

Behavioral Risk Profile of Men Who Have Sex with Men in Beijing, China: Results from a Cross-sectional Survey with Randomized Response Techniques

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Abstract

Background: Human immunodeficiency virus (HIV) is spreading rapidly among men who have sex with men (MSM) in China. Anonymous questionnaires or direct interviews have been frequently used to study their behavior. The aim of the study was to describe the behavioral risk profile of the MSM in Beijing using the randomized response techniques (RRTs).

Methods: A cross-sectional survey of sexual behavior among a sample of MSM was conducted in two HIV counseling and testing clinics in Beijing. The survey was carried out with an anonymous questionnaire containing sensitive questions on sexual behavior. To obtain the honest responses to the sensitive questions, three distinctive RRTs were used in the questionnaire: (1) Additive randomized response model for quantitative questions, (2) randomized response model for multiple choice questions, and (3) Simmons randomized response model for binomial questions. Formulae for the point estimate, variance, and confidence interval (*CI*) were provided for each specific model.

Results: Using RRTs in a sample of 659 participants, the mean age at first homosexual encounter was estimated to be 21.7 years (95% *CI*: 21.2–22.2), and each had sex with about three (2.9, 95% *CI*: 2.4–3.4) male partners on average in the past month. The estimated rate for consistent condom use was 56.4% (95% *CI*: 50.1–62.8%). In addition, condom was estimated to be used among 80.0% (95% *CI*: 74.1–85.9%) of the population during last anal sex with a male partner.

Conclusions: Our study employed RRTs in a survey containing questions on sexual behavior among MSM, and the results showed that RRT might be a useful tool to obtain truthful feedback on sensitive information such as sexual behavior from the respondents, especially in traditional Chinese cultural settings.

Key words: Condom Use; Cross-sectional Survey; Men Who Have Sex with Men; Randomized Response Technique, Sexual Behavior

INTRODUCTION

In recent years, China has witnessed a prominent change in the spread of human immunodeficiency virus (HIV). Sexual transmission has become the primary mode and contributed to the expansion of the HIV epidemic worldwide.^[1] Among those infected by sexual transmission, men who have sex with men (MSM) are a special group and have attracted growing public attention. The proportion of MSM increased rapidly among the nationally reported HIV/acquired immune deficiency syndrome (AIDS) cases during 2005–2014, from 7.3% (total number of reported HIV/AIDS, 47,000) in 2005 to 10.0% (61,470) in 2009 and to 25.8% (103,501) in 2014.^[2-6]

As a high-risk group for HIV infection, MSM and their sexual behavior have been the subject of many studies in China. Unprotected anal intercourse (UAI) and multiple male partnerships are among the frequently studied topics. The prevalence of consistent condom use during anal sex

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among MSM in China is very low.^[7] Zhang *et al.*^[8] reported that 89.7% of MSM in a northern Chinese city had UAI in 2002, and dropped to 71.5% in 2006. In a large-scale national survey among 18,000 MSM conducted in 2008 across 61 cities throughout China, the rate of consistent condom use with male partners was reported as low as 35.4%.^[9] In a more recent study among migrant MSM in Beijing, 60.4% of the respondents having regular male partners reported consistent condom use, and respondents having casual partners reported higher (77.3%) consistent condom use.^[10]

A review article estimated that MSM in China have relatively low number (1.5) of male sexual partners.^[11] In a study using face-to-face anonymous interview, participants were reported to have 6.8 sexual partners on average in the past 6 months, and 63% had used condoms consistently, i.e., in every sexual act.^[12]

The results may vary with survey techniques applied in the study, especially when the study requests participants to disclose sensitive information about themselves.^[13-15] Anonymous paper-based questionnaires and online questionnaires with or without direct interviews are frequently used techniques in the aforementioned studies conducted among Chinese MSM population. These studies were usually conducted in traditional Chinese cultural settings where this population still suffers from significant stigma and discrimination.^[16] Therefore, the results from these studies on sensitive characteristics of MSM may be distorted by participants' evasive answers to the questions soliciting compromising information.

To eliminate the biases caused by possible evasive answers, randomized response techniques (RRTs) have been used in many studies to obtain more accurate sensitive information from respondents. Compared with the results assessed through direct questionnaires, studies using RRTs have reported higher prevalence rates for socially sensitive issues.^[14,17-19] To a large extent, this may result from the nature of RRTs to obtain sensitive information from respondents by protecting their privacy and removing their concerns in providing honest responses to sensitive questions.^[14,17,20]

RRTs have been applied in a few studies on sexual behavior.^[14,20,21] The studies using RRTs in the Chinese MSM population were scarce. Our study aimed to characterize the behavioral profile of this population using anonymous questionnaire with RRTs, to better understand the risk patterns for this specific group.

METHODS

Study subjects and design

A cross-sectional survey on sexual behavior among MSM was conducted in two HIV counseling and testing clinics in Beijing between July 2010 and October 2010. The protocol of the study was reviewed and approved by the Ethics Committee of Soochow University. MSM were recruited

through various approaches, such as website advertisements, outreach to MSM-frequented venues (e.g., MSM clubs, bars, and bathhouses), and peer-referrals. Inclusion criteria were: (1) Chinese men of age 18 years and above, (2) men who self-reported ever having sex with other men, and (3) providing written informed consent.

Before the survey, trained study staff gave an introduction of the study to the participants and obtained their written informed consent to participate in the survey. The study staff then introduced the questionnaire of the survey and the rationale of RRT to mitigate participants' concern over compromising their privacy. After fully understanding the questions on the questionnaire, participants entered a private room for the survey to complete the questionnaire consisting of demographic questions and sensitive questions on sexual behavior. To answer sensitive questions, participants were asked to draw a coin from numbered cloth bags and answer the questions as per the instructions specified on the questionnaire. The numbers printed on the cloth bags corresponded to the order of sensitive questions participants would need to answer. Each cloth bag contained 10 coins, with each coin carrying a digit. The digits and the ratio for the numbers of digits varied according to the RRTs designed for the sensitive questions. Participants were asked to put the coin back into the cloth bag from which it was drawn and reshuffle the coins after each sensitive question was answered. A study staff stayed in the survey room to answer any questions from participants but seated away from where participants drew the coins and completed the questionnaire to ensure privacy. Participants dropped the filled-in questionnaire into a collection box at the end of the survey. The survey was conducted individually, namely one survey session was applied to each participant separately. No two or more participants received the survey at the same time, to further eliminate participants' concern.

Randomized response techniques

Three RRTs were used in this study to obtain answers to three different types of sensitive questions: (1) additive randomized response model for quantitative sensitive questions, (2) randomized response model for multiple choice sensitive questions, and (3) Simmons randomized response model for binomial sensitive questions. Detailed description of each model, the corresponding questionnaire items and formulae used to estimate the parameters, (i.e., point estimates of the means and the proportions, as well as variances and confidence interval [*CI*]) were provided in the supplementary information [Supplementary Text 1] of this article.

Statistical analysis

EpiData (version 3.1; The EpiData Association, Odense, Denmark) was used for double entry and the management of the survey data. Data were recorded as *n*, proportion, or prevalence, and processed with the formulas as shown in the Supplementary Text 1. Statistical analysis was performed using SAS (version 9.2; SAS Institute Inc., Cary, NC, USA).

RESULTS

A total of 694 MSM were recruited for this survey. Thirty-five (5.0%) of them did not give written informed consents and data were not obtained for these MSM; 659 (95.0%) MSM gave written informed consents to participate in the study.

The age of the 659 participants ranged from 18 to 72 years (mean \pm standard deviation: 29.8 ± 7.8 years), with more than half (57.4%) of them aged 20–29 years. Among them, 542 (82.2%) were single, with 468 (71.0%) participants reporting at least one regular male sex partner, and 74 (11.2%) without a regular homosexual partner. A total of 117 (17.8%) participants reported that they were married with a female, of whom 68 (10.3%) participants living with their spouse and 49 (7.4%) separated. More participants were from other provinces (72.4%) than Beijing (27.6%), but the majority of the participants (82.4%) had been lived in Beijing for over 2 years. Among the participants, 93.0% were Han ethnicity and 57.2% reported to have received postsecondary (college or above) education. Detailed demographic characteristics of the participants are presented in Table 1.

All 659 participants provided information about their age at the first sexual encounter with a man. Using RRT, the average age at first homosexual encounter among this population was estimated to be 21.7 years [Table 2]. Of all the 659 participants, 651 answered the question regarding the number of male partners they had sex within the past month and the RRT estimate was 2.9 [Table 3].

A total of 650 participants provided information about the use of condoms during anal sex with male partner(s) in the past month and condom was estimated to be used every time among 56.4% of this population during MSM anal sex in the previous month whereas 5.1% of the population was estimated by RRT as “never used condoms” during MSM anal sex in the same period. The results from the analysis of consistent condom use in the past month are presented in Table 4.

One participant did not answer the binomial sensitive question regarding condom use during the latest anal sex act. From the response of 658 participants, the RRT estimated rate of condom use during last anal sex with a male partner was 80.0% (95% *CI*: 74.1–85.9%) [Table 5].

Subgroup analyses for each model were carried out based on participants' demographic characteristics. Younger MSM participants (<30 years) had earlier first homosexual encounter (19.8 years) and slightly more male partners (3.0) in the past month than participants aged ≥ 30 years (24.4 years, 2.8, respectively). The proportions of consistent condom use (i.e., every time) in the past month and at most recent anal sex were lower in younger participants (53.8% and 78.1%, respectively) than older participants (60.2% and 82.7%, respectively).

Table 1: Demographic characteristics of 659 participants in the survey of sexual behavior among men who have sex with men in Beijing, China, 2010 (*n* (%))

Characteristics	Values
Age	
<30 years	388 (58.9)
≥ 30 years	271 (41.1)
Marital status	
Single*	542 (82.2)
Married	117 (17.8)
Residence	
Beijing	182 (27.6)
Non-Beijing	477 (72.4)
Length of residence in Beijing	
<2 years	116 (17.6)
≥ 2 years	543 (82.4)
Ethnicity	
Han	613 (93.0)
Minorities	46 (7.0)
Education	
High school or below	282 (42.8)
College or above	377 (57.2)

*Single including those who has never married, divorced, or widowed.

Table 2: Estimated age (years) at first homosexual encounter using the additive randomized response technique model among men who have sex with men in Beijing, China, 2010

Items	<i>n</i>	$\hat{\mu}_a$	μ_c	$\hat{\mu}_s$	$\text{Var}(\hat{\mu}_s)$	95% <i>CI</i>
All participants	659	26.2	4.5	21.7	0.06	21.2–22.2
Age group						
<30 years	388	24.3	4.5	19.8	0.05	19.3–20.3
≥ 30 years	271	28.9	4.5	24.4	0.21	23.5–25.3
Marital status						
Single*	542	25.3	4.5	20.8	0.05	20.3–21.3
Married	117	30.4	4.5	25.9	0.64	24.3–27.5
Residence						
Beijing	182	25.6	4.5	21.1	0.23	20.2–22.0
Non-Beijing	477	26.5	4.5	22.0	0.08	21.4–22.6
Length of residence in Beijing						
<2 years	116	25.8	4.5	21.3	0.33	20.2–22.4
≥ 2 years	543	26.3	4.5	21.8	0.08	21.3–22.3
Ethnicity						
Han	613	26.3	4.5	21.8	0.07	21.3–22.3
Minorities	45	25.1	4.5	20.6	0.81	18.8–22.4
Education						
High school or below	282	26.9	4.5	22.4	0.19	21.5–23.3
College or above	377	25.8	4.5	21.3	0.08	20.7–21.9

*Single including those who has never married, divorced, or widowed; *n*: Number of participants answering the question; $\hat{\mu}_a$: Mean of the responses that participants entered for the age at first homosexual encounter; μ_c : Mean of the digits on the coins in the cloth bag; $\hat{\mu}_s$ and $\text{Var}(\hat{\mu}_s)$: Estimated mean and its variance of the actual age at first homosexual encounter; *CI*: Confidence interval.

Table 3: Estimated number of male sex partners in the past month using the additive randomized response technique model among men who have sex with men in Beijing, China, 2010

Items	<i>n</i>	$\hat{\mu}_a$	μ_c	$\hat{\mu}_s$	$\text{Var}(\hat{\mu}_s)$	95% <i>CI</i>
All participants	651	7.4	4.5	2.9	0.06	2.4–3.4
Age group						
<30 years	381	7.5	4.5	3.0	0.11	2.3–3.7
≥30 years	270	7.3	4.5	2.8	0.15	2.0–3.6
Marital status						
Single*	535	7.3	4.5	2.8	0.08	2.3–3.3
Married	116	7.9	4.5	3.4	0.42	2.1–4.7
Residence						
Beijing	179	7.2	4.5	2.7	0.19	2.0–3.4
Non-Beijing	472	7.5	4.5	3.0	0.10	2.4–3.6
Length of residence in Beijing						
<2 years	115	8.9	4.5	4.4	0.81	2.6–6.2
≥2 years	536	7.1	4.5	2.6	0.06	2.1–3.1
Ethnicity						
Han	606	7.4	4.5	2.9	0.07	2.4–3.4
Minorities	45	7.9	4.5	3.4	1.02	1.4–5.4
Education						
High school or below	280	8.5	4.5	4.0	0.24	3.0–5.0
College or above	371	6.6	4.5	2.1	0.05	1.6–2.6

*Single including those who has never married, divorced, or widowed; *n*: Number of participants answering the question; $\hat{\mu}_a$: Mean of the responses that participants entered for the number of male sex partners in the past month; μ_c : Mean of the digits on the coins in the cloth bag; $\hat{\mu}_s$ and $\text{Var}(\hat{\mu}_s)$: Estimated mean and its variance of the actual number of male sex partners in the past month; *CI*: Confidence interval.

DISCUSSION

This study investigated the sexual behavior of Chinese MSM population using a questionnaire with RRTs. Different RRT models were used with the intention to obtain more honest responses to three kinds of sensitive questions. To the best of our knowledge, this is the first time that diverse RRT models have been used to investigate both quantitative and qualitative behavioral characteristics in Chinese MSM population. The participation rate of 95% in this RRT survey is higher than that reported in studies using anonymous telephone survey (57%)^[22] or anonymous structured questionnaire in direct interviews (89.5%).^[23] The high anonymity resulting from the survey techniques may have removed participants' concerns in compromising their privacy and, therefore, contributed to the high participation rate. Other factors such as the short length of the questionnaire and peer-referral recruitment mechanism may have further encouraged participation in this study.

The RRT estimate of age at the first sexual encounter with a male partner in our study is 21.7 years, which is younger than that reported by a study using a direct interview with an anonymous questionnaire in a cross-sectional survey of the MSM population in eastern China.^[24] A case-control study on the MSM population in southwestern China reported

that the average age at the first sexual encounter with a man among the HIV-positive cases was 21.7 years, compared with 22.0 years among the HIV-negative controls.^[25] Our estimate of the age related to MSM debut homosexual encounter using RRT is the same as that for the HIV-positive cases, but slightly younger than that for the HIV-negative controls reported in the case-control study.

For the number of male sex partners in the past month, our RRT estimate is 2.9. A study among migrant MSM in Beijing reported that the median number of male sex partners was 3 in the past 6 months,^[26] which is close to our estimate but the reporting period is much longer than that of our study. Other studies reported more sex partners among Chinese MSM population in the period of the past 6 months before the survey. An online survey conducted among MSM in Beijing reported that the median number of male sex partners in the past 6 months was 5^[27] whereas the overall median number of male sex partners of Chinese MSM in the past 6 months was estimated to be 1.5 by a review article based on the studies published during 2000–2010.^[11] In addition to the difference in reporting period, some studies were conducted several years earlier than the current study and the pattern of sexual behavior among MSM population may have changed with time.^[28]

Most studies on condom use among MSM population in China reported the pattern of use at last sexual act and consistent use in a 6-month period. A study among 20,843 MSM in 16 cities in China reported that self-reported condom use at last homosexual encounter increased from 58% in 2006 to 81% in 2009 whereas the consistent condom use rate in the past 6 months increased from 28% to 49% during the same period.^[29] In China's United Nations General Assembly Special Session (UNGASS) Report 2010, the estimated rate of condom use at last anal sex among MSM surveyed in sentinel surveillance programs was 73.1%.^[30] Our RRT estimate of consistent condom use in the past month is higher than that reported in 2009 in the aforementioned study. However, the shorter length of reporting period (i.e., 1 month) may contribute to the higher estimate in our study, as it is obviously more challenging to be a consistent condom user for 6 months than for only 1 month. A more recent study on money boys (i.e., male sex workers engaging in same-sex sexual activities for economic benefits) reported 80.2% of the participants used condoms consistently with male sex partners in the past 3 months, which is much higher than the RRT estimate of consistent condom use in our study.^[31] This may be caused by the selection of a special study population (i.e., money boys) perceiving higher risks and, therefore, more protective behavior. For condom use at last anal sex with a male partner, our RRT estimate is slightly lower than that reported in 2009 (81%) in the same aforementioned study using questionnaire and interview for data collection, but higher than that reported in China's UNGASS Report 2010 (73.1%), which used questionnaire for the survey at sentinels across the whole country. Consistent condom use

Table 4: Estimated prevalence for consistent condom use in the past month using the randomized response technique model for multiple choice sensitive questions among men who have sex with men in Beijing, China, 2010

Items	n_1	n_2	n_3	n_4	a_i	$\hat{\pi}_{s_i}$ (%)	$\text{Var}(\hat{\pi}_{s_i})$	95% CI (%)
All participants	85	181	285	99	0.438	56.4	0.032,438	50.1–62.8
Age group								
<30 years	54	105	161	61	0.423	53.8	0.001,779	45.5–62.0
≥30 years	31	76	124	38	0.461	60.2	0.002,566	50.2–70.1
Marital status								
Single*	70	145	238	82	0.445	57.5	0.001,282	50.5–64.5
Married	15	36	47	17	0.409	51.4	0.005,837	36.5–66.4
Residence								
Beijing	29	53	69	28	0.385	47.6	0.003,676	35.7–59.5
NonBeijing	56	128	216	71	0.459	59.8	0.001,464	52.3–67.3
Length of residence in Beijing								
<2 years	19	31	48	17	0.417	52.9	0.005,874	37.9–67.9
≥2 years	66	150	237	82	0.443	57.2	0.001,281	50.1–64.2
Ethnicity								
Han	81	167	267	90	0.441	56.9	0.001,132	50.3–63.5
Minorities	4	14	18	9	0.400	50.0	0.014,815	26.1–73.9
Education								
High school or below	32	84	118	44	0.424	54.1	0.002,441	44.4–63.8
College or above	53	97	167	55	0.449	58.2	0.001,847	49.7–66.6

*Single including those who has never married, divorced, or widowed; n_{1-4} : Number of participants selecting “1”, “2”, “3”, and “4,” respectively; a_i : Proportion of participants selecting “3”; $\hat{\pi}_{s_i}$ and $\text{Var}(\hat{\pi}_{s_i})$: Estimated prevalence and its variance for consistent condom use (i.e., “used condoms very time”); *CI*: Confidence interval.

has been proven an effective behavioral strategy to reduce the spread of sexually transmitted infections (STIs) and/or HIV and remains the most effective barrier method against HIV transmission.^[32-34] In China, public health programs targeting MSM population were launched more than a decade ago, and condom use was included in the majority of these programs.^[35] This may have resulted in the increasing use of condoms among MSM to protect against HIV and STIs as reflected in the relatively high RRT estimate of condom use at last sex with a male partner in our study.

Moreover, the risks of the behavioral characteristics investigated in this study were consistently higher in MSM aged <30 years (i.e., having earlier first sexual encounter, more number of sex partners and lower rate of consistent condom use in the past month, and lower rate of condom use at most recent anal sex) than older MSM. Nonetheless, such phenomenon was not observed in this population for other demographic features such as marital status (single vs. married), residence (Beijing resident vs. non-Beijing resident), length of residence in Beijing (<2 years vs. ≥2 years), ethnicity (Han vs. minorities), and education (high school or below vs. college or above). For these above mentioned demographic characteristics, the risks were higher in a subpopulation for some but not all behavioral characteristics under studied. This suggests that younger MSM population (aged <30 years) may be a priority target for intervention programs aiming to reduce the risk behaviors investigated by our study.

In summary, this study explored the profile of risk behaviors among MSM population in Beijing by employing a

questionnaire with RRT in a sample of participants. Compared with the survey using anonymous questionnaires or direct interviews, the MSM population in the current survey using RRT started their first sexual encounter at a younger age had more male partners and lower rate of consistent condom use during anal sex with male partners, especially in younger MSM aged <30 years. These results suggest that RRT might be a useful tool to obtain more truthful feedback on sensitive information such as sexual behavior from the respondents. Meanwhile, RRT might be particularly valuable in traditional Chinese settings where MSM are trying to avoid the stigma incurred and, therefore, incline to respond evasively to conventional direct questionnaires or interviews.

However, a number of limitations of the present study are worthy of identifying. The participants of the study were recruited through peer-referrals and internet advertisements which may result in a sample with limited representativeness and reflect the difference of RRT estimate as compared to the estimate using conventional survey techniques. Moreover, we did not collect the data using a direct questionnaire simultaneously and thus could not compare the results from the direct questionnaire and that from RRT in the same study population. Besides, due to the nature of RRT, participant-level data are not available from the RRT survey and, therefore, preclude more detailed analysis based on individual data.

Furthermore, the reporting period concerning sexual behavior with male partners and condom use was designed as 1 month, which is different from the period of 6 months

Table 5: Estimated prevalence for condom use at last anal sex using Simmons randomized response model for the binomial sensitive question among men who have sex with men in Beijing, China, 2010

Items	n_1	n_2	a_i	$\hat{\pi}_{s_i}$ (%)	$\text{Var}(\hat{\pi}_{s_i})$	95% CI (%)
All participants	450	208	0.684	80.0	0.000,913	74.1–85.9
Age group						
<30 years	261	127	0.673	78.1	0.001,576	70.3–85.9
≥30 years	189	81	0.700	82.7	0.002,160	73.6–91.8
Marital status						
Single*	369	173	0.681	79.5	0.001,114	72.9–86.0
Married	81	35	0.698	82.4	0.005,045	68.5–96.3
Residence						
Beijing	113	68	0.624	70.1	0.003,600	58.3–81.8
Non-Beijing	337	140	0.706	83.7	0.001,208	76.9–90.6
Length of residence in Beijing						
<2 years	85	31	0.733	88.1	0.004,689	74.7–100.0
≥2 years	365	177	0.673	78.2	0.001,127	71.7–84.8
Ethnicity						
Han	424	188	0.693	81.5	0.000,966	75.4–87.6
Minorities	26	20	0.565	60.2	0.014,840	36.3–84.1
Education						
High school or below	191	91	0.677	78.9	0.002,153	69.8–88.0
College or above	259	117	0.689	80.8	0.001,584	73.0–88.6

*Single including those who has never married, divorced, or widowed; n_1 , n_2 : Number of participants selecting “1” (“yes”) and “2” (“no”), respectively; a_i : Proportion of participants selecting “1” (“yes”); $\hat{\pi}_{s_i}$ and $\text{Var}(\hat{\pi}_{s_i})$: Estimated prevalence and its variance for condom use at last anal sex; *CI*: Confidence interval.

used in most studies and makes difficult comparison of the results with other similar studies.

Supplementary information is linked to the online version of the paper on the Chinese Medical Journal website.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

- 2012 China AIDS Response Progress Report. Available from: <http://www.unaids.org.cn/pics/20120614140133.pdf>. [Last accessed on 2015 Nov 03].
- A Joint Assessment of HIV/AIDS Prevention, Treatment and Care

- in China; 2007. Available from: http://www.chinaaids.cn/ddpg/lhpgbg1/zgazybyq/201312/t20131220_91605.htm. [Last accessed on 2015 Apr 16].
- Estimates for the HIV/AIDS Epidemic in China; 2009. Available from: http://www.chinaaids.cn/ddpg/lhpgbg1/zgazybyq/201312/t20131220_91606.htm. [Last accessed on 2015 Apr 16].
- Estimates for the HIV/AIDS Epidemic in China; 2011. Available from: http://www.chinaaids.cn/fzdt/zxddd/201201/t20120129_1745902.htm. [Last accessed on 2015 Apr 16].
- 2005 Update on the HIV/AIDS Epidemic and Response in China. Available from: http://www.data.unaids.org/publications/External-Documents/rp_2005chinaestimation_25jan06_en.pdf. [Last accessed on 2015 Nov 04].
- NCAIDS N, China CDC. Update on the AIDS/STD epidemic in China and main response in control and prevention in December, 2014 (in Chinese). *Chin J AIDS STD* 2015;21:87. doi: 10.13419/j.cnki.aids.2015.02.01
- Lau JT, Lin C, Hao C, Wu X, Gu J. Public health challenges of the emerging HIV epidemic among men who have sex with men in China. *Public Health* 2011;125:260-5. doi: 10.1016/j.puhe.2011.01.007.
- Zhang D, Bi P, Lv F, Zhang J, Hiller JE. Changes in HIV prevalence and sexual behavior among men who have sex with men in a northern Chinese city: 2002-2006. *J Infect* 2007;55:456-63. doi: 10.1016/j.jinf.2007.06.015.
- Wu Z, Xu J, Liu E, Mao Y, Xiao Y, Sun X, *et al*. HIV and syphilis prevalence among men who have sex with men: A cross-sectional survey of 61 cities in China. *Clin Infect Dis* 2013;57:298-309. doi: 10.1093/cid/cit210.
- Xiao Z, Li X, Liu Y, Li S, Jiang S. Sexual communication and condom use among Chinese men who have sex with men in Beijing. *Psychol Health Med* 2013;18:98-106. doi: 10.1080/13548506.2012.687826.
- Zhang L, Fung Chow EP, Wilson DP. Men who have sex with men in China have relatively low numbers of sexual partners. *Infect Dis Rep* 2011;3:e10. doi: 10.4081/idr.2011.e10.
- Ha TH, Liu H, Liu H, Cai Y, Feng T. Concurrent sexual partnerships among men who have sex with men in Shenzhen, China. *Sex Transm Dis* 2010;37:506-11. doi: 10.1097/OLQ.0b013e3181d707c9.
- Caltabiano M, Dalla-Zuanna G. A comparison of survey techniques on sensitive sexual behavior in Italy. *J Sex Res* 2013;50:537-47. doi: 10.1080/00224499.2012.674573.
- Williams BL, Suen H. A methodological comparison of survey techniques in obtaining self-reports of condom-related behaviors. *Psychol Rep* 1994;75(3 Pt 2):1531-7. doi: 10.2466/pr0.1994.75.3f.1531.
- Tezcan S, Omran AR. Prevalence and reporting of induced abortion in Turkey: Two survey techniques. *Stud Fam Plann* 1981;12:262-71. doi: 10.2307/1965874.
- Liao M, Kang D, Tao X, Bouey JH, Aliyu MH, Qian Y, *et al*. Alcohol use, stigmatizing/discriminatory attitudes, and HIV high-risk sexual behaviors among men who have sex with men in China. *Biomed Res Int* 2014;2014:143738. doi: 10.1155/2014/143738.
- Dietz P, Striegel H, Franke AG, Lieb K, Simon P, Ulrich R. Randomized response estimates for the 12-month prevalence of cognitive-enhancing drug use in university students. *Pharmacotherapy* 2013;33:44-50. doi: 10.1002/phar.1166.
- Striegel H, Ulrich R, Simon P. Randomized response estimates for doping and illicit drug use in elite athletes. *Drug Alcohol Depend* 2010;106:230-2. doi: 10.1016/j.drugalcdep.2009.07.026.
- Moshagen M, Musch J, Ostapczuk M, Zhao Z. Reducing socially desirable responses in epidemiologic surveys: An extension of the randomized-response technique. *Epidemiology* 2010;21:379-82. doi: 10.1097/EDE.0b013e3181d61dbc.
- de Jong MG, Pieters R, Stremersch S. Analysis of sensitive questions across cultures: An application of multigroup item randomized response theory to sexual attitudes and behavior. *J Pers Soc Psychol* 2012;103:543-64. doi: 10.1037/a0029394.
- Anglewicz P, Gourvenec D, Halldorsdottir I, O’Kane C, Koketso O, Gorgens M, *et al*. The effect of interview method on self-reported sexual behavior and perceptions of community norms in Botswana. *AIDS Behav* 2013;17:674-87. doi: 10.1007/s10461-012-0224-z.
- Lau JT, Kim JH, Lau M, Tsui HY. HIV related behaviours and attitudes among Chinese men who have sex with men in Hong Kong:

- A population based study. *Sex Transm Infect* 2004;80:459-65. doi: 10.1136/sti.2003.008854.
23. Li D, Li C, Wang Z, Lau JT. Prevalence and associated factors of unprotected anal intercourse with regular male sex partners among HIV negative men who have sex with men in China: A cross-sectional survey. *PLoS One* 2015;10:e0119977. doi: 10.1371/journal.pone.0119977.
 24. Lin H, Ding Y, Liu X, Wu Q, Shen W, He N. High prevalence of HIV infection and bisexual networks among a sample of men who have sex with men in Eastern China. *PLoS One* 2015;10:e0129300. doi: 10.1371/journal.pone.0129300.
 25. Xu HL, Jia MH, Min XD, Zhang RZ, Yu CJ, Wang J, *et al.* Factors influencing HIV infection in men who have sex with men in China. *Asian J Androl* 2013;15:545-9. doi: 10.1038/aja.2013.51.
 26. Mao H, Ma W, Lu H, Wang L, Zheng H, Zhu Y, *et al.* High incidence of HIV and syphilis among migrant men who have sex with men in Beijing, China: A prospective cohort study. *BMJ Open* 2014;4:e005351. doi: 10.1136/bmjopen-2014-005351.
 27. Tao J, Li MY, Qian HZ, Wang LJ, Zhang Z, Ding HF, *et al.* Home-based HIV testing for men who have sex with men in China: A novel community-based partnership to complement government programs. *PLoS One* 2014;9:e102812. doi: 10.1371/journal.pone.0102812.
 28. Zhang L, Chow EP, Wilson DP. Distributions and trends in sexual behaviors and HIV incidence among men who have sex with men in China. *BMC Public Health* 2012;12:546. doi: 10.1186/1471-2458-12-546.
 29. Ye S, Xiao Y, Jin C, Cassell H, Blevins M, Sun J, *et al.* Effectiveness of integrated HIV prevention interventions among Chinese men who have sex with men: Evaluation of a 16-city public health program. *PLoS One* 2012;7:e50873. doi: 10.1371/journal.pone.0050873.
 30. China 2010 UNGASS Country Progress Report; 2010. Available from: http://www.data.unaids.org/pub/Report/2010/china_2010_country_progress_report_en.pdf. [Last accessed on 2015 Jan 08].
 31. Wang LH, Yan J, Yang GL, Long S, Yu Y, Wu XL. Prevalence of consistent condom use with various types of sex partners and associated factors among money boys in Changsha, China. *J Sex Med* 2015;12:936-45. doi: 10.1111/jsm.12821.
 32. Crosby RA, DiClemente RJ, Wingood GM, Lang D, Harrington KF. Value of consistent condom use: A study of sexually transmitted disease prevention among African American adolescent females. *Am J Public Health* 2003;93:901-2. doi: 10.2105/AJPH.93.6.901.
 33. Holmes KK, Levine R, Weaver M. Effectiveness of condoms in preventing sexually transmitted infections. *Bull World Health Organ* 2004;82:454-61.
 34. Shewamene Z, Legesse B, Tsega B, Bhagavathula AS, Endale A. Consistent condom use in HIV/AIDS patients receiving antiretroviral therapy in Northwestern Ethiopia: Implication to reduce transmission and multiple infections. *HIV AIDS (Auckl)* 2015;7:119-24. doi: 10.2147/hiv.s79122.
 35. Wong FY, Huang ZJ, Wang W, He N, Marzullo J, Frangos S, *et al.* STIs and HIV among men having sex with men in China: A ticking time bomb? *AIDS Educ Prev* 2009;21:430-46. doi: 10.1521/aecp.2009.21.5.430.

SUPPLEMENTARY TEXT 1

Randomized Response Techniques Used in the Study

1. Additive randomized response model

For the additive model, each coin in the cloth bag carries a digit ranging from 0 to 9. The participant drew a coin from the cloth bag and added the digit on the coin to the actual quantitative answer to the specific sensitive question on the questionnaire, and then entered the sum as the response to the question he was answering. The study staff do not know which coin the participant has drawn, and the actual answer is not disclosed by this technique.

Additive randomized response model was applied to two sensitive questions aiming to obtain participants' quantitative characteristics of men who have sex with men sexual behavior. Corresponding questionnaire items are provided in Box 1.

Box 1: Additive randomized response model

- Q1. Please enter the sum of the digit on the coin you drew and your age (integer) at first sexual encounter with a man _____
- Q2. Please enter the sum of the digit on the coin you drew and the number of male sex partners you had in last month _____

For the additive randomized response model, suppose $\hat{\mu}_a$ is the mean of the responses that participants entered for a quantitative sensitive question and μ_c is the mean of the digits on the coin in the cloth bag. According to the design, the mean of the actual characteristic μ_s with respect to the sensitive question can be estimated using the formula:

$$\hat{\mu}_s = \hat{\mu}_a - \mu_c$$

As μ_c is a constant (4.5 in our case), the variance of $\hat{\mu}_s$ equals the variance of $\hat{\mu}_a$ and can be estimated using the formula:

$$\text{Var}(\hat{\mu}_s) = \frac{s_a^2}{n}$$

where n denotes the number of participants answering the question, and s_a^2 is the variance of the responses that participants entered for the sensitive question. Accordingly, 95% confidence interval (CI) can be calculated as

$$\hat{\mu}_s \pm 1.96\sqrt{\text{Var}(\hat{\mu}_s)}$$

2. Randomized response model for multiple choice sensitive questions

For the multiple choice model, each coin in the cloth bag carries a digit ranging between 0 and the maximal number of choices for the sensitive question. The ratio of the number of coins carrying 0 and other digits varied according to the designs of the sensitive questions. In our study, the cloth bag contained six coins carrying digit "0" and four coins carrying digits "1" – "4," one for each digit. If participants drew the coin carrying digit "0," they were asked to answer the sensitive questions by entering the corresponding digit that matches his answer into the questionnaire. Otherwise, they were asked to enter into the questionnaire the digit on the coin they drew for this

sensitive question. Items for the multiple choice sensitive question are provided in Box 2.

Box 2: Multiple choice randomized response model

Q3. If you drew the coin carrying digit "0", please enter the digit of the option below that best describes your pattern of condom use during anal sex with male partners in last month

1. Never used condoms
2. Sometimes used condoms
3. Used condoms every time
4. No anal sex

If you drew the coin carrying a digit other than "0", please enter the digit on the coin as the answer to this question

Answer: _____

For multiple choice sensitive questions, suppose a_i is the total proportion of the choice "i" that participants entered as the answer to the question, and p_i is the proportion of the coin carrying digit "i" in the cloth bag. The proportion of participants drawing the coin carrying digit "0" and thus answering the sensitive question is p_0 . The proportion of the choice "i" $\hat{\pi}_{s_i}$ with respect to the sensitive question can be estimated using the formula:

$$\hat{\pi}_{s_i} = \frac{a_i - p_i}{p_0}$$

Its variance can be calculated using the formula:

$$\text{Var}(\hat{\pi}_{s_i}) = \frac{a_i \cdot (1 - a_i)}{n \cdot p_0^2}$$

which can be used to estimate 95% CI, namely $\hat{\pi}_{s_i} \pm 1.96 \cdot \sqrt{\text{Var}(\hat{\pi}_{s_i})}$. In the above formula, n denotes the number of participants answering the question.

3. Simmons randomized response model

Simmons randomized response model is for binomial sensitive questions, namely the answer to the question comprises two options (e.g. "Yes" or "No"). The cloth bag for this model contained six coins carrying digit "1" and four carrying digit "2." If participants drew the coin carrying "1," they were asked to answer the sensitive question honestly. Otherwise, they were asked to answer the unrelated nonsensitive question. Items for one binomial sensitive question are provided in Box 3.

Box 3: Simmons randomized response model

Q4. If you drew the coin carrying digit "1", please answer question A.

If you drew the coin carrying digit "2", please answer question B

Question A: Did you use condoms during latest anal sex with a male partner?

Question B: Is your birthdate on an odd day?

1. Yes
2. No

Answer: _____ (If the answer is "yes", please enter "1"; if "no", please enter "2")

Thus, 40% (4 of 10 coins) of the participants received the nonsensitive question B whereas 60% (6 of 10 coins) received the sensitive question A. Using the formula:

$$\hat{\pi}_s = \frac{a - (1-p) \cdot \pi_n}{p}$$

The proportion of “Yes” responses $\hat{\pi}_s$ with respect to the sensitive question can be estimated from the proportion of total “Yes” responses (a). Here, a denotes the probability of receiving the sensitive question ($p = 60\%$ in our case) whereas $1 - p$ denotes the probability of receiving the unrelated nonsensitive question ($1 - p = 40\%$). The probability of answering the nonsensitive question with

“Yes” is $\pi_n = 51.0\%$ (186.25 of 365.25, i.e., the proportion of respondents’ birthdate on an odd day). The variance of $\hat{\pi}_s$ can be calculated using the formula:

$$\text{Var}(\hat{\pi}_s) = \frac{a \cdot (1-a)}{n \cdot p^2}$$

where n denotes the number of participants answering the question. Therefore, 95% CI for the probability of answering the sensitive question with “Yes” can be estimated using formula:

$$\hat{\pi}_s \pm 1.96 \cdot \sqrt{\text{Var}(\hat{\pi}_s)}$$