

High HIV Incidence Among Men Who Have Sex With Men in 8 Chinese Cities: Results From a Trial

Wenting Huang,^{1,2,3,6} Yehua Wang,³ Haidong Lu,⁴ Dan Wu,^{3,5} Stephen W. Pan,⁶ Joseph D. Tucker,^{3,5,7} and Weiming Tang^{2,3,8,9}

¹Behavioral Sciences and Health Education, Emory University, Atlanta, Georgia, USA, ²Institute for Global Health and Sexually Transmitted Diseases Research, Southern Medical University, Guangzhou, China, ³University of North Carolina Project-China, Guangzhou, China, ⁴Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA, ⁵London School of Hygiene and Tropical Medicine, London, UK, ⁶Department of Public Health, Xi'an Jiaotong-Liverpool University, Suzhou, China, ⁷School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA, and ⁸Dermatology Hospital, Southern Medical University, Guangzhou, China

Background. In China, while the overall HIV prevalence has been decreasing within key populations, the epidemic among men who have sex with men (MSM) is still on the rise. This study aims to assess the HIV incidence rate and identify driving forces of HIV seroconversion among MSM in a closed cohort.

Methods. This study is a secondary analysis of a large trial of HIV testing promotion among Chinese MSM in 2016–2017. Sexual behaviors, HIV testing activities, and HIV serostatus were measured at baseline and follow-up every 3 months. HIV seroconversion in this study was defined as a self-reported HIV-positive test result. Participants who reported testing for HIV at least twice during different follow-up periods were included. Subgroup analysis and Cox regression were used to examine the correlates with HIV seroconversion.

Results. Overall, 347 participants were included in this study, with a mean age of 25.3 ± 6.1 , and 71.2% were migrants. The sociodemographic characteristics of the included participants were similar to the rest of the participants in the trial ($n = 1034$); 7.2% (25/347) of participants seroconverted during the study period, resulting in an incidence rate of 15.56/100 person-years. In subgroup analysis, the HIV incidence rate was higher among migrants than nonmigrants (incidence rate ratio, 1.26; 95% confidence interval [CI], 0.47–3.87). In the time-dependent Cox regression model, bisexual MSM had a higher risk of contracting HIV than gay men (adjusted hazard ratio, 2.19; 95% CI, 1.02–4.72).

Conclusions. Our findings suggest a high HIV incidence rate among Chinese MSM. Further expansion of pre-exposure prophylaxis and other effective HIV prevention interventions are urgently needed.

Keywords. China; HIV; incidence; MSM.

HIV incidence among men who have sex with men (MSM) remains high and is still increasing in many low- and middle-income countries [1]. In China, compared with other key populations in which new HIV infections have been decreasing, MSM are currently the only group in which HIV continues to rise (HIV prevalence has increased from 5.73% to 7.75% between 2010 and 2014) [2]. Empirical studies have mainly reported HIV prevalence or incidence rather than incidence rate. A meta-analysis of HIV prevalence among student MSM showed an increasing prevalence from 3.0% to 6.8% between 2003 and 2010 [3]. The prevalence was also found to have stark geographic disparities among different regions in China [4, 5],

with higher rates in metropolis cities than in small cities [2]. In 2011, data from a meta-analytic study estimated HIV incidence among Chinese MSM to be 3.5% for cohort and 6.7% for cross-sectional studies [6]. In 2014, one cohort study observed the HIV incidence rate to be as high as 13.59/100 PY in a city in Jiangsu province [7]. Still, the limited HIV incidence rate reports among MSM are insufficient to reveal the latest drastic increase of the HIV epidemic.

Typically, calculation of the HIV incidence rate requires a cohort of MSM with health facility attendance or biological sample collections to determine their HIV status. However, due to the nature of this sensitive population, the typical approach may be to underestimate the incidence rate by excluding MSM who have not attended health care facilities and those who did not want to give biological samples.

To increase the generalizability of the HIV incidence rate estimation among MSM, in this study we used self-reported HIV test results to assess the HIV incidence rate in a large closed cohort study in China. We also verified the self-reported testing results by asking the participants sending back their results to do so through photographs. We further identified subgroups of MSM who had a higher risk of HIV seroconversion and its correlates.

Received 23 January 2020; editorial decision 19 April 2020; accepted 22 April 2020.

Correspondence: Weiming Tang, PhD, MD, Dermatology Hospital, Southern Medical University and University of North Carolina Project-China, Guangzhou, China (weimingtangscience@gmail.com).

Open Forum Infectious Diseases®

© The Author(s) 2020. Published by Oxford University Press on behalf of Infectious Diseases Society of America. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial re-use, please contact journals.permissions@oup.com
DOI: 10.1093/ofid/ofaa147

METHODS

Study Design and Study Population

This study is a secondary analysis of a stepped-wedge randomized controlled trial (NCT02796963) focusing on using crowdsourcing to promote HIV testing among Chinese MSM. Detailed information about this trial has been described elsewhere [8]. In brief, participants were recruited through Blue2d (the largest gay social networking app in China) in July 2016 from 8 cities in China (Guangzhou, Jiangmen, Shenzhen, and Zhuhai in Guangdong Province; Jinan, Jining, Qingdao, and Yantai in Shandong Province; ClinicalTrials.gov ID: NCT02796963). Eligibility criteria included (1) being born biologically male, (2) being age 16 years or older, (3) having anal sex with a man at least once during their lifetime, (4) never tested positive for HIV, (5) not tested for HIV within the past 3 months, and (6) currently living or planning to live in 1 of the 8 cities for 12 months after enrollment.

The order of receiving intervention was randomly assigned to the 4 cities of each province. Then cities having the same order of intervention were paired [9]. Participants in each paired city received a 3-month intervention in a randomly assigned order. All participants were followed at 3-month intervals for 12 months. In each follow-up survey, participants were asked about their HIV testing experience and testing results in the last 3 months. HIV seroconversion in this study was defined as self-reported HIV-positive test result. Participants were also encouraged to return a photo of the HIV test result to our research team via WeChat (a Chinese messaging and social media mobile application). Any participant who reported a positive test result was then connected to the local center for disease control for confirmatory testing and was no longer eligible for subsequent follow-up surveys. In this secondary analysis, to ensure that participants were HIV-negative at the beginning and had at least 1 additional HIV test during follow-up, we only included participants who reported having been tested for HIV at least twice during the study period and calculated their HIV incidence rate.

Measures

Sociodemographic characteristics were assessed at baseline and included age, education level, annual income, marital status, and migrant status. Migrant status was defined as the participant's current city's *hukou* status (*hukou* is the household registration system in China, which is also used to provide social services including public health care and education) [10]. *Hukou* status is assigned to citizens based on the place they were born and is difficult to change [11]. We also collected data about sexual orientation, early sexual debut, and sexual orientation disclosure to people other than sexual partners in the baseline survey. We defined early sexual debut as having had first anal sex at or before the age of 16 given the average age of sexual debut among adolescents and the cultural context among MSM in China [12,

13]. In each follow-up survey, we asked the participants about their sexual activities with men and women, condom use, HIV testing, and syphilis testing in the last 3 months. Bisexual behavior was defined as men who had had sex with at least 1 man and at least 1 woman in the last 3 months.

Statistical Analysis

Descriptive analysis was used to describe the sociodemographic characteristics and baseline sexual behaviors of the eligible participants. In this HIV incidence calculation, the total person-time was initially calculated by assuming all the HIV seroconversion happened at the midpoint between the last HIV-negative test result and the HIV-positive result in the follow-up period. For participants who had HIV seroconversion during the study, their follow-up periods were determined as the periods between their first HIV-negative tests and their first HIV-positive tests. Otherwise, the follow-up periods were the time between their first HIV-negative test and their last HIV-negative test.

Considering the representativeness of the included participants for the overall sample in the closed cohort, we conducted a sensitivity analysis that re-calculated the incidence rate by using inverse sampling probability weighting [14]. We used a propensity score to model the probability of each participant being included from the trial, by logistic regression. Covariates included in this logistic regression were age, education, geographic location (city), sexual orientation, disclosure, ever tested for HIV, ever had sex with a female, multiple male sex partners, multiple female sex partners, and bisexual behavior in the last 3 months. These covariates were identified as possible confounders from literature [15, 16].

To identify the geography location differences, we calculated the incidence rate separately for Guangdong and Shandong provinces. We also conducted subanalysis on the HIV incidence rate among participants with different characteristics, including migrant status, whether they had an early sexual debut, and whether they had disclosed their sexual orientation to others. A Cox regression model with time-varying covariates was used to examine the correlation between the time-dependent variables of condom use, multiple male sexual partners, multiple female sexual partners, bisexual behavior, and HIV seroconversion, while the fixed variables were age, education, income, and the order of intervention.

Statistical analyses were conducted using SAS 9.4 (Cary, NC, USA). The estimated effect sizes were reported as hazard ratios (HRs) with 95% confidence intervals (CIs) and *P* values. Statistical significance was based on a *P* value <.05.

Ethical Statement

Ethical approval was obtained from the ethics review committees at the Guangdong Provincial Center for Skin Diseases and STI Control (Guangzhou, China), University of North Carolina at Chapel Hill (Chapel Hill, NC, USA), the University

of California, San Francisco (San Francisco, CA, USA), and Rutgers University (Piscataway, NJ, USA) before the study launched.

RESULTS

Sociodemographic Characteristics and Behaviors

Overall, 1381 participants were enrolled into the stepped-wedged randomized controlled trial, among whom 1219 participants attended at least 1 follow-up survey and 755 reported at least 1 HIV test during the study period (Figure 1). In this analysis, we included 347 eligible participants for this analysis whose first HIV test was negative and who were tested at least twice during the study period. One hundred thirty-two men submitted verified reports of HIV testing results. There was 93.9% concordance between self-report and photo verification [17].

More than half of the MSM were <25 years old (56.8%), had a college degree or beyond (66.6%), were migrants (71.2%), and had disclosed their sexual orientation to others (68.0%). Importantly, most of them had their sexual debut at >16 years old (94.5%). Of the included 347 MSM, more than half of the MSM had condomless sex (52.3%), and over a third had multiple male partners (32.3%) in the last 3 months at baseline (Table 1).

Table 1 also showed the sociodemographic characteristics among the included MSM and the not-included participants. Demographics and behaviors were similar between the included MSM and not-included participants, except whether they had bisexual behavior and multiple male partners in the last 3 months at baseline. Included MSM had a higher proportion of men who had bisexual behavior (5.8%) than not-included MSM (3.3%). Similarly, included MSM had a higher proportion of men who had multiple male partners (32.3) than not-included MSM (24.0%). The sociodemographic characteristics and sexual behaviors were also compared between the included MSM and those who were only tested for HIV once during the study period (Supplementary Data). A significant

difference was only found between these men in whether they had multiple male partners.

HIV Incidence

Among 1219 participants who finished at least 1 follow-up survey, 99 participants reported a positive HIV test result, including 50 from Guangdong province and 49 from Shandong province [17]. Among 755 participants who had at least 1 HIV test over the study period, including baseline and follow-up surveys, the cumulative HIV-positive rate was 13.1% [17]. During the study period, 25 HIV seroconversions were reported among those 347 eligible participants over 12 months, corresponding to an incidence proportion of 7.2% and an incidence rate (IR) of 15.56 per 100 person-years (PY), ranging from 15.17 to 15.97 per 100 PY (Table 2). After adjustment by inverse sampling of probability weight, the overall HIV incidence rate was 17.21 per 100 PY, ranging from 16.75 to 17.70 per 100 PY (Table 2).

Table 3 shows the HIV incidence rate among different subgroups of men. The incidence rate was 17.28 (95% CI, 16.87–17.72) per 100 PY in 4 cities of Guangdong province and 15.56 (95% CI, 13.46–14.19) per 100 PY in 4 cities of Shandong province, respectively. The HIV incidence rate was significantly higher in Guangdong province than in Shandong, which echoed a previous study regarding the geographic differences in HIV incidence [18]. Compared with the incidence rate among participants who had their sexual debut >16 years old (IR, 15.17; 95% CI, 10.08–22.83), the incidence rate among those who had their sexual debut ≤16 was higher (IR, 22.22; 95% CI, 5.56–88.85). The incidence rate among migrants (IR, 16.56; 95% CI, 10.56–25.96) was also higher than that of people who were not migrants (IR, 13.08; 95% CI, 5.88–29.11). In terms of sexual orientation disclosure to people other than sexual partners, the incidence rate was higher among those who did not disclose (IR, 19.51; 95% CI, 10.50–32.26) (Table 3). However, due to the sample size issue, none of results are significantly different from each other.

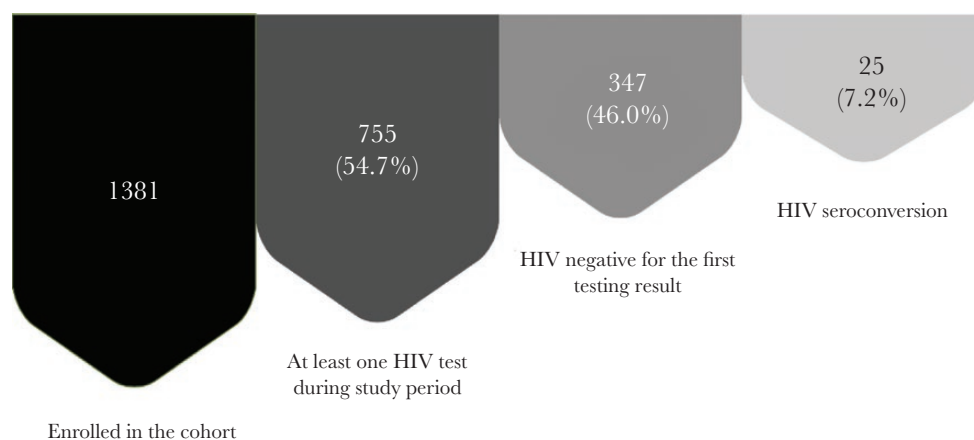


Figure 1. Data extraction process and HIV seroconversion, 2016–2017, China.

Table 1. Baseline Sociodemographic and Behavioral Characters Among Included MSM (who Were Tested for HIV at Least Twice) and Excluded MSM, 2016–2017, China (n = 1381)

Baseline Characteristics	Included MSM (n = 347), No. (%)	Excluded MSM (n = 1034), No. (%)	PValue ^a
Age, y			.90
16–25	197 (56.8)	583 (56.4)	
>25	150 (43.2)	451 (43.6)	
Marital status			.47
Never married	306 (88.2)	888 (85.9)	
Married	41 (11.8)	146 (14.1)	
Highest education			.78
High school or below	116 (33.4)	367 (35.5)	
College or beyond	231 (66.6)	667 (64.5)	
Annual income, \$USD			.56
<3000	73 (21.0)	212 (20.5)	
3000–6000	73 (21.0)	226 (21.9)	
6001–9500	118 (34.0)	316 (30.6)	
>9500	83 (23.9)	280 (27.1)	
Province			.36
Guangdong	178 (51.3)	501 (48.5)	
Shandong	169 (48.7)	533 (51.5)	
Migrant status			.20
No	100 (28.8)	336 (32.5)	
Yes	247 (71.2)	698 (67.5)	
Age of anal sexual debut			.82
<16	19 (5.5)	60 (5.8)	
≥16	328 (94.5)	974 (94.2)	
Disclosure ^b			.18
No	111 (35.0)	372 (36.0)	
Yes	236 (68.0)	662 (64.0)	
Condomless sex ^c			.18
No	104 (30.0)	272 (26.3)	
Yes	243 (70.0)	762 (73.7)	
Bisexual behavior ^c			.04
No	327 (94.2)	1000 (96.7)	
Yes	20 (5.8)	34 (3.3)	
Multiple male partners ^c			<.01
No	235 (67.7)	786 (76.0)	
Yes	112 (32.3)	248 (24.0)	
Multiple female partners ^c			.07
No	344 (99.1)	1032 (99.8)	
Yes	3 (0.9)	2 (0.2)	

Abbreviation: MSM, men who have sex with men.

^aP value for chi-square test/Fisher exact test.

^bDisclosure of sexual orientation to people other than their sexual partners.

^cIn the last 3 months.

Correlates of HIV Seroconversion

After adjusting for age, education, income, and assigned group, the results of the Cox regression model indicated that having bisexual behaviors in the last 3 months was associated with a

Table 2. Overall HIV Seroconversion and Incidence Rates Among MSM With and Without Inverse Sampling Probability Weighting, China, 2016–2017 (n = 347)

	Without Inverse Sampling Probability Weight	With Inverse Sampling Probability Weight
No. of seroconverted cases	25	27
Personal year estimated (Person-year)	160.63 (156.50–164.75)	159.00 (155.00–164.00)
Incidence rate estimated ^a	15.56 (15.17–15.97)	17.21 (16.75–17.70)

Abbreviation: MSM, men who have sex with men.

^aPer 100 person-years.

higher risk of HIV infection (adjusted HR, 2.19; 95% CI, 1.02–4.72). In addition, having had multiple female partners in the last 3 months was also associated with an increased risk of HIV infection (adjusted HR, 4.63; 95% CI, 1.45–14.76) (Table 4).

DISCUSSION

Incidence rate is a critical measure that is suggested by UNAIDS to better track the progress toward ending AIDS [19]. Data on HIV incidence among a key population like MSM are often limited to clinic-based cohorts, which omit those men who never visit health facilities. This study estimated the HIV incidence rate among MSM by expanding the included MSM outside the clinics. The use of inverse sample probability weighting increased the generalizability of this incidence rate estimation. We found an overall significantly high incidence rate among MSM, particularly among those who were migrants or had bisexual behaviors.

The observed high HIV incidence rate indicated that the high burden of ongoing HIV transmission among MSM remained

Table 3. HIV Incidence Rate Among Participants In different Sub-groups, China (n = 347)

	HIV Seroconversion	IR ^a (95% CI)	IRR (95% CI)	PValue
Province				
Guangdong	14	17.28 (10.23–29.18)	1.25 (0.53–3.04)	.29
Shandong	11	13.81 (7.65–24.94)		
Migrant status				
Yes	19	16.56 (10.56–25.96)	1.26 (0.47–3.87)	.32
No	6	13.08 (5.88–29.11)		
Age of anal sexual debut				
<16	2	22.22 (5.56–88.85)	1.46 (0.17–5.93)	.29
≥16	23	15.17 (10.08–22.83)		
Disclosure ^b				
Yes	15	13.71 (8.27–22.75)	0.07 (0.30–1.75)	.20
No	10	19.51 (10.50–32.26)		

Abbreviations: CI, confidence interval; IR, incidence rate; IRR, incidence rate ratio.

^aPer 100 person-years.

^bDisclosure of sexual orientation to people other than their sexual partners.

Table 4. Behavioral Factors of HIV Seroconversion as Time-Dependent Covariates in a Cox Regression Model, 2016–2017 (n = 347)

	HR	95% CI	Adjusted HR ^a	95% CI
Condomless sex				
No	Ref		Ref	
Yes	0.75	0.42–1.34	0.72	0.40–1.28
Bisexual behavior				
No	Ref		Ref	
Yes	2.19*	1.04–4.59	2.19*	1.02–4.72
Multiple male sexual partners				
No	Ref		Ref	
Yes	1.36	0.82–2.26	1.32	0.81–2.17
Multiple female sexual partners				
No	Ref		Ref	
Yes	4.17*	1.52–11.44	4.63*	1.45–14.76

Abbreviations: CI, confidence interval; HR, hazard ratio.

* $P < .05$.

^aAdjusted HR, adjusting for age, education, income, and the order of intervention.

in the study regions. This high HIV incidence rate is consistent with previous Chinese research [17, 20] and is higher than incidence rates from Thailand [21], Peru [22], and other high-income countries [23, 24]. This HIV incidence rate among MSM is comparable to that of Kenya (12.5/100PY) [25]. The observed high HIV incidence may be related to low condom use [15], low pre-exposure prophylaxis (PrEP) uptake [26], high rates of co-infection with sexually transmitted diseases [27], and network factors [28] known to amplify HIV transmission. To address the concern that the selection bias arising from people who self-reported having been tested for HIV at least twice during the study period may have been different from that of the rest of the sample in the cohort study, we conducted a sensitivity analysis to adjust the incidence rate using inverse sample probability weighting. After the adjustment, we found a comparable HIV incidence rate, with an initial high HIV incidence rate. Moreover, due to the HIV-related stigma, people were more likely to report negative results than positive results, which could have yielded an underestimate of HIV incidence rate in this study. This high HIV incidence suggests that HIV prevention strategies such as PrEP should be incorporated into Chinese HIV prevention guidelines and practices to slow down HIV transmission.

We found that migrant MSM were more likely to HIV seroconvert. Although migrant participants constituted less than one-third of the sample size (28.8%), the HIV seroconversion rate of migrant MSM was much higher than that of nonmigrants (19 in migrants vs 6 in nonmigrants). Unsurprisingly, this high HIV seroconversion rate contributed to a high incidence rate among migrant MSM, though the difference between migrants and nonmigrants was not statistically significant (incidence rate ratio, 1.26; 95% CI, 0.47–3.87), which could be due to the limited number of seroconversions observed. Extensive studies

have indicated that migrant MSM are more likely to engage in risky sexual behaviors [29], to have sexually transmitted infectious [30], to have less access to sexual health services [31], and to have high incidence of HIV [32]. Thus, special attention should be given to these migrant MSM, who may have more obstacles in HIV prevention compared with residents, as these previous studies indicated.

Our analysis also indicated that bisexual behavior was associated with risk of HIV infection among the study's MSM. Having sex with women may facilitate HIV transmission to the general population, given the high HIV incidence rate that we found among these MSM. Previous research has suggested that men who have sex with men and women (MSMW) could be the integral bridge and spread the disease across communities through their socio-sexual networks [28]. Given that MSMW are less likely to disclose their sexual orientation to their female partners, to be exposed to HIV prevention interventions, and that they lack social support [33], their vulnerability to acquiring HIV may increase compared with men who only have sex with men. Though facilitating condom use and increasing HIV testing may still be the main focus in HIV prevention, researchers and health educators may need to explore a better approach to reach the MSMW while considering the different characteristics between MSMW and men who only have sex with men.

This study has several limitations. First, the HIV test results were based on self-report in the follow-up survey. However, it is unlikely that participants would have self-reported as HIV-positive if they were uninfected, given the high anticipated HIV stigma. Additionally, we verified the accuracy of these self-report results by asking the participants to send their testing result photos. We found a very high agreement with the HIV testing results with the returned photo results on our platform in this stepped-wedge randomized controlled study, with high sensitivity and specificity of the blood-based HIV testing kits that were distributed to the participants for self-testing [17]. Second, participants for this study was recruited through Blued, which may only reveal the HIV incidence situation among MSM who use online social media. Third, the included participants could have higher risk of HIV (higher proportion of multiple partners and bisexual behaviors), which may introduce selection bias. However, the HIV incidence results adjusted by the inverse probability weighting were comparable with the unadjusted results. More importantly, we found that most risk behavior factors were similar between the included MSM and the overall MSM participants, which could reduce the concern regarding selection bias.

CONCLUSIONS

Through expanding the included MSM with self-reported HIV testing results, we found a high HIV incidence rate among MSM in China. This high HIV incidence rate indicates the high

ongoing HIV transmission among MSM, calling for special attention to migrants and people with bisexual behavior, as well as the need for implementation of more effective HIV prevention strategies (ie, PrEP). Promoting condom use and HIV testing with sexual health education may still be the top priorities in controlling the epidemic among MSM, while clearly understanding the driving force of this high incidence is urgent.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Acknowledgments

The authors acknowledge all study participants and the members of the SESH team, who contributed to data collection and constructive feedback for this manuscript.

Financial support. This work was supported by the National Key Research and Development Program of China (2017YFE0103800), Academy of Medical Sciences and the Newton Fund (NIF\R1\181020), the National Institutes of Health (NIAID 1R01AI114310-01, NIAID K24AI143471), the NIMH (R34MH109359 and R34MH119963), the National Science and Technology Major Project (2018ZX10101-001-001-003), and the National Nature Science Foundation of China (81903371). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Potential conflicts of interest. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

- UNAIDS. Global AIDS Update 2019—Communities at the Centre. Geneva: UNAIDS; 2019.
- Cui Y, Guo W, Li D, et al. Estimating HIV incidence among key affected populations in China from serial cross-sectional surveys in 2010–2014. *J Int AIDS Soc* 2016; 19:20609.
- Li Y, Xu J, Reilly KH, et al. Prevalence of HIV and syphilis infection among high school and college student MSM in China: a systematic review and meta-analysis. *PLoS One* 2013; 8:e69137.
- Zhang X, Tang W, Li Y, et al. The HIV/AIDS epidemic among young people in China between 2005 and 2012: results of a spatial temporal analysis. *HIV Med* 2017; 18:141–50.
- Fu R, Zhao J, Wu D, et al. A spatiotemporal meta-analysis of HIV/syphilis epidemic among men who have sex with men living in mainland China. *BMC Infect Dis* 2018; 18:652.
- Li HM, Peng RR, Li J, et al. HIV incidence among men who have sex with men in China: a meta-analysis of published studies. *PLoS One* 2011; 6:e23431.
- Yang HT, Tang W, Xiao ZP, et al. Worsening epidemic of HIV and syphilis among men who have sex with men in Jiangsu Province, China. *Clin Infect Dis* 2014; 58:1753–9.
- Tucker JD; SESH Study Group. Crowdsourcing to promote HIV testing among MSM in China: study protocol for a stepped wedge randomized controlled trial. *Trials* 2017; 18:447.
- Tang W, Babu GR, Li J, et al. The difference between HIV and syphilis prevalence and incidence cases: results from a cohort study in Nanjing, China, 2008–2010. *Int J STD AIDS* 2015; 26:648–55.
- Wu J, Wu H, Li P, Lu C. HIV/STIs risks between migrant MSM and local MSM: a cross-sectional comparison study in China. *PeerJ* 2016; 4:e2169.
- Chan KW. The household registration system and migrant labor in China: notes on a debate. *Popul Dev Rev* 2010; 36:357–64.
- Guo W, Wu Z, Qiu Y, et al. The timing of sexual debut among Chinese youth. *Int Perspect Sex Reprod Health* 2012; 38:196–204.
- Outlaw AY, Phillips G 2nd, Hightow-Weidman LB, et al. Age of MSM sexual debut and risk factors: results from a multisite study of racial/ethnic minority YMSM living with HIV. *AIDS Patient Care STDS* 2011; 25(Suppl 1):S23–9.
- Ridgeway G, Kovalchik SA, Griffin BA, Kabeto MU. Propensity score analysis with survey weighted data. *J Causal Inference* 2015; 3:237–49.
- Chow EP, Wilson DP, Zhang L. Patterns of condom use among men who have sex with men in China: a systematic review and meta-analysis. *AIDS Behav* 2012; 16:653–63.
- Tang W, Mao J, Tang S, et al. Disclosure of sexual orientation to health professionals in China: results from an online cross-sectional study. *J Int AIDS Soc* 2017; 20:21416.
- Tang W, Wei C, Cao B, et al. Crowdsourcing to expand HIV testing among men who have sex with men in China: a closed cohort stepped wedge cluster randomized controlled trial. *PLoS Med* 2018; 15:e1002645.
- Zhang L, Chow EP, Jing J, et al. HIV prevalence in China: integration of surveillance data and a systematic review. *Lancet Infect Dis* 2013; 13:955–63.
- UNAIDS. Global Aids Response Progress Reporting 2016. Geneva: UNAIDS; 2016.
- Feng Y, Bu K, Li M, et al. Meta-analysis of HIV infection incidence and risk factors among men who have sex with men in China [in Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2015; 36:752–8.
- Piyaraj P, van Griensven F, Holtz TH, et al. The finding of casual sex partners on the internet, methamphetamine use for sexual pleasure, and incidence of HIV infection among men who have sex with men in Bangkok, Thailand: an observational cohort study. *Lancet HIV* 2018; 5:e379–89.
- Sanchez J, Lama JR, Peinado J, et al. High HIV and ulcerative sexually transmitted infection incidence estimates among men who have sex with men in Peru: awaiting for an effective preventive intervention. *J Acquir Immune Defic Syndr* 2009; 51(Suppl 1):S47–51.
- Grulich AE, Kaldor JM. Trends in HIV incidence in homosexual men in developed countries. *Sex Health* 2008; 5:113–8.
- Sullivan PS, Rosenberg ES, Sanchez TH, et al. Explaining racial disparities in HIV incidence in black and white men who have sex with men in Atlanta, GA: a prospective observational cohort study. *Ann Epidemiol* 2015; 25:445–54.
- Lane T, Osmand T, Marr A, et al. Brief report: high HIV incidence in a South African community of men who have sex with men: results from the Mpumalanga Men's Study, 2012–2015. *J Acquir Immune Defic Syndr* 2016; 73:609–11.
- Ding Y, Yan H, Ning Z, et al. Low willingness and actual uptake of pre-exposure prophylaxis for HIV-1 prevention among men who have sex with men in Shanghai, China. *Biosci Trends* 2016; 10:113–9.
- Chen G, Cao Y, Yao Y, et al. Syphilis incidence among men who have sex with men in China: results from a meta-analysis. *Int J STD AIDS* 2017; 28:170–8.
- O'Leary A, Jones KT. Bisexual men and heterosexual women: how big is the bridge? How can we know? *Sex Transm Dis* 2006; 33:594–5.
- Chen Y, Tang W, Chen L, et al. Changing epidemic of HIV and syphilis among resident and migrant men who have sex with men in Jiangsu, China. *Sci Rep* 2017; 7:9478.
- Hu J, Gu X, Tao X, et al. Prevalence and trends of HIV, syphilis, and HCV in migrant and resident men who have sex with men in Shandong, China: results from a serial cross-sectional study. *PLoS One* 2017; 12:e0170443.
- Liu C, Fu R, Tang W, et al. Transplantation or rurality? Migration and HIV risk among Chinese men who have sex with men in the urban areas. *J Int AIDS Soc* 2018; 21:e25039.
- Mao H, Ma W, Lu H, 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.
- Flores SA, Bakeman R, Millett GA, Peterson JL. HIV risk among bisexually and homosexually active racially diverse young men. *Sex Transm Dis* 2009; 36:325–9.