Polydrug use is associated with new HIV infections among men who have sex with men in China: a multicenter cross-sectional survey

Xiang Mao
NHC KEY Laboratory of AIDS Immunology(China Medical University)
Sequoia I. Leuba
University of North Carolina at Chapel Hill
Qinghai Hu
NHC KEY Laboratory of AIDS Immunology(China Medical University)
Hongjing Yan
Jiangsu Province Center for Disease Control and Prevention
Zhe Wang
Henan Province Center for Disease Control and Prevention
Lin Lu
Yunnan Centers for Disease Control and Prevention
Minghua Zhuang
Shanghai Municipal Center for Disease Control and Prevention
Xi Chen
Hunan Centers for Disease Control and Prevention
Jihua Fu
Shandong Center for Disease Control and Prevention
Wenqing Geng
NHC KEY Laboratory of AIDS Immunology(China Medical University)
Yongjun Jiang
NHC KEY Laboratory of AIDS Immunology(China Medical University)
Hong Shang (hongshang100@hotmail.com)
NHC Key Laboratory of AIDS Immunology (China Medical University) https://orcid.org/0000-0001-5333-8943
Junjie Xu
NHC KEY Laboratory of AIDS Immunology(China Medical University)

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Abstract

Background: Recreational drug use is popular among men who have sex with men (MSM), while there is limited information about polydrug use and its consequent impact on sexual health and human immunodeficiency virus (HIV) acquisition.

Methods: Mixed methods were used to recruit MSM from seven cities in China between 2012 and 2013. Participants were divided into four subgroups based on the number of recreational drugs (RDs) used in the past 6 months. “Polydrug use” was defined as simultaneous use of ≥2 types of RDs. Information on demographics and HIV high-risk behaviors (HIV-HRBs) was collected, and blood samples were tested for recent HIV infection by the BED capture enzyme immunoassay.

Results: A total of 4,496 Chinese MSM participated, of which 28.4% used RDs, and 5% were polydrug users. Polydrug users commonly took poppers with one or more types of other RDs (e.g. methamphetamine). Polydrug users were likely to be aged 26–30 years, have low educational attainment, be internal migrants, have a high monthly income, use versatile positions during anal intercourse, and have inadequate knowledge about prevention of HIV infection. As the number of RDs used in the past 6 months increased, the prevalence of HIV-HRBs increased ($P < 0.05$ for all). The odds of recent HIV infection were higher among those who used one type (aOR = 2.2, 95%CI: 1.5–3.0) or two types of RDs (2.3, 1.0–5.2) in the past 6 months compared with those who did not use RDs.

Conclusion: The level and pattern of polydrug use among Chinese MSM were different from high-income countries. Polydrug use had a dose-effect relationship with HIV-HRBs. Polydrug users who have higher levels of RDs use are more likely to engage in various sexual risks, thus may be associated with new HIV infections.

Introduction

Men who have sex with men (MSM) experience a disproportionately high burden of human immunodeficiency virus (HIV) infection [1]. Use of recreational drugs (RDs) among this population is regarded as a serious public health concern in China and overseas [2-4]. Such as ecstasy and methamphetamine, RDs are stimulants synthesized by chemistry, which are different from traditional drugs such as heroin and opium. Most of RDs have a hallucinogenic effect and make it very easy for users to form psychological dependence. RDs are difficult to quit, and excessive ingestion would lead to severe consequences such as sudden death. Therefore, RDs are expressly prohibited by Chinese laws [5]. At the end of the twentieth century, RD use was widespread among MSM in high-income countries [6]. Currently, this phenomenon is expanding to MSM communities in China and other middle-low income countries [3, 7-9]. RDs can enhance sexual function [10], increase sexual pleasure [11], and decrease pain during anal intercourse [12]. However, RD use has been reported to correlate with high-risk sexual behaviors and an increased chance of HIV infection [11-13].

In this context, “polydrug use” refers to use of multiple RDs simultaneously or during the same period to achieve a particular effect. Polydrug use has attracted worldwide attention concerning the prevention of HIV infection. Polydrug use can lead to a greater risk of transmission of HIV or other sexually transmitted infections than the use of a single RD [14]. Polydrug use alters the mental state and decreases cognitive inhibition [15]. This action can lead to an increased prevalence of condomless sex (CLS), CLS with HIV-positive partners, group sex, and the number of sexual partners among MSM [16, 17]. Compared with using a single RD, any combination of psychoactive drugs (e.g., methamphetamine, ecstasy) and physiologically actives substances (e.g., poppers, erectile-dysfunction agents) can increase the risk of HIV acquisition dramatically [18].

Despite the severity of this problem, most of the research on polydrug use has been in high-income countries [2, 17] which, because of political, legal, and cultural differences, may not apply to middle-low income countries [8, 19]. Also, the HIV incidence among MSM is higher in middle-low income countries than in high-income countries [20], which suggests a need for studying the effects of polydrug use upon recent HIV infection in middle-low income countries.

China is the largest middle-low income country in the world. The HIV prevalence among China MSM shows an increasing trend and reached ~ 6.9% in 2019 [1, 21]. By the end of 2017, there were 2.6 million drug addicts nationwide [22]. The rate of RD use among China MSM ranged from 24.1 to 77.1% [23-25]. Thus, it is imperative to understand the relationship between polydrug use and recent HIV infection among Chinese MSM to develop “tailored” interventions that control RD abuse specifically in the hope of mitigating the HIV epidemic. The present study aims to provide researchers and practitioners with information about patterns of polydrug use among Chinese MSM, as well as the impact of polydrug use on HIV high-risk behaviors and HIV acquisition.

Methods

Study participants and questionnaire

In order to better understand the HIV epidemic among Chinese MSM, a multicenter cross-sectional survey was conducted among Chinese MSM in seven large cities in China (Shenyang, Ji’nan, Zhengzhou, Shanghai, Nanjing, Changsha, and Kunming) from June 2012 to June 2013. The cruising areas and service points for MSM were used as the sampling sites. Site-specific sampling periods were determined based on attendance and hours of operation. Participants were recruited by multiple approaches: advertisements on gay websites, collaborating with local MSM community-based organizations, peer referrals, and venues such as gay bars and bathrooms visited by MSM. To be eligible for this study, participants should be physically male aged 16 years or older, self-reported anal/oral sex experiences within the last year, and able to provide informed consent.

Eligible participants completed an anonymous structured questionnaire concerning sociodemographics, recent sexual behaviors, and other HIV related risk factors. (1) demographics: age, residence, city, education, occupation, marital status, monthly income (USD), predominant sex position in anal intercourse (AI); (2) recent sexual behaviors or HIV risk factors: age of sexual debut with males, main venue of seeking male sexual partners in the past 6 months, group sex in

the past 6 months, number of male sexual partners in the past 6 months, commercial sex in the past 6 months, mucosally-traumatic sex in the past 6 months, condom break during AI in the past 6 months, STI-related symptoms in the past year, non-Chinese male sexual partners in the past 6 months.

The positive attitude towards the prevention of HIV infection was assessed by nine relevant questions. If the participant answered all questions correctly, he/she was defined as having an "adequate" positive attitude towards the prevention of HIV infection. The questions were: (1) Is it possible for a person who looks healthy to carry HIV? (2) Is it possible to be infected through transfusion of blood or blood products with HIV? (3) Is it possible to be infected through sharing needles with HIV-infected persons or AIDS patients? (4) Can the proper use of condoms in each sexual activity reduce the risk of HIV transmission? (5) Can having sex with only a single HIV-uninfected sexual partner reduce the risk of HIV transmission? (6) Can an HIV-infected pregnant woman transmit HIV to her child? (7) Is it possible to be infected through eating with HIV-infected persons or AIDS patients? (8) Is it possible to be infected through mosquito bites? (9) If you know or suspect that your partner has AIDS, will you stop having sex with him?

Participants were asked about their use (nonmedical or recreational) of seven commonly used RDs in parties or during sexual contact in the past 6 months: poppers, ecstasy, methamphetamine, amphetamine, codeine, tramadol, and ketamine. Thus, participants were grouped based on the number of drugs used in the past 6 months (i.e., no drug, single drug, two types of drugs, and ≥3 types of drugs). "Polydrug use" was defined as using ≥2 types of drugs simultaneously in the past 6 months.

Laboratory testing

Samples of venous blood were collected from participants to diagnose HIV-1 antibody. HIV-1 antibody was tested using enzyme-linked immunosorbent assay [ELISA] (bioMerieux, Durham, NC, USA), and HIV-seropositive specimens were confirmed by western blotting [WB] (HIV Blot 2.2 WBTM, Genelabs Diagnostics, Singapore). The antibody test for HIV was conducted in respective provincial HIV laboratories of CDC to which the seven study sites were affiliated. These WB-positive samples were tested by the immunoglobulin G (IgG)-capture BED-enzyme immunoassay [BED-CEIA] (Calypte Biomedical Corporation, Rockville, MD, USA) at the key laboratory in Shenyang. Based on the measurement of HIV-1-specific IgG to total IgG after seroconversion, BED-CEIA was able to distinguish between recent and established HIV-1 infections [26, 27]. To test cross-sectional specimens, we followed the algorithm shown in Figure 1. The calibrator (CAL) and control (including high-positive control, low-positive control, and negative control) specimens were tested in triplicate on every plate, and median values were used to calculate the normalized OD (ODn; ODn=specimen OD/calibrator OD). Specimens with initial ODn>1.2 were classified as established infection. Specimens with initial ODn≤1.2 were repeated tested in triplicate to confirm their ODn values by using the median values of the triplicate values. During the retesting, if median ODn values were <0.8, the specimens were considered to be recently infected [28].

Statistical analyses

The chi-square test was used to determine the significance of differences in social demographics of the different subgroups. The Cochran–Armitage trend test was used to analyze the association between different subgroups and social demographics. We calculated the prevalence of nine defined HIV high-risk behaviors in each subgroup. We estimated the ratio of the prevalence of unadjusted HIV high-risk behaviors through the chi-square test, and adjusted this prevalence ratio for social demographics through multivariate logistic regression analysis. An alpha of 0.05 was considered significant. The HIV incidence was estimated using a formula to adjust sensitivity/specificity, and the time window to define recent HIV infection was 168 days. The formula and parameters were recommended by the Chinese Centers for Disease Control and Prevention [29]. Then, we used multivariable logistic regression to determine the adjusted odds ratios (AORs) and respective 95% confidence intervals (CIs) of the different subgroups. We adjusted for social demographics using recent or established HIV infection, as defined by the BED-CEIA, as the outcome. Statistical analyses were carried out using SAS 9.2 (SAS Institute, Cary, NC, USA) and STATA 13.0 (Stata Corporation, College Station, TX, USA).

Results

Prevalence and patterns of polydrug use

In total, 4,496 MSM participated in our study, the Mean and SD of age is 30.2±5.6 years, 1275 (28.4%) reported using RDs in the past 6 months. Of these, 82.4% (n = 1050, 23.4% of all participants) used one type of RD (one-type-RD-users, 1DUs), 12.2% (155, 3.4%) used two types of RDs (2DUs), and 5.5% (70, 1.6%) used ≥3 types of RDs (3DUs).

Among 1DUs, most used poppers (90.9%), followed by codeine (3.2%), and methamphetamine (2.8%). Among 2DUs, 91.6% used poppers, 57.4% used methamphetamines, and 23.9% used ecstasy. Among 3DUs, 95.7% used poppers, 74.3% used methamphetamines, and 71.4% used ecstasy. Among all participants, 5.0% (n = 225, 17.6% of RD users) used two or more types of RDs (i.e., polydrug use). These polydrug users commonly took poppers accompanied by one or more types of other RDs (e.g., methamphetamine) simultaneously or within the same period (Figure 1).

Characteristics of polydrug users

MSM aged 26–30 years had the highest prevalence of RD use in the past 6 months in 1DUs and 2DUs. Also, the proportion of MSM aged 26–30 years increased as the number of RDs used in the past 6 months increased ($P < 0.001$ for trend) (Table 1).

For all the other social demographics examined, participants who were internal migrants, had a monthly income ≥600 USD, used versatile positions during anal intercourse, and who had inadequate positive HIV-prevention attitude had the highest prevalence of all types of RD use in the past 6 months. Also, the proportions of these demographics increased significantly as the number of RDs used in the past 6 months increased ($P < 0.05$ for trend). Although

participants with the educational attainment of junior school or below had the lowest prevalence for the use of one type of RD in the past 6 months, the prevalence of use of two or more types of RDs in the past 6 months was significantly higher (Table 1).

Characteristics of HIV high-risk behaviors

For almost all the HIV high-risk behaviors examined (e.g., seeking male sexual partners through the Internet in the past 6 months, having group sex in the past 6 months), the prevalence of HIV high-risk behavior was higher among those who used RDs in the past 6 months compared with those who did not. There was a significant association between HIV high-risk behavior and RD subgroup (P<0.05 for all). In general, the prevalence of HIV high-risk behaviors increased as the number of RDs used in the past 6 months increased (Table 2).

Prevalence and incidence of HIV based on RD use

The HIV prevalence (13.7%, 95%CI: 11.7–15.9 *vs.* 8.8%, 95%CI: 7.8–9.8) and HIV incidence [13.1 infections per 100 person-years (PY), 95%CI: 9.8–16.3 vs. 7.7 infections per 100 PY, 95% CI: 6.3–9.1] were higher among 1DUs compared with participants who did not use RDs in the past 6 months. In contrast, the HIV prevalence (8.4%, 95%CI: 4.5–13.9; 7.1%, 95%CI: 2.4–15.9) and HIV incidence (9.7 infections per 100 PY, 95%CI: 2.5–16.9; 2.4 infections per 100 PY, 95%CI: –2.3–7.0) of 2DUs and 3DUs were not significantly higher than those who did not use RDs or of 1DUs in the past 6 months (Table 3a).

Association between RD use and HIV infection

After adjustment for social demographics, 1DUs had higher odds of established HIV infection (AOR = 2.1, 95%CI: 1.5–2.8) and higher odds of recent HIV infection (AOR = 2.2, 95%CI: 1.5–3.0) compared with those who did not use RDs. 2DUs also had higher odds of recent HIV infection (AOR = 2.3, 95%CI: 1.0–5.2) compared with those who did not use RDs. In contrast, 2DUs and 3DUs did not have significantly higher odds of established HIV infection compared with those who did not use RDs (Table 3b).

Discussion

We examined the patterns of use of different RD types among Chinese MSM and the impact of such RD use on HIV high-risk behaviors and HIV acquisition. We found that the prevalence of polydrug use among Chinese MSM (5.0%) was lower than the reported prevalence of polydrug use among MSM in western high-income countries(~11.8%) [2]. Chinese MSM who used multiple RDs frequently used poppers along with one or more types of other RDs. As the number of RDs used in the past 6 months increased, the prevalence of various HIV high-risk behaviors also increased. In addition, the odds of recent HIV infection were higher among those who used RDs in the past 6 months compared with those who did not. These data suggested that polydrug users who had higher levels of RD use were more likely to engage in substantially more risky sexual behaviors, and may be associated with a higher risk of HIV acquisition.

Our study has an increased understanding of the characteristics of polydrug use in an MSM population in a middle-low income country and its relationship with HIV infection. Previous studies have shown a correlation between RD use and HIV high-risk behaviors among MSM [6, 30]. Our study confirmed those results and showed that the increase in the number of RDs used for recreation was associated with an increase in the prevalence of HIV high-risk behaviors. A similar finding has been documented among HIV-positive MSM in the UK [16], but this relationship has not been examined in a middle-low income country. In contrast with patterns of polydrug use among MSM in high-income countries [16, 17, 31], Chinese MSM frequently use poppers. We found that 90% of MSM used poppers, and those who used multiple RDs frequently used poppers along with one or more types of other RDs (i.e., methamphetamine, ecstasy, codeine, or ketamine). Poppers are physiologically active substances that facilitate and enhance anal intercourse [2, 12]. They do not affect the mental function or decision-making directly [32]. However, when poppers were used with other psychoactive drugs [2] such as methamphetamine, ecstasy, or ketamine, the prevalence of HIV high-risk behaviors increased significantly (Table 2). Most psychoactive drugs are stimulants and, thus, can alter the mental state [15], cause loss of muscle control [15], enhance sexual desires/sexual functions, and affect risk perception and decision-making [10, 11]. If psychoactive drugs are used with poppers (which relax the anal-sphincter muscles and reduce pain) simultaneously, MSM can experience more serious sexual disinhibition and, thus, anal intercourse may be more robust or last for longer, leading to an increased risk of HIV infection [32]. This pattern of polydrug use is popular among Chinese MSM but was associated with more HIV high-risk behaviors in our study. Scholars have also found that using poppers with methamphetamine or amphetamine is associated with more unprotected sex acts [33] and, hence, is linked to higher risks of HIV seroconversion [34, 35].

The proportion of HIV high-risk behaviors increased as the number of RD used growth in the past 6 months among participants. However, the possible relationship between HIV high-risk behaviors, the number of RDs used, and HIV infections was not clear. However, when we subdivided diagnosed HIV infections into recent and established HIV infections based on the BED-CEIA, we found a significant relationship between recent HIV infection and one type of RD used or two types of RD used compared with no RD used in the past 6 months. While we did not find a significant relationship between recent HIV infection and 3DUs compared with those who did not use RDs, this finding could have been due to our small sample size, which would have led to low statistical power to detect the differences in our AOR estimates. In contrast, we found a significant relationship only between established HIV infection and one type of RD used in the past 6 months compared with no RD used. This result suggests that RDs used in the past 6 months were associated with recent HIV infection. This may have been because those polydrug users who are less risk-averse would have greater levels of RD use and to be more likely to engage in more sexually risky behaviors and, thus, may be associated with new HIV infections.[41, 42] Several longitudinal studies have found similar associations between polydrug use and recent HIV seroconversion [18, 36]. Newly infected individuals have a high level of viral load in plasma and few pronounced symptoms and, thus, are

highly infectious, but detection of such people is difficult [37, 38]. In addition, MSM in this HIV seroconversion period have been found to participate frequently in HIV high-risk behaviors [38]. Thus, polydrug users will take more sexual risks and, thus, may be associated with new HIV infections and an increased risk of secondary HIV transmission.

Although the collected prevalence of polydrug use among Chinese MSM in our study was lower than the prevalence among MSM reported in high-income countries (5.0% *vs.* ~11.8%) [2], the actual prevalence of polydrug use of Chinese MSM may have been underestimated due to two main reasons. First, most RDs are illegal in China, so participants may have been afraid of the repercussions of answering honestly about their use of multiple RDs (though participants were asked through an anonymous survey to minimize this bias in social acceptance). Second, we investigated only the seven most commonly used RDs among Chinese MSM. There are many products used by MSM in which the presence of drugs is not clear, so that MSM may have underestimated their RD use unknowingly. Thus, the estimated HIV incidence among polydrug users may also be underestimated because of this bias.

We elucidated the characteristics and possible mechanisms of HIV transmission among Chinese MSM who use RDs. We undertook this study in the hope of developing targeted interventions to address the HIV epidemic. We found that participants aged 26–30 years had a higher prevalence of overall RD use in the past 6 months (39.0%) and polydrug use in the past 6 months (7.2%) compared with any other age group examined. The number of identified HIV/AIDS cases among MSM aged 26–30 years in China increased rapidly from 2007 to 2015 [39]. Mao and colleagues found a high HIV incidence (~9 infections per 100 PY) among Chinese MSM aged 26–30 years [40]. RD use is associated with behaviors that increase the risk of HIV, so tailored methods reducing RD use must be implemented among Chinese MSM 26–30 years to reduce the risk of HIV acquisition. In addition, we found an association between a decrease proportion in adequate positive attitude towards prevention of HIV infection and an increase in the number of RDs used in the past 6 months, suggesting that strategies focused on increasing positive attitude towards prevention of HIV infection should be targeted at polydrug users. Finally, many Chinese MSM in our study used poppers, which may have been due to the ease of buying this drug (they are not illegal in China) [19]. Thus, the Chinese government should restrict the sale of poppers to reduce RD use to diminish the effect of RD use on HIV transmission. Several intervention measures targeting this group should be considered to control the HIV epidemic: (1) Enhance publicizing the severe irreversible damage to the human body caused by RDs; (2) Emphasize that the use of RDs is a severe illegal behavior to make MSM feel guilty about RDs use; (3) Promote the entertainment venues rectification; (4) Lead MSM to healthy entertainment methods instead of relying on RDs to vent their inner emptiness, depression and pressure.

Our study had limitations that the proportion of participants who self-reported using multiple types of RDs was only 5%. The low number of polydrug users may have led to the inconsistencies found in the dose-effect relationship between HIV high-risk behaviors and drug subgroups; calculation of the incidence and prevalence of HIV infection by RD subgroups; the association between HIV infection and RD subgroups. We speculate that a bias against social acceptance and misclassification because of unknown use of RDs may have limited our ability to develop statistically significant results and reduced the observed effect of polydrug use upon HIV infection.

Conclusions

Chinese MSM who used multiple RDs frequently used poppers along with one or more types of other RDs. The proportion of HIV high-risk behaviors increased as the number of RD used growth in the past 6 months. Using one or two types of RDs was associated with increased odds of recent HIV infection compared with MSM who did not use RDs. So polydrug use may be more likely to be associated with new HIV infections. Strategies focusing on decreasing RD use among Chinese MSM and increased governmental control of RDs could reduce drug use and, thus, mitigate the HIV epidemic in China.

Abbreviations

MSM: men who have sex with men; **HIV:** human immunodeficiency virus; **RDs:** recreational drugs; **HIV-HRBs:** HIV high-risk behaviors; **CLS:** condomless sex; **WB**: western blotting; **BED-CEIA:** immunoglobulin G (IgG)-capture BED-enzyme immunoassay; **CIs:** confidence intervals; **AORs:** adjusted odds ratios; **ORs:** odds ratios; **1DUs:** one-type-RD-users;**2DUs:** two types of RDs users; **3DUs:** three or more types RDs users

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Review Board of the First Affiliated Hospital of China Medical University ([2011]-36; Shenyang, China). The study was undertaken following all relevant guidelines and regulations. Written informed consent was obtained from all participants before study commencement.

Conflicts of interest

The authors declare that they have no conflict of interest.

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Authors' contributions

Conception and design of experiments: XM, HS, JJX, QHH; carried out the study and experiments: HJY, ZW, LL, MHZ, XC, JHF, WQG, YJJ; analyzed the data: XM, QHH, JJX; wrote and revised the manuscript: XM, SIL, JJX. All authors reviewed the manuscript.

Availability of data and materials

Data on this research is available with the corresponding author.

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Tables

Table 1. Distribution of social demographics among different subgroups of RD use (N = 4496)

		1DUs (n = 1050)			1DUs (n = 1050)			2DUs (n = 155)			3DUs (n = 70)		
	N	n	Row Percentage %	Column Percentage %	n	Row Percentage %	Column Percentage %	n	Row Percentage %	Column Percentage %	n	Row Percentage %	Column Percentage %
Age (years)													
18–25	1617	1123	69.4	34.9	412	25.5	39.2	59	3.6	38.1	23	1.4	32.9
26–30	1181	721	61	22.4	375	31.8	35.7	63	5.3	40.6	22	1.9	31.4
>30	1698	1377	81.1	42.8	263	15.5	25	33	1.9	21.3	25	1.5	35.7
Residence													
Local cities	1785	1327	74.3	41.2	385	21.6	36.7	45	2.5	29	28	1.6	40
Non-local cities	2711	1894	69.9	58.8	665	24.5	63.3	110	4.1	71	42	1.6	60
Education													
Junior school or below	916	674	73.6	20.9	169	18.4	16.1	45	4.9	29	28	3.1	40
High school	1201	877	73	27.2	269	22.4	25.6	37	3.1	23.9	18	1.5	25.7
College or above	2379	1670	70.2	51.8	612	25.7	58.3	73	3.1	47.1	24	1	34.3
Marital status													
Never married	3303	2266	68.6	70.4	860	26	81.9	129	3.9	83.2	48	1.5	68.6
Married	1193	955	80.1	29.6	190	15.9	18.1	26	2.2	16.8	22	1.8	31.4
Occupation													
Student	565	418	74	13	127	22.5	12.1	16	2.8	10.3	4	0.7	5.7
Non-student	3931	2803	71.3	87	923	23.5	87.9	139	3.5	89.7	66	1.7	94.3
Monthly income (USD)													
No income	769	591	76.9	18.3	146	19	13.9	25	3.3	16.1	7	0.9	10
1–599	2858	2069	72.4	64.2	658	23	62.7	94	3.3	60.7	37	1.3	52.9
≥600	869	561	64.6	17.4	246	28.3	23.4	36	4.1	23.2	26	3	37.1
Primary sex position during AI[a]													
Top	1395	1053	75.5	33.4	291	20.9	28	34	2.4	23.1	17	1.2	24.6
Bottom	988	725	73.4	23.1	222	22.5	21.3	31	3.1	21.1	10	1	14.5
Versatile	2022	1371	67.8	43.5	527	26.1	50.7	82	4.1	55.8	42	2.1	60.9
Positive HIV-prevention attitude													
Inadequate	2730	1861	68.2	57.8	676	24.8	64.4	128	4.7	82.6	65	2.4	92.9
Adequate	1766	1360	77	42.2	374	21.2	35.6	27	1.5	17.4	5	0.3	7.1

0DUs: No RDs used in the past 6 months; 1DUs: One type of RD (one-type-RD-users) used in the past 6 months; 2DUs: Two types of RDs used in the past 6 months; 3DUs: Three or more types of RDs used in the past 6 months. AI: anal intercourse. Unadjusted *P*-values were calculated by the chi-square test. The *P* for the trend of social demographics changing in different subgroups was determined by the Cochran–Armitage trend test a. Ninety-one participants did not respond to this variable on the questionnaire, so it differs from the total sample size.

[Please see the supplementary files section to view Table 2.]

Table 3a. HIV prevalence and BED-CEIA-based HIV incidence among MSM participants (N = 4496)

	Total	HIV infection	HIV recent infection	HIV established infection	HIV prevalence (%) (95%CI)[b]	HIV incidence/100 PY (95%CI)[c]
Subgroups of RD use	4496	444	186	250	9.9 (9.0–10.8)	8.9 (7.6–10.2)
0DUs	3221	282	116	161	8.8 (7.8–9.8)	7.7 (6.3–9.1)
1DUs	1050	144	62	79	13.7 (11.7–15.9)	13.1 (9.8–16.3)
2DUs	155	13	7	6	8.4 (4.5–13.9)	9.7 (2.5–16.9)
3DUs	70	5	1	4	7.1 (2.4–15.9)	2.4 (−2.3 to 7.0)

Table 3b. Association between recent or established HIV infection and subgroup of RD use (N = 4488)[a]

Subgroups of RD use	Total	Recent HIV infection (N=186)			Established HIV infection (N=250)		
		n (%)	Adjusted model[d] aOR (95%CI)	*P*	n (%)	Adjusted model[d] aOR (95%CI)	*P*
0DUs	3216	116 (3.6)	1	–	161 (5.0)	1	–
1DUs	1047	62 (5.9)	2.2 (1.5–3.0)	<0.001	79 (7.5)	2.1 (1.5–2.8)	<0.001
2DUs	155	7 (4.5)	2.3 (1.0–5.2)	0.054	6 (3.9)	1.4 (0.6–3.4)	0.433
3DUs	70	1 (1.4)	0.8 (0.1–5.8)	0.809	4 (5.7)	1.9 (0.6–5.4)	0.247

0DUs: No RDs used in the past 6 months; 1DUs: One type of RD (one-type-RD-users) used in the past 6 months; 2DUs: Two types of RDs used in the past 6 months; 3DUs: Three or more types of RDs used in the past 6 months. a: Recent and established infections were determined using the BED-CEIA. Because of insufficient numbers of blood specimens, the BED-CEIA could not be conducted on samples from eight HIV antibody-positive participants. b: HIV prevalence was calculated from all HIV infections (i.e., recent and established) diagnosed through the study. c. The HIV incidence determined using the BED-CEIA was then adjusted using the sensitivity and specificity adjustment formula and parameters recommended by the Chinese Centers for Disease Control and Prevention. d. Adjusted odds ratios (AORs) and the corresponding 95%CI were derived through multivariate logistic regression analysis with adjustment for the following social demographics: study site (Shanghai, Nanjing, Changsha, Zhengzhou, Ji'nan, Shenyang, and Kunming), age (18–25, 26–30, and >30 years), residence (local cities and non-local cities), education (junior school or below, high school, and college or above), marital status (never married and married), occupation (student and non-student), monthly income (no income, 1–599, and ≥600 USD), primary position during AI (top, bottom, and variable), and positive HIV-prevention attitude (inadequate and adequate).

Figures

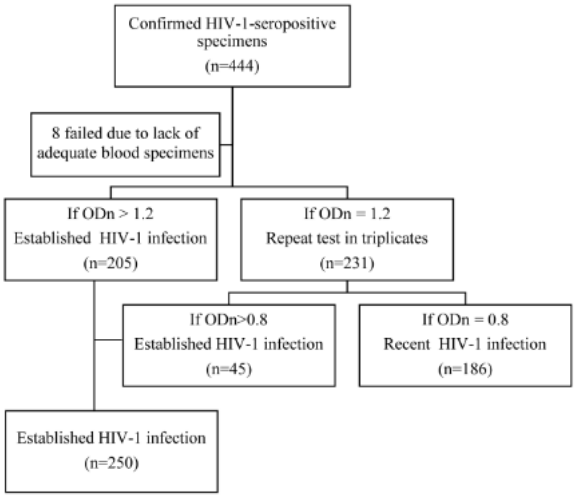

Figure 1

Algorithm for testing cross-sectional specimens to detect recent HIV-1 infection

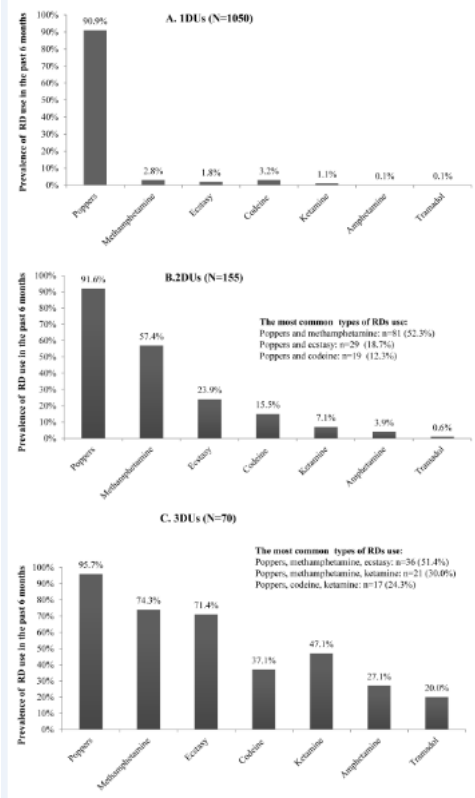

Figure 2

Prevalence of specific RD use in the past 6 months among different subgroups of RD use (N=4496) 1DUs: One type of RD (one-type-RD-users) used in the past 6 months; 2DUs: Two types of RDs used in the past 6 months; 3DUs: Three or more types of RDs used in the past 6 months. Out of the 4496 MSM participants, 1050 participants used one type of RD in the past 6 months (Panel A), 155 used two types of RDs in the past 6 months (Panel B), and 70 used three or more types of RDs in the past 6 months (Panel C). The prevalence of the types of most common used RDs are also listed above.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- database.sav
- Table2.tif