in the LCA were frequency of condom use, number of sexual partners, group sex, knowledge of the HIV status of sexual partners, commercial sex work, use of sexualized substance, and history of STDs in the past year. Model fit was evaluated across models with two to five classes using the Akaike information criterion (AIC), Bayesian Information Criterion (BIC), sample-size-adjusted Bayesian information criterion (aBIC), and model entropy, as well as considerations of interpretability and utility to determine the optimal number of classes. Models with lower AIC and BIC values indicated a better fit. Entropy ranges from 0 to 1, where higher values represented better ability of the model to classify clustering (i.e., separation of class members).²³ In this study, we used BIC as the primary criterion for evaluation, as it was more accurate when the sample size exceeded 1000. To avoid the possibility of convergence to the local maxima, 500 initial values were generated for each model. Upon identifying the best-fitting model, distinct mutually exclusive sexual behavior categories were assigned to each individual based on the maximum posterior probability. The average posterior probability for the latent classes was calculated, with values closer to 1 indicating a better fit. Subsequently, the satisfaction of the local independence assumption in the final model was assessed by examining the correlations between variables within each class. This was analyzed by calculating the Spearman's correlation coefficient for all variables within each category, with a correlation of 0.5 or higher signaling a violation of the independence assumption.

After identifying the patterns of sexual behavior, we further analyzed the differences among MSM with different patterns of sexual behavior. Chi-square tests were used to compare differences in sociodemographic characteristics as well as awareness, willingness, uptake, and adherence to PrEP among MSM in different sexual behavior risk groups. Following the analysis of multicollinearity, variables with significance in the univariate analysis were included in the multinomial logistic regression analysis, with the results presented as odds ratios (OR) and 95 % confidence intervals (CI). In logistic regression, it is necessary to conduct a parallel lines assumption analysis. If the assumption is met, ordinal logistic regression is used; if not, multinomial logistic regression is used. Covariates included in the logistic regression model were selected using a stepwise selection process. All statistical analyses were performed using SAS 9.4, with the LCA procedure using PROC LCA.²⁴ A two-sided p-value of <0.05 was considered statistically significant.

3. Results

3.1. Characteristics of MSM eligible for PrEP

A total of 5,877 MSM eligible for PrEP uptake were included in the analysis. The majority of the participants were aged 25–44 (62.51 %) and had a college or undergraduate degree (66.05 %). Approximately 26.54 % of MSM had a monthly income of ¥3000–5000. Freelancers accounted for 33.59 % of all MSM, while those from high-GDP areas accounted for 38.34 %. Only a small proportion were from high HIV prevalence (high-risk) areas (19.36 %) or pilot cities (16.03 %). The

majority of MSM did not engage in commercial sex work (93.69 %) and had no history of STDs (91.07 %). Regarding sexual behavior in the past 6 months, 40.82 % engaged in receptive anal intercourse (top position), 77.93 % reported a high frequency of condom use, 86.10 % had less than 6 sexual partners, 85.86 % reported no participation in group sex, 47.25

Table 1
Characteristics of MSM who were eligible for PrEP, N(%).

Characteristics	Total(N = 5877)	Characteristics	Total(N = 5877)
Age		In pilot cities^b	
16~	1799 (30.61)	No	4935 (83.97)
25~	3674 (62.51)	Yes	942(16.03)
45~	404(6.88)	Have commercial sexual behavior	
Educational level		No	5506 (93.69)
Junior high school education or lower	397(6.76)	Yes	371(6.31)
Senior high school education or professional qualification	1007 (17.13)	Have STDs during the preceding year^c	
Junior college or college graduate	3882 (66.05)	No	5352 (91.07)
Graduate degree or higher	591(10.06)	Yes	525(8.93)
Monthly income (CNY)		Sexual role during anal sex with a man^c	
<3000	1730 (29.44)	Top	2399 (40.82)
3000~	1560 (26.54)	Versatile	1430 (24.33)
5000~	1335 (22.72)	Bottom	2048 (34.85)
8000~	1252 (21.30)	Frequency of condom use during homosexual anal sex^c	
Occupation		Low	1297 (22.07)
Company employee or civil servant	1932 (32.87)	High	4580 (77.93)
Factory worker	647(11.01)	Number of sexual partners^c	
Farmer	120(2.04)	<6	5060 (86.10)
Student	1014 (17.25)	6~	817(13.90)
Freelancers	1979 (33.59)	Have group sexual behavior	
Unemployed	190(3.24)	No	5046 (85.86)
Economic level zoning		Yes	831(14.14)
High GDP level	2253 (38.34)	Knowledge of HIV infection status of sexual partners^c	
Middle GDP level	2117 (36.02)	Full	2777 (47.25)
Low GDP level	1507 (25.64)	Partial	1999 (34.01)
In high-risk areas^a		No	1101 (18.73)
No	4739 (80.64)	Sexualized substance used^{d,e}	
Yes	1138 (19.36)	No	3130 (53.26)
		Yes	2747 (46.74)

^a High-risk areas are Yunnan, Sichuan, Guangxi, Guangdong, and Henan.

^b The pilot cities are Beijing, Shenyang (Liaoning), Shenzhen (Guangdong), and Chongqing.

^c Sexually transmitted diseases (STDs) in the last year included gonorrhoea, syphilis, condyloma acuminatum, genital herpes, genital chlamydia trachomatis infection, and other STDs.

^d The use of sexualized substance during homosexual sex in the last 6 months included Viagra, Rush, capsules Zero, G-spot liquid, methamphetamine, and other drugs.

^e Within 6 months before this survey.

% knew the HIV status of all their sexual partners, and 53.26 % did not use sexualized substance during sexual activity (Table 1).

3.2. Model fitting and selection

LCA was conducted on the sexual behaviors of 5,877 MSM who were eligible for PrEP uptake. Following the assumption of "local independence," a correlation check was conducted for the seven candidate variables, revealing correlation coefficients below 0.4 for all pairs (Table 2, Fig. 2). This suggests that the observed indicators are likely to be independent within the class. In the final model, the three-class models were chosen based on the minimization of the BIC and high entropy, which was only 0.01 lower than that of the two-class model (Table 3). Consequently, a three-class model was selected for its goodness-of-fit statistics and interpretability. Based on the conditional probabilities of MSM sexual behaviors within the three latent classes, the low-risk, medium-risk, and high-risk behavior groups, respectively. The high-risk behavior group exhibited lower condom use frequency, higher rates of previous STD infection, engagement in commercial sex work, more than six sexual partners, participation in group sex, knowledge of the HIV status of only some sexual partners, and use of sexualized substances. In contrast, the low-risk behavior group had a relatively higher condom use frequency, lower rates of ever having an STD and engagement in commercial sex work, had six or fewer sexual partners in the past six months, no participation in group sex, knowledge of the HIV status of all sexual partners, and no use of sexualized substance (Fig. 3).

3.3. Composition of three sexual behavior patterns

The study participants were categorized into three sexual behavior patterns based on posterior probability values: 4815(81.93 %) MSM in the low-risk sexual behavior group, 516(8.78 %) in the medium-risk sexual behavior group, and 546(9.29 %) MSM in the high-risk sexual behavior group.

The findings from the univariate analysis revealed that individuals under the age of 25 were more represented in both the low- and high-risk sexual behavior groups. MSM with a monthly income of less than ¥5,000 were more prevalent in the low-risk behavior group. Workers, farmers, and students were more likely to be in the low-risk and high-risk sexual behavior groups. MSM hailing from regions with high HIV prevalence and PrEP pilot cities were predominantly in the medium-risk behavior group. MSM identified as bottom were more prevalent in both the medium- and high-risk behavior groups (Table 4).

To delve deeper into significant factors, a multivariable logistic regression analysis was carried out following a multicollinearity assessment, which revealed no multicollinearity among variables (the variance inflation factor (VIF) was less than 5). While the three sexual behavior patterns could be viewed as ordinal variables, a multinomial logistic regression analysis was conducted because of the breach of the proportional odds assumption.

Compared to the low-risk sexual behavior group, those aged 25–44 (OR = 1.273, 95% CI: 1.004–1.613) and 45 or older (OR = 1.461, 95% CI: 1.002–2.128), with a monthly income of above ¥8,000 (OR = 1.443,

Table 2
Correlation matrix of sexual behavior variables.

Variables	Condom use	Previously had STDs	Commercial sex work	Number of sexual partners	Group sex	Knowledge of the HIV status of sexual partners	Use of sexualized substance
Condom use	1.00	0.08	0.06	-0.01	0.07	0.03	0.06
Previously had STDs	0.08	1.00	0.10	-0.09	0.10	-0.10	0.10
Commercial sex work	0.06	0.10	1.00	-0.17	0.21	-0.05	0.13
Number of sexual partners	-0.01	-0.09	-0.17	1.00	-0.37	0.21	-0.23
Group sex	0.07	0.10	0.21	-0.37	1.00	-0.16	0.21
Knowledge of the HIV status of sexual partners	0.03	-0.10	-0.05	0.21	-0.16	1.00	-0.16
Use of sexualized substance	0.06	0.10	0.13	-0.23	0.21	-0.16	1.00

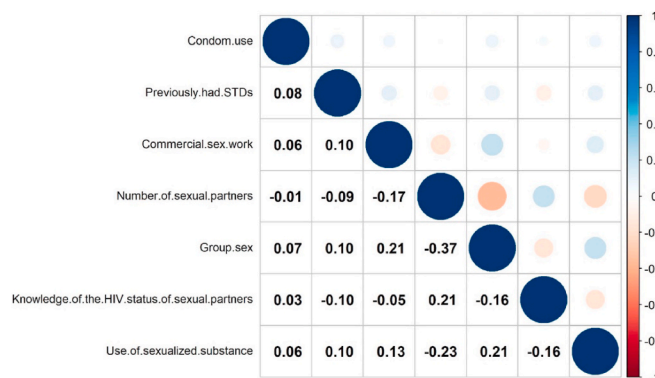


Fig. 2. Heat map of correlations between sexual behavior variables

Fig. 2 In the upper-right area of the correlation heat map, different shades of colors and sizes of circles were used to represent the strength of the correlation. The redder and darker the color and the larger the circle, the stronger the correlation. Conversely, the bluer and lighter the color and the smaller the circle, the weaker the correlation. The strength of the correlation is represented by the magnitude of the correlation coefficient in the lower-left area of the map. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

95% CI: 1.102–1.892), residing in areas with high HIV prevalence (OR = 1.533, 95% CI: 1.240–1.896), and identifying as versatile in sexual behavior (OR = 1.749, 95% CI: 1.408–2.173) were more likely to belong to the medium-risk behavior group. Compared to the low-risk sexual behavior group, those residing in areas with high HIV prevalence (OR = 1.279, 95% CI: 1.032–1.586) and identified as versatile in sexual behavior (OR = 1.591, 95% CI: 1.278–1.980) were more likely to belong to the high-risk behavior group (Fig. 4).

3.4. Differences in awareness, willingness, uptake, and adherence rates of PrEP across sexual behavior patterns

The willingness rates for PrEP in the low-, medium-, and high-risk sexual behavior groups were 53.85 %, 63.57 %, and 69.13 %, respectively. The uptake rates were 9.03 %, 18.41 %, and 23.81 % and adherence rates 36.78 %, 29.47 %, and 44.62 %, respectively. The medium- and high-risk sexual behavior groups had higher willingness, uptake, and adherence rates than the low-risk sexual behavior group (with the adherence rate of the medium-risk behavior group being lower than that of the low-risk behavior group) (Table 5).

In terms of reasons for not wanting to use PrEP or wanting to use it but not doing so, the primary concerns among the most eligible MSM were related to concerns about medication side effects and the financial constraints of affording the medication. Other factors influencing the decision against PrEP use included the ability to consistently use condoms, having a stable or trusted partner, and doubts about the medication effectiveness in prevention. Reasons for desiring to use PrEP but not following through included a lack of promotion and guidance from healthcare institutions, unclear medication instructions, and reluctance

Table 3
Model fit statistics for latent classes of MSM who were eligible for PrEP.

Number of classes	Log-likelihood	G ^{2a}	DF ^b	AIC ^c	BIC ^d	aBIC ^e	Entropy
2	-18253.31	304.97	112	334.97	435.15	387.48	0.68
3	-18217.91	234.17	104	280.17	433.78	360.69	0.67
4	-18180.20	158.75	96	220.75	427.79	329.28	0.47
5	-18165.88	130.10	88	208.10	468.57	344.64	0.53

^a G², Likelihood ratio test statistic.

^b DF, Degrees of freedom.

^c AIC, Akaike information criterion.

^d BIC, Bayesian information criterion.

^e aBIC, Adjusted Bayesian information criterion.

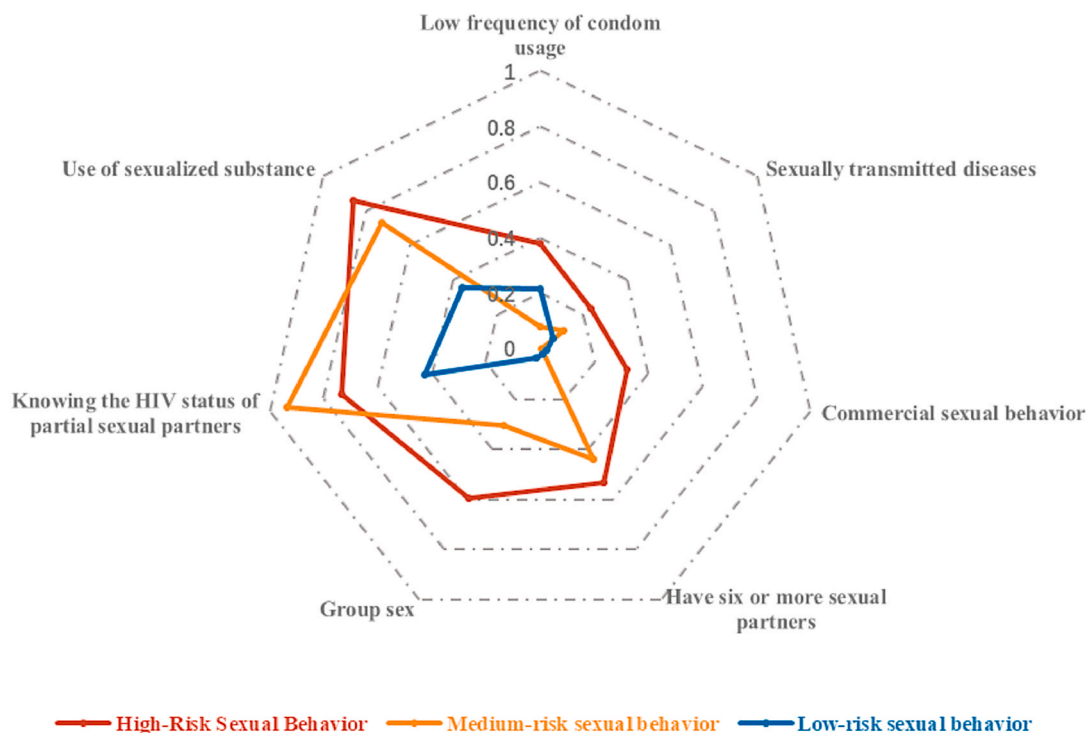


Fig. 3. Response probabilities of the variables in the three sexual behavior patterns

Item-response probabilities are the probabilities that participants will respond to different projects based on their latent class membership. For example, among those in the high-risk sexual behavior group, the probability of group sex was 0.6.

Fig. 3 Item-response probabilities of lifestyle behaviors for the four-class model: probability of endorsing an item given a latent class. Item-response probabilities are the probabilities of participants responding to different items depending on their latent class membership. For example, among those in the healthy behavioral group, the probability of endorsing regular exercise was 0.7.

to proceed without clear guidance. Upon conducting intergroup comparisons, it was observed that MSM in the low-risk sexual behavior group were less inclined to either use or not use PrEP due to their confidence in consistently using condoms and having a stable or trusted partner. Conversely, MSM in the medium- or high-risk behavior groups were deterred from PrEP usage by factors such as the absence of promotion and guidance from medical institutions, concerns about medication side effects, doubts about the effectiveness of medication in prevention, and financial constraints. Additionally, they refrained from using PrEP due to uncertainties about its effectiveness in prevention, reports of PrEP failures, and a lack of knowledge about where to procure PrEP (Appendix: Tables 6–9).

4. Discussion

This study is a community-based cross-sectional study in mainland China. It applied LCA to identify distinct patterns of sexual behavior among MSM who are eligible for PrEP uptake, and explored the

demographic and PrEP uptake differences among MSM with different sexual behavior patterns.

Three distinct sexual behavior patterns were shown in our study: low-risk sexual behavior, medium-risk sexual behavior, and high-risk sexual behavior. The low-risk sexual behavior group, the most prevalent category in our sample (n = 4815), exhibited safer sexual practices. They were more inclined to use condoms consistently, had lower rates of previous STDs and engagement in commercial sex, fewer sexual partners, no experience of group sex, were aware of the HIV status of all sexual partners, and did not use sexualized substances during sexual encounters. The use of sexualized substances itself is not directly related to HIV infection but represents an environmental factor that is more likely to lead to risky behaviors such as group sex, casual encounters, and unprotected sex, thereby increasing the risk of HIV and other sexually transmitted diseases.²⁵ All three groups were eligible for PrEP uptake, but when allocating PrEP to MSM at the highest risk for HIV, risk groups based on sexual behavior characteristics may provide more informative criteria than simple PrEP eligibility.

Table 4
Demographic difference of MSM who are eligible for PrEP among the three sexual behavior patterns, N(%).

Characteristic	Total(N = 5877)	Low-risk sexual behavior (N = 4815)	Medium-risk sexual behavior (N = 516)	High-risk sexual behavior (N = 546)	χ^2	P value
Age					16.313	0.003 ^d
16~	1799(30.61)	1497(31.09)	122(23.64)	180(32.97)		
25~	3674(62.51)	2985(61.99)	351(68.02)	338(61.90)		
45~	404(6.88)	333(6.92)	43(8.34)	28(5.13)		
Educational level					10.861	0.093
Junior high school education or lower	397(6.76)	314(6.52)	35(6.78)	48(8.79)		
Senior high school education or professional qualification	1007(17.13)	823(17.09)	85(16.47)	99(18.13)		
Junior college or college graduate	3882(66.05)	3212(66.71)	330(63.95)	340(62.27)		
Graduate degree or higher	591(10.06)	466(9.68)	66(12.80)	59(10.81)		
Monthly income(CNY)					26.966	<0.001 ^d
<3000	1730(29.44)	1434(29.78)	133(25.78)	163(29.85)		
3000~	1560(26.54)	1302(27.04)	113(21.90)	145(26.56)		
5000~	1335(22.72)	1105(22.95)	125(24.22)	105(19.23)		
8000~	1252(21.30)	974(20.23)	145(28.10)	133(24.36)		
Occupation					19.316	0.036 ^d
Company employee or civil servant	1932(32.87)	1567(32.54)	186(36.05)	179(32.78)		
Factory worker	647(11.01)	537(11.15)	49(9.50)	61(11.17)		
Farmer	120(2.04)	102(2.12)	7(1.36)	11(2.01)		
Student	1014(17.25)	845(17.55)	72(13.95)	97(17.77)		
Freelancers	1979(33.59)	1624(33.73)	181(35.08)	169(30.95)		
Unemployed	190(3.24)	140(2.91)	21(4.06)	29(5.32)		
Economic level zoning					8.883	0.064
High GDP level	2253(38.34)	1858(38.59)	200(38.76)	195(35.71)		
Middle GDP level	2117(36.02)	1708(35.47)	207(40.12)	202(37.00)		
Low GDP level	1507(25.64)	1249(25.94)	109(21.12)	149(27.29)		
In high-risk areas^a					19.932	<0.001 ^d
No	4739(80.64)	3932(81.66)	383(74.22)	424(77.66)		
Yes	1138(19.36)	883(18.34)	133(25.78)	122(22.34)		
In pilot cities^b					12.557	0.002 ^d
No	4935(83.97)	4075(84.63)	406(78.68)	454(83.15)		
Yes	942(16.03)	740(15.37)	110(21.32)	92(16.85)		
Sexual role during anal sex with a man^c					55.572	<0.001 ^d
Top	2399(40.82)	2008(41.70)	194(37.60)	197(36.08)		
Versatile	1430(24.33)	1081(22.45)	180(34.88)	169(30.95)		
Bottom	2048(34.85)	1726(35.85)	142(27.52)	180(32.97)		

^a High-risk areas are Yunnan, Sichuan, Guangxi, Guangdong, Henan.

^b The pilot cities are Beijing, Shenyang (Liaoning), Shenzhen (Guangdong) and Chongqing.

^c Within 6 months prior to test.

^d $p < 0.05$ indicates a statistical difference between the sociodemographic characteristics of MSM who are eligible for PrEP with different sexual behavior pattern.

Compared to the low-risk sexual behavior group, MSM aged 25 and above, as well as those with a monthly income exceeding ¥8000, were more likely to be categorized in the medium-risk behavior group. Several studies corroborate our findings by indicating that older age is linked to engaging in unprotected anal intercourse²⁶ and other risky behaviors.²⁷ Older MSM may be more adventurous in their sexual behaviors and more proactive in seeking sexual gratification, which may be influenced by the differential impact of HIV on the sexual lives of MSM with different experiences over time.²⁸ Research conducted in Chongqing, China, revealed that MSM with higher incomes are more inclined to participate in multipartner sexual activities.²⁹ Additionally, evidence suggests that risky behaviors often coincide with substance use,³⁰ which can be a significant expense for low-income MSM. In comparison to the low-risk sexual behavior group, individuals residing in areas with a high prevalence of HIV and those engaging in versatile sexual roles are more likely to be part of the medium-risk and high-risk sexual behavior groups. A study conducted on MSM in southwestern China highlighted a notable correlation between favoring receptive or versatile anal intercourse and engaging in unprotected anal intercourse with non-regular partners.³¹ MSM who engage in both receptive and insertive anal intercourse (known as versatile) face a heightened risk of HIV and rectal transmission infections compared with those solely involved in insertive anal intercourse. Moreover, highly versatile individuals at risk of receptive anal intercourse may contribute to HIV transmission through insertive anal intercourse, potentially increasing the risk of infection among subsequent partners.³² Given their

involvement in riskier sexual behaviors, versatile MSM play a significant role in HIV transmission and warrant close attention as a distinct subgroup.

The findings suggest that among MSM eligible for PrEP uptake in mainland China, both awareness and willingness to take PrEP are high. However, the actual uptake rate remains low, reflecting a scenario of "high awareness, high willingness, low uptake." Previous research has indicated a generally low PrEP uptake rate among MSM in China. A cross-sectional survey conducted among MSM across 34 provinces in China in 2019 revealed that only 1.20 % of MSM used PrEP.¹⁰ Comparatively, PrEP uptake rates among MSM in other countries vary: 17.99 % in the United States,³³ 18.3 % in Brazil,¹¹ and 21.5 % in Portugal.¹¹ While there has been an increase in PrEP uptake among MSM in China, a notable gap persists compared to the aforementioned countries. Although PrEP has demonstrated efficacy as a biomedical preventive measure against HIV infection among MSM, its effectiveness depends on a high level of adherence. The study results indicated that 37.27 % of MSM using PrEP were able to maintain adherence, a rate comparable to that observed among Black Americans³⁴ and in Kenya.³⁵ This suggests that while the adherence rate to PrEP among MSM in China aligns with the global averages, there remains room for improvement. Therefore, China needs to accelerate investigations and improvement of PrEP promotion and HIV prevention strategies suitable for the MSM population to increase the uptake of and adherence to PrEP among MSM who are eligible. .

The willingness, uptake, and adherence rates of PrEP in the medium-

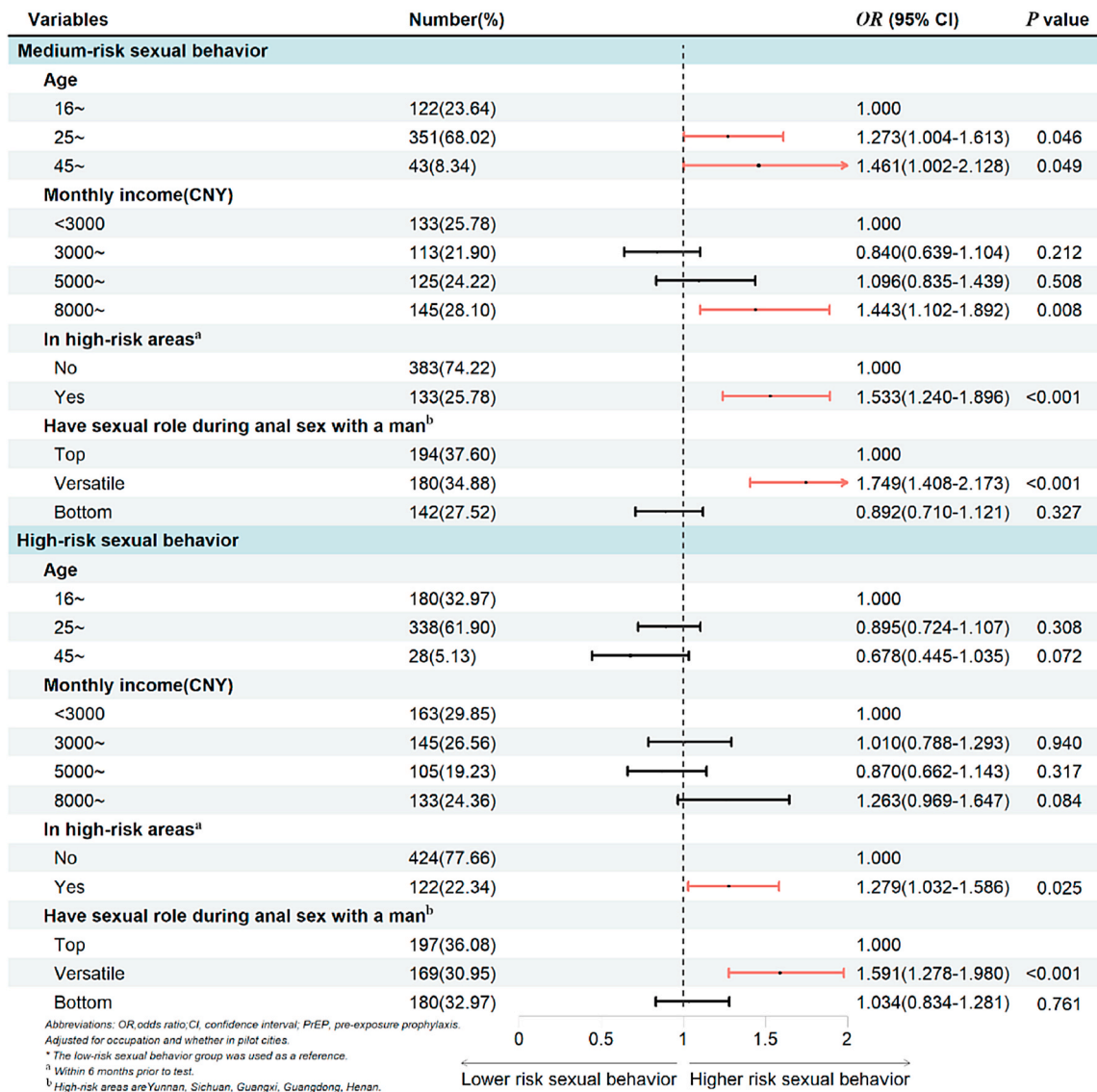


Fig. 4. Factors associated with class membership identified using multinomial logistic regression.

Table 5

Awareness, willingness, uptake, and adherence rates of PrEP, N(%).

Variables	Total (N = 5877)	Low-risk sexual behavior (N = 4815)	Medium-risk sexual behavior (N = 516)	High-risk sexual behavior (N = 546)	χ^2	P
PrEP awareness					1.6753	0.433
No	839(14.28)	688(14.29)	66(12.79)	85(15.57)		
Yes	5038(85.72)	4127(85.71)	450(87.21)	461(84.43)		
PrEP willingness					53.619	<0.001 ^b
No	2584(43.97)	2222(46.15)	188(36.43)	174(31.87)		
Yes	3293(56.03)	2593(53.85)	328(63.57)	372(69.13)		
PrEP uptake					136.646	<0.001 ^b
No	5217(88.77)	4380(90.97)	421(81.59)	416(76.19)		
Yes	660(11.23)	435(9.03)	95(18.41)	130(23.81)		
PrEP adherence					67.326	<0.001 ^b
No	5631(95.81)	4655(96.68)	488(94.57)	488(89.38)		
Yes	246(4.19)	160(3.32)	28(5.43)	58(10.62)		
PrEP adherence rate^a	37.27	36.78	29.47	44.62		

^a PrEP adherence rate was calculated among MSM who had undergone PrEP.

^b $p < 0.05$, indicating statistically significant differences between MSM with different sexual behavior patterns in terms of willingness, use, and adherence to PrEP.

and high-risk sexual behavior groups were higher than those in the low-risk sexual behavior group. Both domestic and international studies have indicated that risky behaviors, such as unprotected anal intercourse and the use of stimulants, are associated with willingness to use PrEP.³⁶ Risky anal sexual behaviors, including a higher number of sexual partners,^{9,10} engagement in group sex,¹¹ and unprotected anal intercourse^{8,37} are linked to PrEP uptake. This cross-sectional study did not establish a causal time sequence, leading to two potential explanations for this outcome. First, MSM engaging in riskier sexual behaviors may perceive a heightened risk of HIV infection, prompting them to take and adhere to PrEP, as supported by numerous studies.^{38,39} Enhancing the perception of HIV risk among MSM should be a primary focus of future interventions to boost PrEP uptake and adherence. Second, the outcome could be attributed to risk compensation. Specifically, individuals taking PrEP or adhering well to it might engage in riskier behaviors, such as having more sexual partners, engaging in group sex, and reducing condom use.⁴⁰ Risk compensation may increase the risk of HIV and other STD transmission, especially in high-risk groups like MSM. Therefore, PrEP should be viewed as a supplementary intervention rather than an alternative intervention to condoms. In the process of promoting PrEP, targeting MSM engaged in risky behaviors as an initial step and increasing PrEP uptake among low-risk sexual behavior MSM while maintaining adherence among high-risk sexual behavior MSM are more likely to yield success and be cost-effective. Relevant organizations such as the Centers for Disease Control or community-based organization can develop action plans for MSM with diverse sexual behavior patterns to reduce the likelihood of HIV infection or transmission.

Our study identified concerns regarding medication side effects and affordability as primary barriers to PrEP uptake among MSM. These findings suggest that China should enhance the healthcare environment, lower drug prices, and consider incorporating PrEP into health insurance or establishing a reimbursement program promptly to alleviate the financial burden on eligible individuals and thereby boost PrEP uptake among less affluent MSM. Furthermore, MSM with low-risk behaviors may be hesitant to use or opt out of PrEP, because they consistently use condoms and have regular or trusted partners. Therefore, enhancing the perception of HIV risk among MSM with low-risk sexual behaviors could enhance PrEP uptake. The unwillingness or non-use of PrEP among the medium- and high-risk sexual behavior groups stemmed from insufficient promotion and guidance from medical institutions as well as concerns about the efficacy of the medication. Subsequent efforts should concentrate on reinforcing promotion, guidance, and education to further enhance PrEP uptake among MSM engaging in high-risk behaviors.

There are certain limitations to this study. Firstly, it is a cross-sectional study, which may have a selective bias (volunteer bias) and could potentially overestimate the uptake and adherence rates. However, the large sample size helps to reduce some of the selection bias. What is more the causal relationship between sexual behavior factors and PrEP usage cannot be determined. Further longitudinal studies may be needed. Secondly, since all outcomes were self-reported by study participants, there may have been a social expectation bias, leading to the underestimation of risky behaviors and overestimation of uptake and adherence rates. However, our study was led by the CBO, which helps reduce bias to some extent. In the future, we may employ machine learning methods to build predictive models to unearth more valuable insights and conduct predictive analyses on MSM with diverse sexual behavior patterns.

5. Conclusions

This study identified three sexual behavior patterns among MSM that were closely associated with PrEP uptake. Intervention plans should be developed targeting MSM with diverse sexual behavior patterns to promote the uptake of PrEP among MSM and reduce the risk of HIV infection in this population.

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Availability of data and material

Data are not currently publicly available.

Code availability

Code are not currently publicly available.

Ethics approval

All study protocols and procedures involving human subjects were approved by the Ethics Committees of Tianjin Medical University and performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent to participate

Informed consent was obtained from all participants included in the study.

CRedit authorship contribution statement

Yuanyuan Liu: Data curation, Formal analysis, Funding acquisition, Writing – review & editing. **Xuan Liu:** Conceptualization, Data curation, Software, Visualization, Writing – original draft, Writing – review & editing. **Siyue Wei:** Data curation, Investigation. **Zhaoyu Cheng:** Data curation, Investigation. **Yidan Xian:** Data curation, Formal analysis. **Yicheng Zhao:** Investigation, Software. **Jun Ma:** Resources, Validation, Visualization. **Jiageng Chen:** Conceptualization, Software. **Zhongdan Chen:** Conceptualization, Formal analysis, Methodology. **Jie Yang:** Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration. **Fengli Liu:** Data curation, Investigation, Project administration. **Maohe Yu:** Conceptualization, Funding acquisition. **Zhuang Cui:** Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – review & editing. **Changping Li:** Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability

The data used is confidential.

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Appendix

Table 6
Reasons for wanting to uptake PrEP but did not uptake, N (%)

Reasons	Total(N = 2633)	Low-risk sexual behavior(N = 2158)	Medium-risk sexual behavior (N = 233)	High-risk sexual behavior (N = 242)	P
Service Competence	929(35.28)				
No promotion or guidance from medical institutions	752(28.56)	619(28.68)	66(28.33)	67(17.69)	0.945
Medical institutions had negative attitude about PrEP	316(12.00)	260(12.05)	27(11.59)	29(11.98)	0.979
Staff expressed unclearly	175(6.65)	148(6.86)	15(6.44)	12(4.96)	0.526
Self-Perception/Cognition	1645 (62.48)				
Worried about the conditions of use	445(16.90)	375(17.38)	34(14.59)	36(14.88)	0.379
Concerned about PrEP side effects	900(34.18)	726(33.64)	91(39.06)	83(34.30)	0.254
Concerned about the preventative effects of PrEP	379(14.39)	289(13.39)	45(19.31)	45(18.60)	0.007*
Heard of failure cases	31(1.18)	20(0.93)	2(0.86)	9(3.72)	<0.001*
Cannot take medication as ordered	96(3.65)	82(3.80)	6(2.58)	8(3.31)	0.611
Cannot guarantee that PrEP will be available before each sexual intercourse	101(3.84)	80(3.71)	10(4.29)	11(4.55)	0.756
Can stick to condom use	309(11.74)	267(12.37)	28(12.02)	14(5.79)	0.010*
Have a regular sexual partner or trust him	178(6.76)	165(7.65)	6(2.58)	7(2.89)	<0.001*
HIV treatment sites are PrEP purchase sites	27(1.03)	24(1.11)	1(0.43)	2(0.83)	0.586
PrEP Guidance	654(24.84)				
No clear instructions on how to take the PrEP and afraid to try it	654(24.84)	541(25.07)	57(24.46)	56(23.14)	0.797
Affordability	1002 (38.06)				
Unable to cover costs associated with PrEP	976(37.07)	779(36.10)	95(40.77)	102(42.15)	0.086
High burden of medical examination costs	62(2.35)	45(2.09)	8(3.43)	9(3.72)	0.148
Availability and accessibility	209(7.94)				
Not sure where to buy PrEP	191(7.25)	147(6.81)	27(11.59)	17(7.02)	0.028*
Remote or inaccessible locations for PrEP purchases	25(0.95)	22(1.02)	2(0.86)	1(0.41)	0.646
Complexity	41(1.56)				
Frequent medical checkups	26(0.99)	22(1.02)	2(0.86)	2(0.83)	0.939
Cumbersome medical examination process	26(0.99)	23(1.07)	2(0.86)	1(0.41)	0.609
Others	69(2.62)	58(2.69)	3(1.29)	8(3.31)	0.349

*p < 0.05 indicates that the difference is statistically significant.

Table 7
Reasons for not wanting to uptake PrEP, N (%)

Reasons	Total(N = 1745)	Low-risk sexual behavior(N = 1534)	Medium-risk sexual behavior (N = 122)	High-risk sexual behavior (N = 89)	χ^2 value	P value
Service Competence	414 (23.72)					
No promotion or guidance from medical institutions	365 (20.92)	306(19.95)	33(27.05)	26(29.21)	7.348	0.025*
Medical institutions had negative attitude about PrEP	0(0.00)	0(0.00)	0(0.00)	0(0.00)		
Staff expressed unclearly	128(7.34)	104(6.78)	13(10.66)	11(12.36)	5.981	0.051
Self-Perception/Cognition	1489 (85.33)					
Think themselves are not eligible to use	198 (11.35)	167(10.89)	21(17.21)	10(11.24)	4.498	0.106
Concerned about PrEP side effects	864 (49.51)	738(48.11)	75(61.48)	51(57.30)	10.353	0.006*
Concerned about the preventative effects of PrEP	406 (23.27)	336(21.90)	43(35.25)	27(30.34)	13.895	0.001*
Heard of failure cases	75(4.30)	52(3.39)	17(13.93)	6(6.74)	31.911	<0.001*
Cannot take medication as ordered	163(9.34)	133(8.67)	20(16.39)	10(11.24)	8.358	0.015*
Cannot guarantee that PrEP will be available before each sexual intercourse	234 (13.41)	200(13.04)	22(18.03)	12(13.48)	2.429	0.297
Can stick to condom use	703 (40.29)	642(41.85)	37(30.33)	24(26.97)	13.155	0.001*
Have a regular sexual partner or trust him	509 (29.17)	484(31.55)	14(11.48)	11(12.36)	34.872	<0.001*
A friend/sexual partner advised me to stop taking	25(1.43)	13(0.85)	9(7.38)	3(3.37)	36.616	<0.001*

(continued on next page)

Table 7 (continued)

Reasons	Total(N = 1745)	Low-risk sexual behavior(N = 1534)	Medium-risk sexual behavior (N = 122)	High-risk sexual behavior (N = 89)	χ^2 value	P value	
PrEP Guidance	HIV treatment sites are PrEP purchase sites	84(4.81) 476 (27.28)	69(4.50)	8(6.56)	7(7.87)	2.952	0.229
	No clear instructions on how to take the PrEP and afraid to try it	400 (22.92)	343(22.36)	31(25.41)	26(29.21)	2.696	0.260
Affordability	The drug instructions only contain HIV treatment functions, not "prevention". I am worried that others will see it and think I am infected.	160(9.17)	133(8.67)	19(15.57)	8(8.99)	6.471	0.039
	Unable to cover costs associated with PrEP	574 (32.89)	434(28.29)	55(45.08)	41(46.07)	25.989	<0.001*
Availability and accessibility	High burden of medical examination costs	530 (30.37)	434(28.29)	55(45.08)	41(46.07)	25.989	<0.001*
	Not sure where to buy PrEP	107(6.13) 224 (12.84)	80(5.22)	18(14.75)	9(10.11)	20.448	<0.001*
Complexity	Remote or inaccessible locations for PrEP purchases	175 (10.03)	148(9.65)	14(11.48)	13(14.61)	2.597	0.273
	Conflicting drug purchase times	47(2.69)	35(2.28)	5(4.10)	7(7.87)	10.994	0.004*
	Reservation is required for registration at designated hospitals	31(1.78)	19(1.24)	7(5.74)	5(5.62)	21.041	<0.001*
	Others	29(1.66)	21(1.37)	4(3.28)	4(4.49)	7.126	0.028*
Others	Frequent medical checkups	134(7.68)	82(5.35)	15(12.30)	10(11.24)	13.728	0.001*
	Cumbersome medical examination process	107(6.13)	82(5.35)	15(12.30)	10(11.24)	13.728	0.001*
Others	Cumbersome medical examination process	89(5.10)	72(4.69)	11(9.02)	6(6.74)	4.885	0.087
	Others	31(1.78)	26(1.69)	2(1.64)	3(3.37)	1.368	0.505

*p < 0.05 indicates that the difference is statistically significant.

Table 8

Reasons for giving up daily PrEP, N (%)

Reasons	Total(N = 172)	Low-risk sexual behavior(N = 122)	Medium-risk sexual behavior (N = 21)	High-risk sexual behavior (N = 29)	χ^2 value	P value	
Service Competence	8(4.65)						
Self-Perception/Cognition	Medical institutions have a negative attitude toward PrEP	0(0.00)	0(0.00)	0(0.00)	0(0.00)		
	The person who provided counseling service was not clear and made me lose confidence	8(4.65)	6(4.92)	1(4.76)	1(3.45)		1.000
PrEP Guidance	Blindly following others before	146 (84.88)					
	Physical reasons	20(11.63)	13(10.66)	2(9.52)	5(17.24)		0.556
	Switching to event-driven PrEP	14(8.14)	9(7.38)	1(4.76)	4(13.79)		0.495
	Concerned about drug side effects	57(33.14)	38(31.15)	7(33.33)	12(41.38)		0.563
	Concerned about the effectiveness of drug prevention	57(33.14)	39(31.97)	10(47.62)	8(27.59)	2.466	0.291
	Heard of failure cases	13(7.56)	8(6.56)	2(9.52)	3(10.34)		0.584
	Cannot guarantee daily PrEP	5(2.91)	4(3.28)	0(0.00)	1(3.45)		1.000
	Can stick to condom use	21(12.21)	11(9.02)	5(23.81)	5(17.24)		0.089
	Have a regular sexual partner or trust him	37(21.51)	26(21.31)	7(33.33)	4(13.79)	2.764	0.251
	A friend/sexual partner advised me to stop taking	24(13.95)	20(16.39)	2(9.52)	2(6.90)		0.392
	HIV treatment sites are drug purchase sites	8(4.65)	8(4.56)	3(2.46)	3(10.34)		0.063
	Affordability	The drug instructions only contain HIV treatment functions, not "prevention". I am worried that others will see it and think I am infected.	3(1.74)	2(1.64)	0(0.00)	1(3.45)	
The drug instructions only contain HIV treatment functions, not "prevention". I have been seen by others and thus others think I am infected.		7(4.07)	5(4.10)	1(4.76)	1(3.45)		1.000
Availability and accessibility	Cannot afford drug prices	40(23.26)	33(19.19)	8(38.10)	6(20.69)	5.912	0.052
	High burden of medical examination costs	10(5.81)	7(5.74)	1(4.76)	2(6.90)		0.877
0	Access to PrEP disrupted	8(4.65)					
	Remote or inaccessible locations for PrEP purchases	6(3.49)	2(1.64)	3(14.29)	1(3.45)		0.024*
Complexity	Conflicting drug purchase times	0(0.00)	0(0.00)	0(0.00)	0(0.00)		
	Reservation is required for registration at designated hospitals	0(0.00)	0(0.00)	0(0.00)	0(0.00)		1.000
Others	Frequent medical examination, consultations and follow-up visits	10(5.81)	6(3.49)	5(4.10)	1(3.45)		1.000
	Cumbersome process of medical examination, consultation and follow-up	4(2.33)	3(2.46)	1(4.76)	0(0.00)		0.507
Others	Others	8(4.65)	4(3.28)	1(4.76)	3(10.34)		0.143

*p < 0.05 indicates that the difference is statistically significant.

Table 9

Reasons for giving up event-driven PrEP, N (%)

Reasons	Total(N = 75)	Low-risk sexual behavior(N = 45)	Medium-risk sexual behavior (N = 19)	High-risk sexual behavior (N = 11)	χ^2 value	P value
Service Competence	16 (21.33)					
No promotion or guidance from medical institutions	13 (17.33)	11(24.44)	1(5.26)	1(9.09)		0.141
Medical institutions had negative attitude about PrEP	6(8.00)	5(11.11)	0(0.00)	1(9.09)		0.329
The person who provided counseling service was not clear and made me lose confidence	4(5.33)	4(8.89)	0(0.00)	0(0.00)		0.340
Self-Perception/Cognition	60 (80.00)					
Physical reasons	7(9.33)	4(8.89)	1(5.26)	2(18.18)		0.625
Switching to daily PrEP	3(4.00)	3(6.67)	0(0.00)	0(0.00)		0.721
Don't know if I will take drugs next time	9(12.00)	4(11.11)	4(21.05)	0(0.00)		0.301
Concerned about PrEP side effects	21 (28.00)	11(24.44)	7(36.84)	3(27.27)	1.022	0.600
Concerned about the preventative effects of PrEP	9(12.00)	6(13.33)	2(10.53)	1(9.09)		1.000
Heard of failure cases	2(2.67)	2(4.44)	0(0.00)	0(0.00)		1.000
Cannot take medication as ordered	11 (14.67)	6(13.33)	5(26.32)	0(0.00)		0.071
Can stick to condom use	25 (33.33)	15(33.33)	7(36.84)	3(27.27)	0.287	0.866
Have a regular sexual partner or trust him	13 (17.33)	12(26.67)	1(5.26)	0(0.00)		0.034*
A friend/sexual partner advised me to stop taking HIV treatment sites are drug purchase sites	3(4.00) 1(1.33) 5(6.67)	2(4.44) 0(0.00)	1(5.26) 1(5.26)	0(0.00) 0(0.00)		1.000 0.400
PrEP Guidance	5(6.67)					
The drug instructions only contain HIV treatment functions, not "prevention". I am worried that others will see it and think I am infected.	5(6.67)	3(6.67)	1(5.26)	1(9.09)		1.000
The drug instructions only contain HIV treatment functions, not "prevention". I have been seen by others and thus others think I am infected.	3(4.00)	1(2.22)	1(5.26)	1(9.09)		0.350
Affordability	21 (28.00)					
Cannot afford drug prices	19 (25.33)	11(24.44)	2(10.53)	6(54.55)		0.032*
High burden of medical examination costs	2(2.67)	1(2.22)	1(5.26)	0(0.00)		0.643
Availability and accessibility	9(12.00)					
Not sure where to buy PrEP	4(5.33)	2(4.44)	2(10.53)	0(0.00)		0.608
Access to "preventive medicine" disrupted	3(4.00)	2(4.44)	1(5.26)	0(0.00)		1.000
Remote or inaccessible locations for PrEP purchases	1(1.33)	1(2.22)	0(0.00)	0(0.00)		1.000
Conflicting drug purchase times	2(2.67)	1(2.22)	0(0.00)	1(9.09)		0.335
Advance reservation is required for hospital registration	3(4.00)	2(4.44)	1(5.26)	0(0.00)		1.000
Complexity	3(4.00)					
Frequent medical checkups	2(2.67)	0(0.00)	2(10.33)	0(0.00)		0.081
Cumbersome medical examination process	2(2.67)	0(0.00)	2(10.53)	0(0.00)		0.081
Others	4(5.33)	2(4.44)	2(10.53)	0(0.00)		0.608

*p < 0.05 indicates that the difference is statistically significant.

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