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Estimation of the Proportion of Potential Nondisclosed Men Who Have Sex With Men Among Self-Reported Heterosexual Men With HIV Using a Randomized Response Technique

Yi Chen, MD, PhD,*† Yuhua Ruan, MD, PhD,*‡ Zhiyong Shen, MD,* Edward B. McNeil, MSc,† Hui Xing, MD,*‡ Yiming Shao, MD, PhD,*‡ Mei Lin, MD, PhD,*‡ Guanghua Lan, MD, PhD,* and Virasakdi Chongsuvivatwong, MD, PhD†

Background: Because of HIV-related stigma and gender minority stigma, the number of men who have sex with men (MSM) among registered HIV/AIDS cases may be underreported in Guangxi, China. In addition to the sensitivity of direct inquiry of sexual identity and behavior, our study aims to determine the proportion of potential nondisclosed MSM (pnMSM) among self-reported heterosexual men with HIV.

Method: The study subjects were self-reported heterosexual men with HIV who were diagnosed in recent 20 years in Guangxi, China. A randomized response technique was executed by randomly putting them to secretly answer either whether their birthday was odd or even day, or whether they experienced anal sex in the last 3 years. Personal characteristics were linked with randomized response technique answers for subgroup analysis.

Results: The proportion of pnMSM ever having anal sex was estimated to be 14.3% in Guangxi, China. Being younger, having a college or above education level, single, employed, of Han ethnicity, diagnosed with HIV in the past 6 years, and not on antiretroviral therapy were associated with giving positive answer.

Conclusions: The reported number of MSM cases with HIV in the past may have been underestimated in Guangxi, China. Information about preexposure and postexposure prophylaxis should be provided to this stigmatized subgroup—pnMSM, especially those who are younger and with a higher socioeconomic status among self-reported heterosexual men with HIV.

The HIV epidemic began in China from the early 1990s among injecting drug users through needle sharing along China's southern border.¹ Heterosexual contact became the most common transmission route in China in the 2000s, with 50% of new HIV

cases detected in 2005.² Subsequently, the number of new infections among men who have sex with men (MSM) increased rapidly, accounting for 2.5% of all new cases in 2006 and increasing to 26% in 2014.³ There were around 1.25 million people living with HIV/AIDS in China by 2018.⁴ Guangxi Zhuang Autonomous Region (Guangxi) is an underdeveloped economic region located in the southwest of China. It accounted for 7.5% of newly diagnosed HIV cases in China in 2019 and has been predominated by heterosexual transmission (90%) since 2011.⁵ In the meantime, the HIV prevalence among MSM increased from 0.83% in 2008 to 11.2% in 2015^{6–8} before stabilizing at around 10% in 2017 to 2020. However, the number of self-reported MSM in Guangxi is still relatively low, accounting for 3.13% in 2010 to 2017 on average⁹ before increasing to 7.0% in 2020. The proportion was 23.0% in the whole country, whereas in neighboring provinces, it ranged from 14.4% in Chongqing to 43.5% in Hainan in 2018.

Same-sex partnerships challenge the Chinese traditional mindset for continuity of family “lines.”¹⁰ Guangxi is a relatively underdeveloped province where people retain traditional values of heterosexuality. Stigma resulted from homosexuality deepens the stigma and discrimination. Thus, many MSM would tend to conceal their sexual identity by reporting to health services as heterosexual men. This group of MSM is called potential nondisclosed MSM (pnMSM). In so doing, they would miss receiving services targeted MSM, such as preexposure prophylaxis, postexposure prophylaxis, and HIV testing. Missing these services may delay HIV diagnosis and subsequently increase the fatality rates.^{11,12}

From the *Guangxi Key Laboratory of Major Infectious Disease Prevention and Control and Biosafety Emergency Response, Guangxi Center for Disease Control and Prevention, Nanning, China; †Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Hat Yai, Thailand; and ‡State Key Laboratory of Infectious Disease Prevention and Control (SKLID), Chinese Center for Disease Control and Prevention (China CDC), Collaborative Innovation Center for Diagnosis and Treatment of Infectious Diseases, Beijing, China

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Correspondence: Virasakdi Chongsuvivatwong, MD, PhD, Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Hat Yai 90110, Thailand. E-mail: cvirasak@medicine.psu.ac.th; Guanghua Lan, MD, PhD, Guangxi Key Laboratory of Major Infectious Disease Prevention and Control and Biosafety Emergency Response, Guangxi Center for Disease Control and Prevention, Nanning 530028, China. E-mail: lgh605@163.com.

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In addition, pnMSM tend to have female sexual partners, putting these females at higher risk for HIV infection based on their bisexual behavior.

Because any inquiry concerning sexual identity or behavior is sensitive, respondents may not provide honest responses on direct questioning. Randomized response technique (RRT) is an effective statistical method used to reduce the response distortion arising from dishonest answers to sensitive questions.^{13,14} It provides a chance randomly for the participant to take either a question with known probability of a positive answer or a question of the research interest, where the probability of the positive answer is our objective. By mathematical reasoning, one can calculate the latter probability based on the overall proportion of positive answers in the whole sample (details followed in the Materials and Methods section). It has been used to explore many sensitive issues such as illicit drug use,¹⁵ risk sexual behaviors involvement,^{16,17} noncompliant behavior for drivers,¹⁸ and voter turnout measurement,¹⁹ and so on.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional survey in 2 HIV/AIDS antiretroviral therapy (ART) clinics targeting self-reported heterosexual men with HIV was conducted from December 2020 to July 2021 in Nanning, the capital of Guangxi, China.

Rationale of Applying RRT

Previous studies have used phylogenetic technology^{20,21} and triangulation analysis combining case-reported data and behavioral data²² to identify or estimate pnMSM among heterosexual men with HIV. Phylogenetic studies can give strong evidence for pnMSM, but it would cost a huge amount of money. Triangulation analysis uses secondary data, which is inaccurate. The RRT method of data collection is simple and can be carried out in low-resource settings.

RRT Data Collection

Figure 1 summarizes the process of the RRT survey, including data collection and data linkage for analysis. The RRT process using Simmons randomized response model²³ was applied for the sensitive question in our study. We asked 2 questions; the answers to both consisted of 2 options (“yes” or “no”). A die was put in a

box and placed before the participant. The participant was asked to roll the die inside the box without disclosing the result to the investigator. If he rolled a “1,” “2,” “4,” or “6,” he was instructed to answer the sensitive question honestly: hereby, “Have you ever had anal sex with another man in the past 3 years?” If he rolled a “3” or “5,” he was instructed to answer an unrelated nonsensitive question: hereby, “Is your birthdate on an odd day?” Answers to the sensitive question were therefore not known to researchers at the individual level.

Personal epidemiological data were self-completed using a specific form after answering the RRT question. The response forms to the RRT and the epidemiological data were collected.

A research team was trained before conducting the survey. Written informed consent from each participant was waived to reduce the risk of personal information release. Only oral informed consent was required from the participants. A unique code used to link the 2 forms was deidentified to prevent tracing back sensitive information to the individual. The study was approved by the Ethical Committee of Prince of Songkla University (REC.63-348-18-1) and the institutional review board of the Guangxi Centre for Disease Prevention and Control (GXIRB2020-0069).

Study Variables

The outcome variable was the answer to the RRT-sensitive question. Independent variables included age, ethnicity, education, occupation, marital status, current place of residence, time and location of HIV diagnosis, and HIV/AIDS treatment status.

Data Analysis

Table 1 presents the definitions of parameters used in the calculations. We followed the guideline for estimating the proportion of individuals answering “yes” to the sensitive question as described by Greenberg et al.²³ This proportion was estimated from (1) the probabilities of selecting the sensitive question and the unrelated nonsensitive question and (2) the proportion of “yes” answers to the RRT question. According to our study design, two-thirds of the participants answered the sensitive question and one-third answered the unrelated nonsensitive question.

The proportion of subjects who answered the sensitive question in our study was $2/3$ (P), and $1 - P$ is $1/3$. Let π_S denote the probability of a “yes” answer for the sensitive question (which means the subject was pnMSM) and π_N is the proportion of odd days, which is 186.25 of 365.25 days in a year = 51.0% (whether

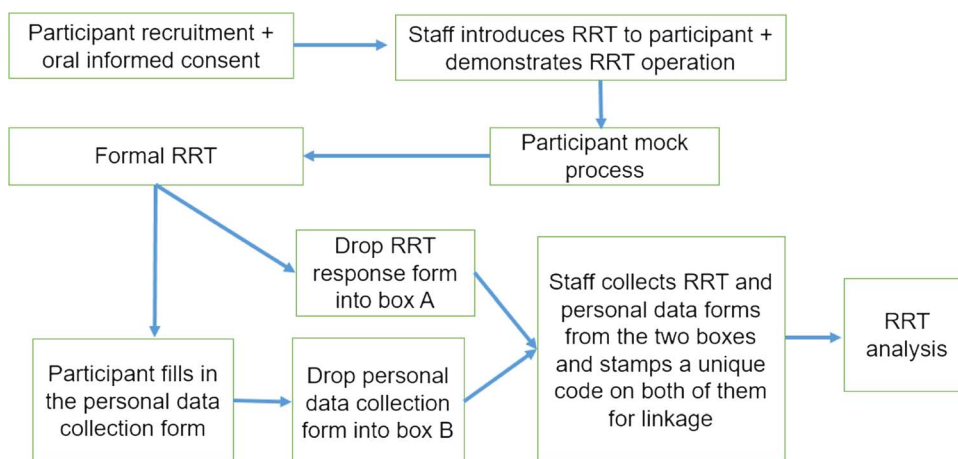


Figure 1. Flowchart of the RRT survey.

TABLE 1. Definitions of Parameters Used in RRT “Yes” Response Calculation

Type of Question	Proportion of Participants Answering the Question	Proportion of True “Yes” Answers
Sensitive	P	π_S
Nonsensitive	$1 - P$	π_N

the subject was pnMSM was not asked and answered). The total proportion of all “yes” answers in the sample, λ , is as follows:

$$\lambda = P\pi_S + (1-P)\pi_N \tag{1}$$

Algebraically, π_S can be solved as

$$\pi_S = \frac{\lambda - (1-P)\pi_N}{P} \tag{2}$$

The variance of π_S is as follows:

$$\text{Var}(\pi_S) = [\lambda(1-\lambda)]/nP^2 \tag{3}$$

Hence, a 95% confidence interval (CI) of π_S is: $\pi_S \pm 1.96 \sqrt{\text{Var}(\pi_S)}$.

Study Subjects

Study subjects were recruited from HIV/AIDS ART clinics in Guangxi’s Center for Disease Control and Prevention and Nanning’s No. 4 People’s Hospital. Males aged 18 years or older, and who self-reported as heterosexual were eligible to participate in the study. Finally, our study recruited 1530 participants using a consecutive sampling technique.

Comparison of π_S Between Subgroups

Because the sample size of the subgroups under all variables is large, and the proportions of pnMSM among self-reported heterosexual men with HIV in each subgroup are not too close to 0 and 1, the proportions (π_S) in 2 subgroups under each variable are approximately normally distributed. Thus, the z test was used to determine significant differences between subgroups.²⁴

$$Z = \frac{\Delta\pi_S}{\sqrt{\pi_S(1-\pi_S)(\frac{1}{n_1} + \frac{1}{n_2})}} \tag{4}$$

where $\Delta\pi_S$ is the difference for π_S of 2 subgroups, and n_1 and n_2 are the respective sample sizes.

RESULTS

Personal Characteristics of the Subjects

Table 2 shows the details of personal characteristics for the 1530 study subjects. Their ages ranged from 18 to 86 years, and the majority were aged between 41 and 60 years. More than half were from the Zhuang ethnic group, and most of the remaining were Han. Nearly half had an education level at or below junior school. Most were married and resided in Nanning. Nearly half were diagnosed with HIV in 2016 to 2021, and greater than 90.0% were diagnosed in Nanning. Nearly 90.0% had initiated ART.

Proportion of pnMSM Among Self-Reported Heterosexual Men With HIV

According to formulas 1 to 3, π_S and $\text{Var}(\pi_S)$ were deduced for total samples and subgroups. Table 3 summarizes the results

of all these parameters for the whole sample and for various subgroups.

The estimated proportion of pnMSM among self-reported heterosexual men with HIV in Nanning was 14.3% (95% CI, 10.9%–17.6%). In subgroup analyses, the proportion was significantly higher among those who were 30 years or younger, those of Han ethnicity, those with a college or above education level, and those who were employed, single, diagnosed with HIV in 2016 to 2021, and diagnosed outside of Nanning. There was no difference in the proportion of pnMSM between subjects who resided in Nanning and other cities of Guangxi.

DISCUSSION

Our study used the RRT to elicit sensitive responses in terms of same-sex behavior among self-reported heterosexual men with HIV. The result indicated that the proportion of pnMSM among self-reported heterosexual men with HIV was 14.3%. The proportion was higher among younger participants, those from the Han ethnic group, those with a college or above education, and those who were single, actively employed, diagnosed with HIV in 2016 to 2021, diagnosed outside of Nanning, and currently receiving ART.

TABLE 2. Personal Characteristics of the Study Subjects

Variable	N (%)
Total	1530 (100.0)
Age group, y	
≤30	135 (8.8)
31–40	288 (18.8)
41–50	468 (30.6)
51–60	354 (23.1)
>60	284 (18.6)
Ethnicity	
Han	656 (42.9)
Zhuang	832 (54.4)
Yao	23 (1.5)
Miao	5 (0.3)
Other	14 (0.9)
Education	
Elementary school or less	353 (23.1)
Junior school	659 (43.1)
High school	283 (18.5)
College or above	235 (15.4)
Occupation	
None	463 (30.3)
Employee	193 (12.6)
Employer	364 (23.8)
Other	510 (33.3)
Marital status	
Single	379 (24.8)
Married	889 (58.1)
Divorce or separate or widowhood	261 (17.1)
Residence	
Nanning	1112 (72.7)
Other city of Guangxi	418 (27.3)
Diagnosis year of HIV	
2001–2005	19 (1.3)
2006–2010	269 (18.1)
2011–2015	457 (30.8)
2016–2021	741 (49.9)
Diagnosis city of HIV	
Nanning	1393 (91.0)
Other city of Guangxi	137 (9.0)
ART	
On ART	1347 (88.3)
Not on ART	179 (11.7)

ART indicates antiretroviral therapy.

TABLE 3. Estimated Proportion of pnMSM Among Study Participants and Various Subgroups

Variable	N (%)	N (Yes)	λ , %	π_s , %	Var (π_s), %	95% CI, %	z	P
Total	1530 (100.0)	406	26.5	14.3	0.029	10.9–17.6		
Age group, y							11.662	<0.0001
≤30	135 (8.8)	66	48.9	47.9	0.420	35.2–60.5		
>30	1394 (91.2)	340	24.4	11.1	0.030	7.7–14.5		
Ethnicity							2.954	0.0016
Han	656 (42.9)	187	28.5	17.3	0.070	12.1–22.4		
Zhuang	832 (54.4)	207	24.9	11.9	0.051	7.4–16.3		
Education							–7.493	<0.0001
Below college level	1295 (84.6)	319	24.6	11.4	0.032	7.9–14.9		
College or above	235 (15.4)	87	37.0	30.0	0.223	26.5–33.5		
Occupation							–3.542	0.0002
Nonoccupied	463 (30.3)	108	23.3	9.5	0.087	3.7–15.2		
Occupied	1067 (69.7)	298	27.9	16.4	0.042	12.3–20.4		
Marital status							7.439	<0.0001
Single	640 (24.8)	203	31.7	22.1	0.076	16.6–27.5		
Married	889 (58.1)	202	22.7	8.6	0.044	4.4–12.7		
Residence							0.996	0.1597
Nanning	1112 (72.7)	299	26.9	14.9	0.040	10.9–18.8		
Other city of Guangxi	418 (27.3)	107	25.6	12.9	0.100	6.6–19.2		
Diagnosis year of HIV							–4.074	<0.0001
2001–2015	745 (50.1)	182	24.4	11.1	0.056	6.5–15.7		
2016–2021	741 (49.9)	217	29.3	18.5	0.063	13.5–23.4		
Diagnosis city of HIV							–1.787	0.037
Nanning	1,393 (91.0)	365	26.2	13.8	0.031	10.3–17.3		
Other city of Guangxi	137 (9.0)	41	29.9	19.4	0.344	7.9–30.8		
ART							–5.206	<0.0001
On ART	1,347 (88.3)	343	25.5	12.8	0.019	10.1–15.4		
Not on ART	179 (11.7)	63	35.2	27.3	0.287	16.8–37.8		

ART indicates antiretroviral therapy.

The study estimated that around 1 in 7 of the registered HIV-positive heterosexual men were, at least one time, MSM. This important figure suggested that stigma of homosexuality did exist in the study community. Not using RRT, the proportion of MSM would be underestimated and HIV control would be less effective.

These associated factors are consistent with the MSM characteristics in the local registration system.^{6,25} A previous study also found that MSM with higher education attainment were more likely to disclose their sexual identity.²⁶ It may be that younger and well-educated men are more at liberty to experiment with different sexual experiences and are less likely to be contained by the norms of a conventional society. Disclosing their sexual identity or behaviors may be due to their strong self-confidence, which is likely linked to education.

The fact that there was a higher proportion of pnMSM among the younger subjects has a social implication. To prevent future HIV and other sexually transmitted diseases, information about preexposure prophylaxis and postexposure prophylaxis should be provided to the young population among self-reported heterosexual men.

The proportion of pnMSM was higher among those who were diagnosed outside of Nanning, the capital city of Guangxi. Large urban cities may be more tolerant of MSM; thus, they are more likely to disclose their true sexual identity. In other words, the HIV epidemic for MSM living beyond Nanning city has been previously overlooked, and many of these MSM still do not dare to disclose their same-sex identity or behaviors. This is consistent with many studies from around the world.²⁶

We also found that the proportion of pnMSM among those on ART was lower than those not on ART. Subjects on ART have more contact with healthcare professionals and receive more prevention and control information from them. Thus, MSM would be more likely to disclose their true sexual identity.^{27,28} Those

not on ART may worry about stigma and breach of confidentiality; thus, they dare not disclose their true sexual identity and behaviors.

There are some limitations of this study. First, the proportion of pnMSM among all self-reported heterosexual men with HIV estimated by our study may not reflect the actual proportion because the sensitive question asked about same-sex behaviors as far back as 3 years ago. An individual's sexual behavior may change over time. Thus, the estimated proportion of pnMSM among self-reported heterosexual men with HIV in recent 3 years may be overestimated because the subjects might not be the current active pnMSM. The route of infection might also be from other than sex act, such as drug injection. Second, even people in the community have strong feelings against MSM and social unacceptable for disclosing same sexual behavior or identity, and some pnMSM may feel comfortable with the RRT. They were not ready to disclose their true identity. Thus, the proportion of pnMSM may have been underestimated. Finally, it is not possible to tell whether differences in the subgroups were due to real differences in the proportion of pnMSM among self-reported heterosexual men with HIV or due to differences in the tendency to disclose their real gender identity.

In conclusion, the reported number of MSM cases with HIV in the past may have been underestimated in Guangxi, China. Information about preexposure prophylaxis and postexposure prophylaxis should be provided to this stigmatized group: pnMSM, especially those who are younger and with a higher socioeconomic status among self-reported heterosexual men with HIV.

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