

RESEARCH ARTICLE

Prevalence and protective factors of HIV and syphilis infection among men who have sex with men in Northwest China

Lirong Wang¹  | Anthony J. Santella² | Xiaoli Wei³ | Guihua Zhuang¹ | Hengxin Li³ | Hailan Zhang³ | Xiaodan Huang³ | Yalan Zhang³ | Haichao Zheng³ | Anqin Zhou⁴

¹Department of Epidemiology and Biostatistics, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an, China

²Department of Health Professions, Hofstra University, Hempstead, New York

³Department of Sexually Transmitted Disease Prevention and Control, Xi'an Centers for Disease Control and Prevention, Xi'an, China

⁴Department of HIV Testing Mobilization, Xi'an Center for Marie Stopes International, Xi'an, China

Correspondence

Xiaoli Wei, Xi'an Centers for Disease Control and Prevention, Xi'an 710054, China.
Email: xlwei1973@xiancdc.cn

Guihua Zhuang, Department of Epidemiology and Biostatistics, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an 710061, China.
Email: zhuanggh@mail.xjtu.edu.cn

Funding information

Social Development Guidance Plan of Xi'an Science and Technology Project, Grant/Award Number: SF1424

Abstract

Background: Men who have sex with men (MSM) continue to be disproportionately impacted by human immunodeficiency virus (HIV) and syphilis in China. Little is known about HIV and syphilis infections among MSM in Xi'an, a developing city in Northwest China. A cross-sectional study with recruitment via snowball sampling was conducted to collect HIV and syphilis infection status and risk factors among MSM in Xi'an between April 2013 to December 2016. Among the 5000 participants, the mean age was 29.0 years (SD 7.7) and the prevalence of HIV, syphilis, and coinfection was 6.5%, 2.2%, and 0.4%, respectively. There was no significant change in HIV prevalence from 2013 to 2016, while the prevalence of syphilis and coinfection showed a downward trend. Multiple logistic regression analyses found that being over 25 years old (OR = 1.647), junior high school/middle school education and below (OR = 3.085), with a sexual role of passive or versatile (OR = 3.300; OR = 2.337), rush poppers use during the last 6 months (OR = 1.660) and syphilis infection (OR = 2.235) were more likely to acquire HIV infection, whereas used condoms in the last episode of anal sex (OR = 0.572) and tested HIV antibody previously (OR = 0.252) were protective factors for HIV infection. HIV prevalence among MSM in Xi'an was stable, whereas the prevalence of syphilis and coinfection showed a downward trend. Interventions to promote HIV and sexually transmitted disease testing and condom use should be strengthened, especially for MSM with low education.

KEYWORDS

China, HIV, MSM, syphilis

1 | INTRODUCTION

Over the past 30 years, the incidence of human immunodeficiency virus (HIV) has increased significantly in China.¹ In recent years, the proportion of infection among people who inject drugs has declined, whereas sexual transmission has increased. Men who have sex with men (MSM) continue to be disproportionately impacted by HIV in China.^{2,3} In 2011, a survey of 15 large and medium-sized cities, including Xi'an, found that HIV prevalence among MSM was as high

as 6.27%.⁴ In the provincial capital cities and large and medium-sized cities (ie, Xi'an), sexual transmission fueled by MSM have led to more than 50% of the total number of newly reported cases in a year.⁵ Syphilis is also a public health epidemic among MSM. In most high-risk populations in China, syphilis infection is higher than HIV.⁶⁻⁸

Studies have found that HIV and syphilis infections in Chinese MSM vary depending on geography or other population differences such as economic conditions.⁹ Xi'an is an important central city in Northwest China and one of the 15 subprovincial cities in China.

Syphilis incidence estimates were the highest in Northeast (38.5/100 person-years), while the lowest in Northwest China (3.1/100 person-years).⁹ Another study indicated that the prevalence of syphilis infection was lower in less developed cities (such as Xining, Urumqi, and Lanzhou) than in developed cities (such as Shenzhen, Guangzhou, and Suzhou) (8.6% vs 15.1%).¹⁰ However, syphilis incidence among Chinese MSM is high which varied from 3.1/100 to 12.1/100 person-years, even to the 38.5/100 person-years,⁹ and this may increase the spread of other sexually transmitted infections, including HIV. It is essential to integrate syphilis and HIV control programs.

Empirical studies and modeling exercises of HIV testing and treatment have demonstrated the effectiveness of universal HIV testing and early treatment in preventing sexual transmission of HIV, lowering community viral load, and consequently reducing HIV incidence among high-risk populations such as MSM and general populations in both concentrated and generalized epidemic settings.¹¹⁻¹³ China has also adopted HIV prevention strategies that target MSM by expanding HIV and sexually transmitted disease (STD) testing as a means of promoting HIV and STD case finding, reducing the incidence of HIV.¹⁴⁻¹⁶

To achieve such benefits, a cascade of linked services and strategies are needed to increase HIV testing uptake among populations with risk behaviors and improve linkage to care among those diagnosed with HIV. However, in many countries including China, social, cultural, and structural barriers to HIV testing exist.¹⁷ Thus, community-based organizations (CBOs) have targeted their HIV prevention efforts toward reaching this vulnerable and often hidden community. With the assistance of international agencies such as the Bill and Melinda Gates Foundation, cities such as Xi'an, have seen an increase in CBOs implementing HIV and syphilis testing and other sexual health behavioral interventions. With the implementation of expanded testing programs, the work of CBOs in promoting testing is becoming more widespread and accepted.¹⁸ Therefore, through CBOs dedicated to HIV prevention among MSM in Xi'an, this study recruited participants via snowball sampling to collect HIV and syphilis infection status and risk factors.

2 | SUBJECT AND METHODS

2.1 | Study design and participants

A cross-sectional study was conducted to collect data among MSM between April 2013 to December 2016 in Xi'an. Men who have had oral sex or anal sex with men in the last year and aged 16 or older were eligible for the study.

We used snowball sampling as our main recruitment strategy because MSM are a hard-to-reach population in China. Every year from 2013 to 2016 seeds were chosen to recruit MSM. We chose the initial seeds according to five demographic and behavioral characteristics (age, home address [urban or suburban], education level, the main place to find MSM and sex-role). Fifteen initial seed participants with different demographic characteristics were first recruited. After training on recruitment eligibility, these participants

were given "recruitment cards" to refer other MSM in their social networks to the study, who were then screened for eligibility and if eligible invited to participate. All subsequent participants were asked to refer other MSM to this study using the card. Each "recruitment card" had information about the study testing site and a contact telephone number. Condoms or lubricants reward worth 20 Chinese yuan were offered to recruiters.

Investigators were CBO staff who received 1-week training at the Xi'an Centers for Disease Control and Prevention before they implemented the surveys. The content of the training included how to identify seeds, how to implement surveys, and how to collect blood samples. Investigators conducted one-to-one anonymous surveys in CBO offices. The questionnaire was based on the National Sentinel Monitoring Program. The questionnaire consisted of 16 questions, assessing demographic characteristics (six items), and HIV infection-related behaviors (10 items). After written consent was obtained, the questionnaire was implemented. A blood specimen (5 mL) was also collected from each participant to test for HIV and syphilis antibodies.

The study was approved by the Ethics Committee of Xi'an Jiaotong University.

2.2 | Laboratory tests

2.2.1 | HIV antibody

The HIV screening test was performed by using rapid gold-labeled HIV 1 + 2 antibody assay (South Korea SD Company) and if the result was reactive/positive, the specimen was retested using four generations of enzyme-linked immunoassay reagent (ELISA; Anti-HIV ELISA Kit, Shanghai BioMerier Diagnostics Inc, China). If the results of one or both tests were reactive/positive, a Western blot assay (HIV Blot 2.2, MP Diagnostics, Singapore) was conducted to confirm the diagnosis.

2.2.2 | Syphilis antibody

The syphilis test was conducted using Tolidine Red Unheated Serum Test (TRUST, Shanghai Rongsheng Biotechnology Co, Ltd). If the screening result was reactive/positive, the specimen was retested by Treponemapallidum (TPPA, FUJIREBIOINC, Tokyo). Syphilis infection was confirmed if TRUST/TPPA tests were both reactive/positive.

2.3 | Statistical analysis

Data from the paper surveys were inputted into a Microsoft Excel database which was subsequently converted to a Microsoft Access database. Data were analyzed using SPSS 13.0 software. The difference among groups was compared χ^2 statistic, a trend the χ^2 test was used for comparison in different years. Unconditional logistic regression models were used to analyze factors influencing HIV and syphilis infections. Statistical significance was assessed using two-sided tests with $\alpha = 0.05$ for all analyses.

3 | RESULTS

3.1 | General information

From 2013 to 2016, a total of 5000 MSM participated in this study. The mean age of study participants was 29.0 years (SD 7.7), 1973 (39.5%) were less than 25 years old,^{19,20} with the lowest proportion in 2013 (34.6%) and the highest proportion in 2016 (47.6%) ($\chi^2 = 36.906$; $P = .000$). Single, divorced, separated, or widowed participants accounted for 3620 (72.5%), with the lowest proportion in 2013 (63.0%) and the highest proportion in 2016 (83.2%) ($\chi^2 = 36.906$; $P = .000$). A total of 3688 (73.8%) of the participants had a college education or above. Almost 4000 ($n = 3923$, 78.6%) indicated their main method for finding sexual partners was by the internet dating software, from 2013 to 2016, the proportion increased from 52.0% to 93.3% ($\chi^2 = 532.324$; $P = .000$). Other participant characteristics are presented in Table 1.

3.2 | HIV and syphilis infection-related behaviors

As seen in Table 2, 3365 (67.4%) of the participants' sexual orientation was homosexual. The participants with a sexual role of versatile during anal sex accounted for 2169 (43.5%). 3569 (83.0%) reported condom use in the last episode of anal sex, while 1788 (41.6%) used a condom during all episodes of anal sex in the last 6 months. 4194 (83.9%) of the participants received HIV-related services such as condom distribution or HIV counseling, with the lowest proportion in 2016 (73.6%) ($\chi^2 = 13.238$; $P = .000$). 3962 (79.2%) of the participants had been tested for HIV antibody, the lowest testing rate was 68.3% in 2013 ($\chi^2 = 6.394$; $P = .011$). A question about the use of rush poppers was added in 2014. A total of

630 (17.0%) of the participants had used rush poppers in the last 6 months, and the lowest proportion was 7.6% in 2016 ($\chi^2 = 62.653$; $P = .000$).

3.3 | Prevalence of HIV, syphilis, and coinfection

Among the 5000 participants, 325 were HIV antibody positive, the HIV prevalence was 6.5%; 109 were syphilis antibody positive, the syphilis prevalence was 2.2%; 21 were infected with both HIV and syphilis, the prevalence of coinfection was 0.4%. Education-adjusted prevalence of HIV, syphilis, and coinfection in different years are shown in Table 3. There was no significant change in HIV prevalence from 2013 to 2016 ($\chi^2 = 0.577$; $P = .448$), while the prevalence of syphilis and coinfection showed a downward trend (syphilis, $\chi^2 = 17.579$, $P = .000$; coinfection, $\chi^2 = 11.403$; $P = 0.001$) (Figure 1).

3.4 | Predictors of HIV and syphilis infection

Multiple logistic regression analyses found that being over 25 years old (OR = 1.647; 95% CI: 1.208–2.246), residence in Xi'an more than 2 years (OR = 1.788; 95% CI: 1.098–2.911), junior high school/middle school education and below (OR = 3.085; 95% CI: 1.743–5.459), with a sexual role of passive or versatile during anal sex with men (OR = 3.300; 95% CI: 2.134–5.105; OR = 2.337; 95% CI: 1.516–3.603), used rush poppers during the last 6 months (OR = 1.660; 95% CI: 1.187–2.322) and infected syphilis (OR = 2.235; 95% CI: 1.022–4.890) were more likely to acquire HIV infection, while used condoms in the last episode of anal sex (OR = 0.572; 95% CI: 0.385–0.851) and tested HIV antibody previously (OR = 0.252; 95% CI: 0.185–0.343) were protective factors for HIV

TABLE 1 Participant characteristics in a different year, n (%)

	2013 (n = 1008)	2014 (n = 1694)	2015 (n = 1112)	2016 (n = 1186)	χ^2	P
Age, y					36.906	.000
≤ 25	349 (34.6)	640 (37.8)	419 (37.7)	565 (47.6)		
> 25	659 (65.4)	1054(62.2)	693 (62.3)	621(52.4)		
Nationality					10.936	.001
Han	998 (99.0)	1683(99.4)	1101(99.2)	1143(97.6)		
Others	10 (1.0)	11 (0.6)	9 (0.8)	28 (2.4)		
Residence time in Xi'an*, y					33.515	.000
≤ 2	368 (36.5)	336 (19.8)	134 (12.1)	309 (26.1)		
> 2	640 (63.5)	1358(80.2)	976 (87.9)	874 (73.9)		
Marital status*					116.691	.000
Single, divorced, separated or widowed	635 (63.0)	1185(70.0)	822 (73.9)	978 (83.2)		
Married or have a regular partner	373 (37.0)	509 (30.0)	290 (26.1)	198 (16.8)		
Education*					40.08	.000
Junior/middle school and below	115 (11.4)	115 (6.8)	78(7.0)	86 (7.3)		
High school and technical school	271 (26.9)	299 (17.7)	141 (12.7)	204 (17.2)		
College and above	622 (61.7)	1280(75.6)	893 (80.3)	893 (75.5)		
Main place to find MSM*					532.324	.000
Bar, club or public bathhouse	292 (29.0)	103 (6.1)	18 (1.6)	68 (5.8)		
Parks, public toilets or grasslands	192 (19.0)	279 (16.5)	108 (9.7)	11 (0.9)		
Internet dating software	524 (52.0)	1312(77.4)	986 (88.7)	1101(93.3)		

*Not all participants answered this question.

TABLE 2 HIV and syphilis infection-related behaviors in a different year, n (%)

	2013 (n = 1008)	2014 (n = 1694)	2015 (n = 1112)	2016 (n = 1186)	χ^2	P
Sexual orientation*					73.026	.000
Homosexual	556 (55.2)	1164(68.8)	855 (76.9)	790 (66.8)		
Heterosexual	13 (1.3)	6 (0.4)	3 (0.3)	29 (2.5)		
Bisexual	207 (20.5)	291 (17.2)	170 (15.3)	275 (23.2)		
Not sure	232 (23.0)	230 (13.6)	84 (7.6)	89 (7.5)		
Sex role*					13.285	.000
Active	282 (28.1)	417 (24.6)	286 (25.7)	431 (36.6)		
Passive	293 (29.2)	506 (29.9)	328 (29.5)	276 (23.4)		
Versatile	430 (42.8)	770 (45.5)	498 (44.8)	471 (40.0)		
Used condoms in the last anal sex*					81.243	.000
Yes	600 (69.0)	1230(85.8)	883 (87.9)	856 (86.2)		
No	269 (31.0)	204 (14.2)	121 (12.1)	137 (13.8)		
Used condoms in anal sex in the last 6 mo*					208.521	.000
Never	86 (9.9)	57 (4.0)	43 (4.3)	52 (5.2)		
Sometimes	566 (65.1)	880 (61.4)	437 (43.6)	389 (39.2)		
Every time	217 (25.0)	496 (34.6)	523 (52.1)	552 (55.6)		
Commercial sex in the last 6 mo*					4.864	.027
Yes	53 (6.1)	73 (5.1)	27 (2.7)	46 (4.6)		
No	816 (93.9)	1356(94.9)	976 (97.3)	945 (95.4)		
Hetero sex in the last 6 mo*					73.026	.000
Yes	276 (27.4)	339 (20.0)	151 (13.7)	207 (17.5)		
No	732 (72.6)	1353(80.0)	954 (86.3)	976 (82.5)		
Had STDs in the last year*					12.502	.000
Yes	56 (5.6)	102 (6.0)	29 (2.6)	42 (3.6)		
No	952 (94.4)	1592(94.0)	1078(97.4)	1132(96.4)		
Received HIV-related services*					13.238	.000
Yes	844 (83.7)	1404(82.9)	1074(96.6)	872 (73.6)		
No	164 (16.3)	290 (17.1)	38 (3.4)	312 (26.4)		
Tested HIV antibody previously					6.394	.011
Yes	688 (68.3)	1446(85.4)	929 (83.5)	899 (75.8)		
No	320 (31.7)	248 (14.6)	183 (16.5)	287 (24.2)		
Used rush poppers in the last 6 mo*					62.653	.000
Yes	/	300 (20.1)	246 (22.3)	84 (7.6)		
No	/	1193(79.9)	857 (77.7)	1024(92.4)		

*Not all participants answered this question.

infection (Table 4). As to syphilis infection, junior high school/middle school education and below (OR = 3.671; 95% CI: 1.486–9.070) and with sexual orientation of homosexual (OR = 12.985; 95% CI: 1.715–98.330) were risk factors (Table 5).

4 | DISCUSSION

This study surveyed 5000 MSM in Xi'an for 4 consecutive years from 2013 to 2016. The results showed that some changes had taken place in the demographic characteristics of the recruited MSM, which is similar to the results of the meta-analysis of young MSM in China and the survey in Nanjing city from 2011 to 2015.^{21,22} The change of demographic characteristics may be related to the fact that most internet dating users are young adults (around 20 years old) and those with higher education.²³ Studies have reported that internet dating users have a higher proportion of participants who identified

as MSM.²³ This study also found that with the increasing proportion of MSM searching for sexual partners from the internet, the proportion of those who identified as MSM also increased year by year.

A survey implemented in Nanjing found that the proportion of MSM who inconsistently used condoms during anal sex in the last 6 months increased year by year,²¹ however this study found that the condom use during the last episode of anal sex and the condom use during each episode of anal sex in the last 6 months increased year by year. The rate of condom use during the last episode of anal sex was 83.0%, while the rate of condom use for each episode of anal sex in the last 6 months was only 41.6%, which was equivalent to the 42.0% condom use rate among MSM in China.²²

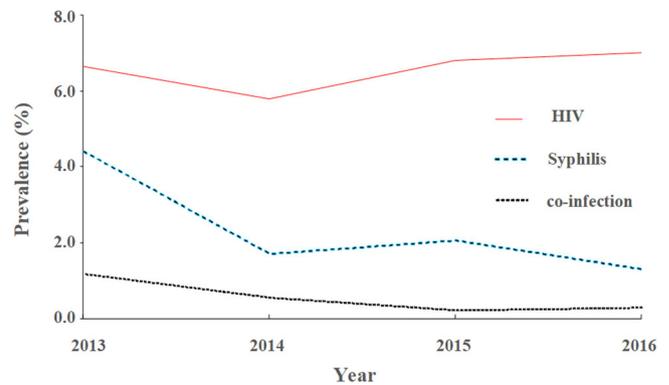
Many studies in the world have shown that persistent use of condoms is an important measure to prevent HIV infection. The multiple logistic regression analysis in this study also found that condom use in the last episode of anal sex is a protective factor for

TABLE 3 Education-adjusted prevalence of HIV, syphilis, and coinfection in a different year (%)

	N	HIV		Syphilis		Coinfection	
		n	%	n	%	n	%
2013	1008	67	6.6	44	4.2	11	1.0
2014	1694	98	5.8	28	1.7	7	0.4
2015	1112	78	6.8	22	2.0	1	0.1
2016	1186	82	7.0	15	1.3	2	0.2
Total	5000	325	6.5	109	2.2	21	0.4

HIV infection. This behavioral indicator has been rising annually, which explains to some extent the gradual stability of HIV prevalence in MSM 2013 to 2016 in Xi'an. It also reflects the targeted condom distribution program being done by CBOs. Although 83.9% of all the participants received HIV-related services such as condom distribution or HIV counseling, in the year 2016 the proportion was only 73.6%, which suggests that the number of MSM receiving preventive services did not continue to increase. Exploring effective ways to increase access to counseling and testing services is needed.

Rush poppers are smooth muscle relaxants, which were first documented among the MSM population in the United States to reduce anal pain and help MSM achieve rapid sexual arousal in a short period of time.²⁴ Studies in China have shown that the use of rush poppers reached between 10% and 40% among MSM.²⁵⁻²⁹ This study found that 17.0% of the participants used rush poppers in the last 6 months. The use of rush poppers has been shown to be associated with HIV infection due to risky behaviors, such as multiple sexual partners, commercial sex, group sex, and other high-risk sexual behaviors; 28% of new HIV infections in MSM could be attributed to the use of rush poppers.³⁰ Regression analysis showed that the use of rush poppers was a risk factor for HIV infection. In 2016, the use rate of the rush poppers was the lowest, suggesting that the decrease of the usage rate of rush poppers may be one of

**FIGURE 1** Education-adjusted prevalence of HIV, syphilis, and coinfection in a different year (%)

the reasons why the HIV prevalence of MSM in Xi'an did not increase significantly from 2013 to 2016.

The implementation of free HIV voluntary counseling and testing in China includes adequate counseling before and after testing. Counseling by medical workers can improve the knowledge of HIV prevention and reduce unsafe behaviors. Therefore, China has put forward the strategy of "testing is prevention". Studies have shown that the role of people living with HIV as a source of transmission has been greatly reduced after being aware of their infection.^{31,32} Through posttest counseling and other forms of secondary prevention, MSM who have been tested for HIV may increase their HIV-related knowledge and thus reduce high-risk behaviors.³³ In 2013, the Chinese government has expanded HIV testing as a means to promote HIV case finding. Our study found that 79.2% of the participants had been tested for HIV antibody, with the lowest testing rate of 68.3% in 2013, and then increased to over 75.8% in the following 3 years, which was higher than that in Nanjing (57.6%-67.7%) and the survey of 2105 MSM in eight Chinese cities (64.9%).^{21,34} Multivariate analysis showed that HIV testing was a

TABLE 4 Predictors of HIV infection

	B	SE	Wald	df	Sig.	Exp (B)	95% CI	
							Lower	Upper
Over 25 y old	0.499	0.158	9.962	1	0.002	1.647	1.208	2.246
Residence in Xi'an more than 2 y	0.581	0.249	5.461	1	0.019	1.788	1.098	2.911
Education			15.127	2	0.001			
Junior high school and below	1.127	0.291	14.964	1	0.000	3.085	1.743	5.459
High school and technical school	0.074	0.239	0.098	1	0.755	1.077	0.675	1.719
Sex role			28.783	2	0.000			
Passive	1.194	0.223	28.781	1	0.000	3.300	2.134	5.105
Versatile	0.849	0.221	14.771	1	0.000	2.337	1.516	3.603
Used rush poppers in the last 6 mo	0.507	0.171	8.752	1	0.003	1.660	1.187	2.322
Infected syphilis	0.804	0.399	4.054	1	0.044	2.235	1.022	4.890
Used condoms in the last anal sex	-0.558	0.203	7.599	1	0.006	0.572	0.385	0.851
Tested HIV antibody previously	-1.378	0.158	76.325	1	0.000	0.252	0.185	0.343
Constant	-4.299	0.683	39.612	1	0.000	0.014		

TABLE 5 Predictors of syphilis infection

	B	SE	Wald	df	Sig.	Exp (B)	95% CI	
							Lower	Upper
Education			9.054	2	0.011			
Junior high school and below	1.300	0.462	7.939	1	0.005	3.671	1.486	9.070
High school and technical school	0.589	0.380	2.410	1	0.121	1.803	0.857	3.795
Sexual orientation			13.053	3	0.005			
Homosexual	2.564	1.033	6.160	1	0.013	12.985	1.715	98.330
Heterosexual	-15.274	12432.992	0.000	1	0.999	0.000	0.000	.
Bisexual	0.552	1.232	0.200	1	0.654	1.736	0.155	19.425
Constant	-6.517	1.041	39.189	1	0.000	0.001		

protective factor for HIV infection, suggesting that the increase of the testing rate was another factor for the stability of HIV prevalence MSM in Xi'an from 2013 to 2016.

Biological studies have shown that anal and rectal mucosa are easily damaged during anal intercourse, resulting in the spread of HIV and other diseases. Sexual role during anal sex and sexual orientation are also important factors affecting HIV transmission. Similar to the findings of several other cities in China,²³ this study found that a sexual role of passive or versatile is a risk factor for HIV infection and with the sexual orientation of homosexuals is a risk factor for syphilis infection. In addition, being over 25 years old and having a junior high school/middle school education or less are also risk factors for HIV and syphilis infections. Targeted evidence-based interventions are needed to accommodate the special needs of these populations.

HIV, syphilis, and coinfection prevalence in this study were 6.5%, 2.2%, and 0.4%, respectively, which were lower than that in seven Chinese cities.³⁵ This study also found that HIV prevalence was stable, while the prevalence of syphilis and coinfection showed a downward trend from 2013 to 2016. This is similar to the results of numerous studies in China.^{21,36,37} The reason for this trend may be that syphilis is a curable disease that spreads through sexual contact. In this study, syphilis infection refers to those who are both ELISA and TRUST positive. After syphilis is cured, the TRUST test is judged to be negative due to the decrease of titer, while HIV antibody will persist after HIV infection, so there will be inconsistencies between HIV infection status and syphilis infection or coinfection status among MSM. Similar to other studies,^{21,38} multivariate analysis in this study showed that syphilis infection is a risk factor for HIV infection. The reason may be that syphilis infection will cause local mucosal damage, thereby increasing susceptibility to HIV infection. Multivariate analysis showed that having STDs in the past year was the only risk factor of syphilis infection, suggesting that curing STDs could reduce the risk of syphilis.

This study has limitations. First, participants were not recruited randomly, so the results only represent the characteristics of MSM in Xi'an and may not be representative of all MSM in China. Second, the participants surveyed in different years were not the same so there may be selection bias when describing the trends in prevalence from 2013 to 2016. Third, recall bias may exist when collecting information that has occurred in the past, such as "have you received HIV-related services

before" or "have you tested HIV antibody previously". Nevertheless, this study does include a large sample size of 5000 participants, and there were more than 1000 participants recruited in different years. To reduce the information bias, the 4-year monitoring data was collected by trained and experienced investigators, thus ensuring the authenticity and reliability of the data.

In conclusion, this study shows that HIV prevalence among MSM in Xi'an was stable, while the prevalence of syphilis and coinfection showed a downward trend. Evidence-based interventions to promote HIV and STD testing and condom use should be strengthened, especially for MSM with low education, to help end HIV/AIDS in China.

ACKNOWLEDGMENTS

This study was supported by Social Development Guidance Plan of Xi'an Science and Technology Project (Number: SF1424; title: Promoting early highly active antiretroviral therapy among newly diagnosed men who have sex with men living with HIV in Xi'an).

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

AUTHOR CONTRIBUTIONS

XW, GZ, HL conceptualized the study. Data analysis was performed by LW, HZ, XH. Project administration was done by GZ, YZ, AZ. AJS and HZ visualized the study. The original draft was written by LW, XW. Writing, review, and editing were performed by LW and AJS.

ORCID

Lirong Wang  <http://orcid.org/0000-0002-9092-6282>

REFERENCES

- Zhang W, Xu JJ, Zou HC, Zhang J, Wang N, Shang H. HIV incidence and associated risk factors in men who have sex with men in Mainland China: an updated systematic review and meta-analysis. *Sex Health*. 2016;13(4):373-382.

2. Huang MB, Ye L, Liang BY, et al. Characterizing the HIV/AIDS epidemic in the United States and China. *Int J Environ Res Public Health*. 2015;13:ijerph13010030.
3. Zhang L, Chow EP, Jing J, et al. HIV prevalence in China: integration of surveillance data and a systematic review. *Lancet Infect Dis*. 2013;13:955-963.
4. Qi J, Zhang D, Fu X, et al. High risks of HIV transmission for men who have sex with men—a comparison of risk factors of HIV infection among MSM associated with recruitment channels in 15 cities of China. *PLOS One*. 2015;10:e0121267.
5. National HIV/syphilis/HCV sentinel surveillance report in 2017 (2017). National Center for AIDS/STD Control and Prevention China CDC, Beijing, China.
6. Ning Z, Fu J, Zhuang M, et al. HIV and syphilis epidemic among MSM and non-MSM aged 50 and above in Shanghai, China: A yearly cross-sectional study, 2008-2014. *Global Public Health*. 2018;13:1625-1633.
7. 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.
8. Xu JJ, Reilly KH, Lu CM, et al. A cross-sectional study of HIV and syphilis infections among male students who have sex with men (MSM) in northeast China: implications for implementing HIV screening and intervention programs. *BMC Public Health*. 2011;11:287.
9. Zhou Y, Li D, Lu D, Ruan Y, Qi X, Gao G. Prevalence of HIV and syphilis infection among men who have sex with men in China: a meta-analysis. *BioMed Res Int*. 2014;2014:1-12.
10. 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;28:170-178.
11. Cohen MS, Chen YQ, McCauley M, Gamble T, Hoseinipour MC, Kumarasamy N. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011;365:493-505.
12. Das M, Chu PL, Santos G, et al. Decreases in community viral load are accompanied by reductions in new HIV infections in San Francisco. *PLOS One*. 2010;5:e11068.
13. Sorensen SW, Sansom SL, Brooks JT, et al. A mathematical model of comprehensive test-and-treat services and HIV incidence among men who have sex with men in the United States. *PLOS One*. 2012;7(2):e29098.
14. Chow EP, Lau JT, Zhuang X, Zhang X, Wang Y, Zhang L. HIV prevalence trends, risky behaviours, and governmental and community responses to the epidemic among men who have sex with men in China. *BioMed Res Int*. 2014;2014:1-19.
15. Wong NS, Tang W, Han L, et al. MSM HIV testing following an online testing intervention in China. *BMC Infect Dis*. 2017;17:437.
16. Fan EL. HIV testing as prevention among MSM in China: the business of scaling-up. *Global Public Health*. 2014;9:85-97.
17. Yu F, Mi GD, Chen ZH, et al. Qualitative research on factors of HIV testing among men who have sex with men in China based on Blued. *Zhonghua Yu Fang Yi Xue Za Zhi*. 2018;52:1229-1233.
18. Zhang D, Lu H, Zhuang M, et al. Enhancing HIV testing and treatment among men who have sex with men in China: a pilot model with two-rapid tests, single blood draw session, and intensified case management in six cities in 2013. *PLOS One*. 2016;11:e0166812.
19. Rocha GM, Guimaraes MDC, de Brito AM, et al. High rates of unprotected receptive anal intercourse and their correlates among young and older MSM in Brazil. *AIDS Behav*. 2019. <https://doi.org/10.1007/s10461-019-02459-y>
20. Mao X, Wang Z, Hu Q, et al. HIV incidence is rapidly increasing with age among young men who have sex with men in China: a multicentre cross-sectional survey. *HIV Med*. 2018;19(8):513-522.
21. Xu YY, Zhu ZP, Wu SS, et al. [Infection status of HIV in men who have sex with men in Nanjing, 2011-2015]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2016;37:1503-1508.
22. Cao Y, Meng XY, Weng H, Peng MJ, Yan H, Li SY. [Prevalence of AIDS-related sexual behaviors and HIV infection status in young men who have sex with men in China: a Meta-analysis]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2016;37:1021-1027.
23. Guo W, Li Y, Zhou N, et al. Risk factors related to HIV new infections among men who have sex with men in a cohort study. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2018;39:16-20.
24. Rudy ET, Shoptaw S, Lazzar M, Bolan RK, Tilekar SD, Kerndt PR. Methamphetamine use and other club drug use differ in relation to HIV status and risk behavior among gay and bisexual men. *Sex Transm Dis*. 2009;36:693-695.
25. Chen MQ, Cheng WB, Xu HF, et al. [Predictors of rush popper use among 825 men who have sex with men in education in Guangdong Province]. *Zhonghua Yu Fang Yi Xue Za Zhi*. 2016;50:949-953.
26. Thurtle N, Dargan PI, Hunter LJ, Lovett C, White JA, Wood DM. A comparison of recreational drug use amongst sexual health clinic users in London with existing prevalence data. *Int J STD AIDS*. 2016;27:1309-1316.
27. Yang GL, Zhang AD, Yu Y, Liu H, Long FY, Yan J. Drug use and its associated factors among money boys in Hunan Province, China. *Public Health*. 2016;140:213-220.
28. Xu JJ, Zhang C, Hu QH, et al. Recreational drug use and risks of HIV and sexually transmitted infections among Chinese men who have sex with men: mediation through multiple sexual partnerships. *BMC Infect Dis*. 2014;14:642.
29. Xu JJ, Qian HZ, Chu ZX, et al. Recreational drug use among Chinese men who have sex with men: a risky combination with unprotected sex for acquiring HIV infection. *BioMed Res Int*. 2014;2014:725361.
30. Buchbinder SP, Vittinghoff E, Heagerty PJ, et al. Sexual risk, nitrite inhalant use, and lack of circumcision associated with HIV seroconversion in men who have sex with men in the United States. *J Acquir Immune Defic Syndr*. 2005;39:82-89.
31. Fox J, White PJ, Macdonald N, et al. Reductions in HIV transmission risk behaviour following diagnosis of primary HIV infection: a cohort of high-risk men who have sex with men. *HIV Med*. 2009;10:432-438.
32. Gorbach PM, Weiss RE, Jeffries R, et al. Behaviors of recently HIV-infected men who have sex with men in the year post diagnosis: effects of drug use and partner types. *J Acquir Immune Defic Syndr*. 2011;56:176-182.
33. Huan X, Tang W, Babu GR, et al. HIV risk-reduction counseling and testing on behavior change of MSM. *PLOS One*. 2013;8:e69740.
34. Ong JJ, Fu H, Pan S, et al. Missed opportunities for human immunodeficiency virus and syphilis testing among men who have sex with men in China: a cross-sectional study. *Sex Transm Dis*. 2018;45:382-386.
35. Das A, Li J, Zhong F, Ouyang L, Mahapatra T. Factors associated with HIV and syphilis co-infection among men who have sex with men in seven Chinese cities. *Int J STD AIDS*. 2015;26:145-155.
36. Zhong F, Liang B, Xu H, et al. Increasing HIV and decreasing syphilis prevalence in a context of persistently high unprotected anal intercourse, six consecutive annual surveys among men who have sex with men in Guangzhou, China, 2008 to 2013. *PLOS One*. 2014;9:e103136.
37. Li D, Ge L, Wang L, et al. Trend on HIV prevalence and risk behaviors among men who have sex with men in China from 2010 to 2013. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2014;35:542-546.
38. Feng Y, Bu K, Li M, Zhang X, Jin S, Wang L. [Meta-analysis of HIV infection incidence and risk factors among men who have sex with men in China]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2015;36:752-758.

How to cite this article: Wang L, Santella AJ, Wei X, et al. Prevalence and protective factors of HIV and syphilis infection among men who have sex with men in Northwest China. *J Med Virol*. 2019;1–7. <https://doi.org/10.1002/jmv.25622>