

Disparity of human immunodeficiency virus incidence and drug resistance in college student, non-student youth and older men who have sex with men: a cross-sectional study from seven major cities of China

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Abstract

Background: Human immunodeficiency virus (HIV) prevalence among student men who have sex with men (MSM) in college is more than 5.0% and keeps on increasing in China. This study aims to clarify the proportion of HIV recent infection, its propeller and the source among college student MSM.

Methods: We conducted a multicenter cross-sectional study in seven major Chinese cities during 2012–2013. HIV recent infections (≤ 168 days) and incidence was measured and estimated by BED HIV-1 capture enzyme immunoassay (BED-CEIA) testing strategy. HIV-related behaviors and transmitted drug resistance (TDR) were investigated and compared between the college student MSM, < 25-year-old non-student youth MSM (NSYM), and ≥ 25 -year-old non-student non-youth MSM (NSNYM), using structured survey, and analyses of drug resistance.

Results: Overall, 4496 (4496/4526, 99.3%) were eligible for enrollment, comprising 565 college student MSM, 1094 NSYM, and 2837 NSNYM. The proportion of HIV recent infection were 70.3% (26/37), 50.8% (65/128) and 35.1% (95/271), the HIV incidence rate were 10.0 (95% CI: 6.2–13.9)/100 person-year (PY), 12.9 (95% CI: 9.8–16.1)/100PY, 6.8 (95% CI: 5.4–8.2)/100 PY, and TDR prevalences were 7.4% (2/27), 2.0%, (2/98) and 4.9% (11/226), among student MSM, NSYM, and NSNYM, respectively. Among HIV positive student MSM with age <21 years, the proportion of HIV recent infection is 90.9% (10/11). Factors independently associated with HIV recent infection in student MSM was usage of recreational drug in the past 6 months (adjusted odds ratio [aOR]: 2.5; 95% CI: 1.0–5.8).

Conclusions: College student MSM had higher proportion of HIV recent infection and TDR than the youth and older MSM in China during 2012–2013. The HIV infections were more likely to happen during the early year of college life among student MSM.

Keywords: HIV incidence; Drug resistance; Men who have sex with men; Male; Students; Cross-sectional studies; Sexual behavior

Introduction

Human immunodeficiency virus (HIV) epidemics has been disproportionately concentrated among men who have sex with men (MSM).^[1] Pooled HIV prevalence of MSM population ranges from 3% in the North and Middle East Africa of MSM to 25.4% in the Caribbean, which is 3 to 30 times that of counterparts in the general adult male population.^[2] The HIV prevalence of young MSM (YMSM), commonly defined as age between 15 and

24 years, were reported from 14.0% in YMSM in Arica countries^[3] to 36.0% in Black YMSM in Atlanta, USA.^[4]

Although the HIV prevalence among youth MSM is still much lower than the general MSM population in China,^[5] the 35% annual increase of national newly reported HIV cases in youth in China from 2011 to 2015 has caused substantial concern,^[6] among which 81% were MSM^[7] and 65% were infected during college life.^[8] According to a cross-sectional study of 155 HIV infected student cases in

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a single city of China conducted in 2015–2017, 96% was MSM and more than half of the HIV infected cases were sophomore or lower grades.^[9] The alarmingly increasing HIV epidemic and the trend of young age among student MSM in China requires urgent attention from public health.

China has taken many actions to mitigate the HIV epidemic among students in higher education institutions, including provision of comprehensive education of sexual health and more accessible HIV testing.^[10] However, HIV incidence, as the most crucial indicators of the trend of HIV epidemic and the impact of prevention,^[11] was lack. Most of existing studies were about HIV prevalence and related risk behavior, reporting the HIV prevalence among student MSM in China increased from 3.0% in 2005–2007 to 6.0% in 2008–2010.^[12] This increasing HIV prevalence can be led by both expanded HIV testing in China or the growing epidemic. Study of HIV incidence rate among student MSM is needed, in order to clarify the increasing HIV prevalence found in this population.

Meanwhile, China has adopted immediate antiretroviral therapy (ART) since 2016.^[13] The proportion of ART initiation in both student and non-student youths has improved significantly.^[14] Transmitted drug resistance (TDR) rate of HIV is crucial indicator in evaluation of ART treatment strategies and tracking of the source of HIV incidence. Previous study reported a 2.1% of TDR among a small size sample of student in Beijing, China.^[15] This low rate of TDR was interpreted as a result of the limited social network of students. However, this interpretation was in contrast with the recent rapidly increasing HIV epidemic among students in China. The potential role of the widely use of gay dating geosocial networking app among young MSM in recent years has to be considered, which is correlated with enlarged sexual network and HIV transmission.^[16] Study of TDR rate among student MSM with larger sample sized and more study sites is urgently required.

Hence, we conducted this study to 1) determine the proportion of HIV recent infection and its associated factors in college student MSM in seven major cities of China; 2) explore TDR among college student MSM in China. Above results were compared with none-student young MSM and the local general MSM population, to better interpret the HIV incidence among student MSM and provide reference for evaluation of current HIV prevention and control.

Methods

Ethics approval

The Institutional Review Board (IRB) of the First Affiliated Hospital of China Medical University (No. [2011]-36) approved this study. The protocol and procedures of this study were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration. Written informed consent was obtained from all participants.

Study design and population

We conducted a cross-sectional study in seven major cities in China (Shenyang, Nanjing, Shanghai, Ji'nan, Changsha, Zhengzhou, and Kunming) from June 2012 to June 2013, to understand recent HIV infections among student MSM. Information of subject sampling, criteria of recruitment and structured interview have been reported previously.^[17] Inclusion criteria of participants were the following: (1) born male, (2) self-reported to have engaged in oral and/or anal sex with other males in the past 12 months, (3) 18 years old or older, and (4) willing to provide written informed consent to join this study. Considering the stigma of sexual identity of MSM participants, the study adopted three methods of recruitment, including gay websites and online chat rooms by posting the IRB-approved introduction of the study by staffs, venue-based recruitment by local MSM community-based organization at hot-spots such as gay bars, parks and bathhouse, and peer referrals.

Variables and definitions

Enrolled participants who self-reported “occupation” as “currently a student” were defined as “college student MSM”. Among college student MSM, those aged between 18 and 21 years were defined as “undergraduate”; those aged >21 years were defined as “graduate”, including younger (between 21 and 23 years), middle-age (between 24 and 25 years), and older (>26 years) graduates. Participants who self-reported their “occupation” as other than “currently a student” and were aged < or ≥ 25 years were defined as “non-student youth MSM” (NSYM) and “non-student and non-youth MSM (NSNYM)”, respectively. The variable, “Recreational drug using behavior” meant any use of the following drugs, including poppers (alkyl nitrites), amphetamine, ecstasy, tramadol, ice (methamphetamine), and ketamine. The variable “sexually transmitted infections (STI) symptoms” was defined as having had at least one of the following symptoms: genital ulcers, genital warts, urethral discharge, scrotal swelling, inguinal bubo, and lower abdominal pain.^[18] Transmitted drug resistance (TDR) was defined as individual acquires an HIV-1 strain containing one or more resistance-associated mutations and is already resistant to certain antiretroviral drugs according to the World Health Organization (WHO) 2009 surveillance list.^[19]

Serological measures

We collected blood samples from participants to detect antibodies against HIV and syphilis. Samples with positive results in both enzyme-linked immunosorbent assay (ELISA) and western blot were further tested by BED HIV-1 capture enzyme immunoassay (BED-CEIA) (Calypte Biomedical Corporation, Rockville, MD, USA) to identify recent HIV infection. Specimens with initial optical density number (OD-*n*) >1.2 were classified as established HIV infection. Several publications have exploited BED-CEIA for HIV incidence estimation in HIV high risk population by cross-sectional study design.^[20] Specimens with initial OD-*n* ≤ 1.2 were retested a further three times to confirm OD-*n* values. If the median OD-*n* of these three tests was still ≤ 0.8, the specimen was

considered to represent a recent infection (≤ 168 days, defined based on China HIV reference lab estimated HIV recent infection window period^[21]), if not, the specimen was considered an established infection. Samples were positive in both in *Treponema pallidum* particle assay and the rapid plasma reagent test were defined as currently syphilis infections. Above testing procedure has been reported in previous published study.^[17] Drug resistance mutations were identified using the online tool of Stanford University HIV Drug Resistance Database (HIVdb; <http://hivdb.stanford.edu>) and interpreted by the HIVdb program. The methodology used for sequence assembly, phylogenetic and genotypic resistance analyses, and quality control was reported previously.^[22] All laboratory tests described above were conducted at the National Health Commission Key Laboratory of AIDS Immunology.

Statistical analysis

We compared demographics characteristics, recent infection rate and TDR among college student MSM, NSYM and NSNYM using the Chi-square test, and calculated their proportion and 95% confidence interval (CI). Associations with recent HIV infection were analyzed by Hierarchical Linear Modeling (HLM),^[23] which utilizes factors from both level of study site and study individual. The study site level factors included the cumulative number of reported HIV/AIDS cases in the province^[24] and the proportion of homosexual transmission accounted in these cases by 2011. The seven study cities were the capital city of the province or the Municipality, which accounted for most of the reported cumulative HIV/AIDS cases. According to the 2011 Estimates for the HIV/AIDS Epidemic in China by Ministry of Health of China and World Health Organization, by the end of 2011, the level of cumulative HIV/AIDS cases was 1001 to 5000 cases in Shandong province (capital city as Jinan) and Liaoning province (capital city as Shenyang) separately, and 5001 to 10,000 cases in Jiangsu province (capital city as Nanjing) and Shanghai (Municipality) separately, 10,001 to 50,000 cases in Hunan province (capital city as Changsha), and 50,001 to 90,000 cases in Yunnan province (capital city as Kunming) and Henan province (capital city as Zhengzhou) separately.^[24] The corresponding proportion of homosexual transmission of above cases in Shandong, Liaoning, Jiangsu, Shanghai, Hunan, Yunnan and Henan province was 36.95%,^[25] 47.0%,^[26] 38.8%,^[27] 42.8%,^[28] 4.3%,^[29] 6.3%,^[30] and 4.16%.^[31] The included individual level factors included main venues for sexual partner seeking, main sexual position, condomless anal intercourse, number of male sexual partner, and usage of recreational drug in the past 6 months and STIs symptoms in the past 12 months, anal bleeding and positive for syphilis infection. Variables with P -values < 0.05 were considered as independent correlates. All statistical analyses were performed by SPSS 23.0 (IBM Corporation) and HLM 8.0 (Scientific Software International, Inc).

Based on the test result of BED-CEIA, crude HIV incidence was estimated by formula: $I = 100 \times [(365/w) \times R]/[N + (365/w) \times (R/2)]$,^[32,33] where 'w' is the window period (168 days), 'R' is the total tested counts of recent HIV

infections determined by BED, and 'N' is the total tested counts of HIV-seronegative subjects. We then adjusted for false positive rate (FPR) of recent infection testing algorithm (RITA) by using the Sensitivity/Specificity Adjustment formula: $I = [F \times (365/w) \times R]/[N + F \times (365/w) \times (R/2)]$, where $F = \text{Correction Factor}$, and $F = [(R/P) + \gamma - 1]/[(R/P)(\alpha - \beta + 2\gamma - 1)]$ in which $w = 168$ days, $\alpha = 0.8098$, $\beta = 0.7571$, $\gamma = 0.9315$, $\text{FPR} = R/P = 0.0685$, where P is the total number of cases of longstanding infection in the survey used for estimation of the FRR, and R is the number of these specimens classified as recent by the BED-CEIA. All above values were based on the reference recommended by National HIV Reference Laboratory, National Center for AIDS/STD Control and Prevention, Chinese CDC, which can be used to accurately predict HIV recent infection status for the specific strains of Chinese population.^[21]

Results

Participants

We approached a total of 4526 MSM from seven Chinese cities (Shenyang, Nanjing, Shanghai, Ji'nan, Changsha, Zhengzhou, and Kunming). Of these, 4496 MSM were eligible for enrollment; 10 refused to join the study and 20 were excluded because they were under 18 years old. All 4496 enrolled participants completed the questionnaire and provided blood samples. Among them, 565 (12.6%) were college student MSM, 1094 (24.3%) were NSYM, and 2837 (63.1%) were NSNYM.

Comparisons of the characteristics of college student MSM, NSYM, and NSNYM

Of college student MSM, 80.5% used the Internet as the main venue for seeking male partners, while the corresponding percentages were 71.4% and 64.1% for NSYM and NSNYM, respectively ($P < 0.001$). Additionally, college student MSM were more likely than NSNYM to have had first anal intercourse before 18 years old (44.6% *vs.* 26.2%), to have experienced anal bleeding in the past 12 months (22.3% *vs.* 12.3%), and to have self-reported sexually transmitted infections (STIs) symptoms in the past 12 months (9.6% *vs.* 6.9%, all $P < 0.001$); and were less likely to have had multiple (≥ 2) male sexual partners in the past 6 months (29.2% *vs.* 40.1% *vs.* 40.0%) and to engage in commercial sex (including both selling and buying sexual service) in the past 6 months (buying sex 1.8% *vs.* 4.2% *vs.* 8.6%, selling sex 2.0% *vs.* 9.4% *vs.* 7.6%, $P < 0.001$) than NSYM and NSNYM. The prevalence of condomless anal intercourse (CAI) in last anal sex had no statistical difference among above three subgroups (29.6% *vs.* 28.2% *vs.* 27.4%, $P = 0.557$) [Table 1].

Prevalence of HIV and syphilis

HIV prevalence was 6.5% (37/565) in college student MSM, 11.7% (128/1094) in NSYM, and 9.8% (279/2837) in NSNYM ($P = 0.004$). Those for prevalence of syphilis was 4.1% (23/565) in college student MSM, 8.7% (95/1094) in NSYM, and 9.3% (263/2837) in NSNYM ($P < 0.001$) [Table 1].

Table 1: Characteristics of non-student MSM in different age subgroups compared with college student MSM in China, 2012-2013 (n = 4496).

Risk behavior	Sub-population*	95% CI	P-value for student % vs. NSYM %	P-value for student % vs. NSNYM %
Internet as main venue for seeking homosexual sexual partners	Student	80.5 (77.1–83.6)	0.011	< 0.001
	NSYM	71.4 (68.6–74.0)		
	NSNYM	64.1 (62.3–65.9)		
Being receptive or versatile in homosexual intercourse	Student	57.2 (53.1–61.2)	0.112	< 0.001
	NSYM	62.5 (59.6–65.3)		
	NSNYM	77.1 (75.5–78.6)		
Had anal bleeding [†]	Student	22.3 (19.1–25.9)	0.319	< 0.001
	NSYM	20.2 (17.9–22.7)		
	NSNYM	12.3 (11.1–13.5)		
Had CAI in last anal sex with male [†]	Student	29.6 (25.9–33.4)	0.218	0.557
	NSYM	28.2 (25.6–30.9)		
	NSNYM	27.4 (25.8–29.1)		
Had > 2 male sexual partners [†]	Student	29.2 (25.6–33.1)	< 0.001	< 0.001
	NSYM	40.1 (37.3–43.1)		
	NSNYM	40.0 (38.2–41.8)		
Had used recreational drugs ^{†,‡}	Student	26.0 (22.6–29.8)	0.005	0.594
	NSYM	32.8 (30.1–35.7)		
	NSNYM	27.1 (25.5–28.7)		
Had sold sex to males [†]	Student	2.0 (1.1–3.5)	< 0.001	< 0.001
	NSYM	9.3 (7.7–11.2)		
	NSNYM	7.6 (6.7–8.6)		
Had STI symptoms in the past 12 months	Student	9.6 (7.4–12.3)	0.578	0.032
	NSYM	8.8 (7.2–10.6)		
	NSNYM	6.9 (6.0–7.9)		
Currently syphilis infected [§]	Student	4.1 (2.7–6.0)	< 0.001	< 0.001
	NSYM	8.7 (7.2–10.5)		
	NSNYM	9.3 (8.3–10.4)		
HIV infected	Student	6.5 (4.8–8.9)	0.001	0.004
	NSYM	11.7 (9.9–13.7)		
	NSNYM	9.8 (8.8–11.0)		

* The total sample sizes of each sub-population were: student MSM, 565; NSYM, 1094; and NSNYM, 2837. [†] In the past 6 months. [‡] Recreational drugs included poppers (alkyl nitrites), ecstasy, ice (methamphetamine), amphetamine, tramadol, and ketamine. [§] Currently syphilis infected was defined as positive for both rapid plasma reagent test and Treponema pallidum particle assay. CI: confidence interval; NSYM: none student young MSM (<25 years old); NSNYM: none student none young MSM (≥25 years old); CAI: condomless anal intercourse; STI: sexually transmitted infections.

Recent HIV infection rate, HIV incidence, TDR, and HIV genotype

Among the 436 HIV-positive MSM, 186 were detected positive by BED-CEIA test and were defined as recent infections, while 8 HIV-positive MSM did not undergo the BED-CEIA test for the lack of sufficient blood specimens. The HIV recent infection rate was 70.3% (26/37) for college student MSM, 50.8% (65/128) for NSYM, and 35.1% (95/271) for NSNYM, yielding an HIV incidence of 10.0 (95% CI: 6.2–13.9)/100 person years (PY) in college student MSM, 12.9 (95% CI: 9.8–16.1)/100PY in NSYM and 6.8 (95% CI: 5.4–8.2)/100PY in NSNYM, respectively [Figure 1]. Compared with college student MSM, NSYM had a lower rate of recent HIV infection (50.8% vs. 70.3%, *P* = 0.036), as did NSNYM (35.1% vs. 70.3%, *P* < 0.0001) [Table 2].

The pol sequences were successfully amplified from 351 of the 444 samples (79.1%), including 27 samples of college

student MSM, 98 samples of NSYM and 226 samples of NSNYM. Amplification failure was commonly due to condition of the samples, which was not a function of group assignment.^[22] TDR prevalence rates were 7.4% (2/27), 2.0%, (2/98) and 4.9% (11/226), among college student MSM, NSYM, and NSNYM, respectively. We found no significant difference of TDR among the three groups, which had rates of 7.4% (95% CI: 2.1–23.4%), 2.0% (95% CI: 0.5–7.1%), and 4.9% (95% CI: 2.7–8.5%) in college student MSM, NSYM, and NSNYM, respectively (*P* = 0.572) [Table 2].

The HIV genotype was successfully tested from 306 of the 444 samples (68.9%), including 26 samples of college student MSM, 97 samples of NSYM and 183 samples of NSNYM. CRF01_AE was the most popular subtype of HIV in all three subgroups, which accounted for 51.4% (95% CI: 34.7–67.8%) in college student MSM, 34.4% (95% CI: 26.4–43.4%) in NSYM, and 41.9% (95% CI: 36.1–48.0%) in NSNYM [Table 2].

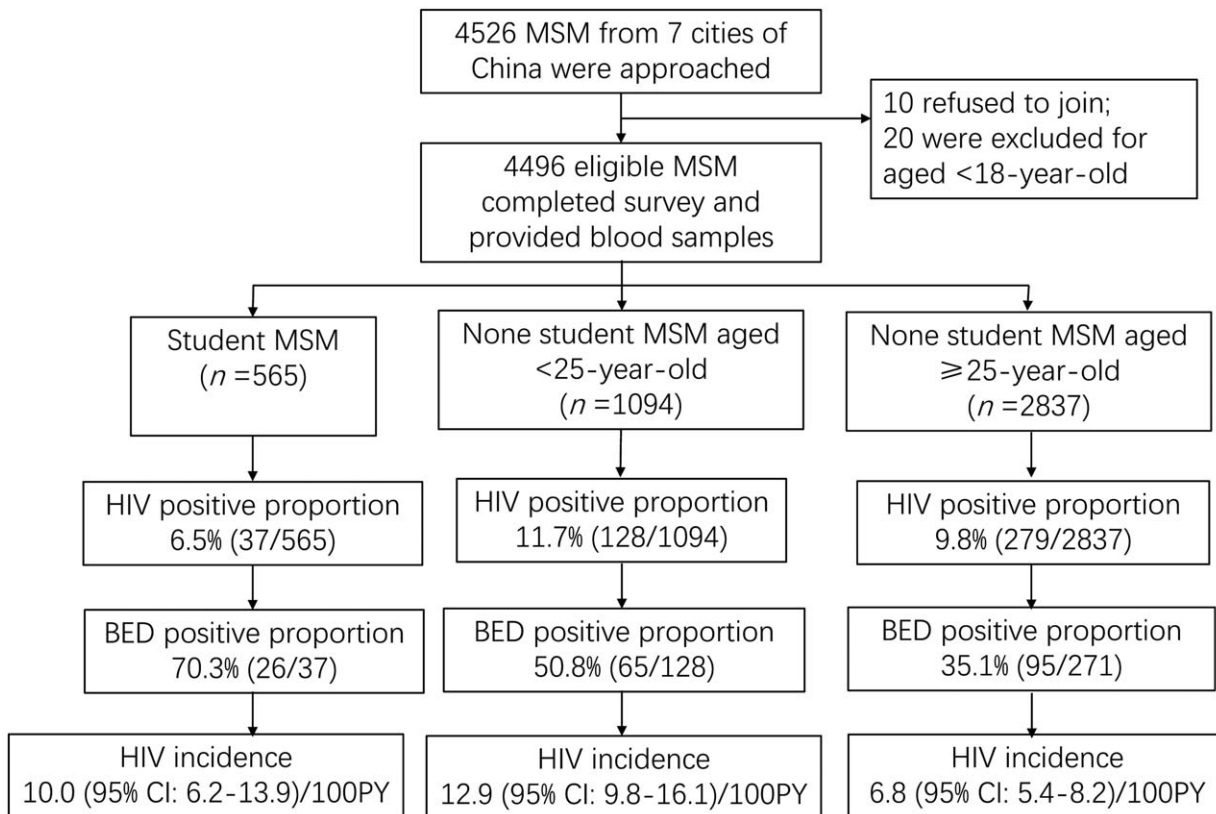


Figure 1: Study flow chart. MSM: men who have sex with men; HIV: human immunodeficiency virus; BED: BED-capture-enzyme immunoassay; PY: person years.

Table 2: Proportion of recent HIV infection, TDR and HIV subtype among HIV positive student MSM, NSYM, and NSNYM in China, 2012-2013.

Variable	Sub-population	Total number tested	95% CI	P value for student % vs. NSYM %	P value for student % vs. NSNYM %
Recent HIV infection by BED-CEIA*	Student	37	70.3 (54.2-82.5)	0.036	< 0.0001
	NSYM	128	50.8 (42.2-59.3)		
	NSNYM	271	35.1 (29.6-40.9)		
Transmitted drug resistance†	Student	27	7.4 (2.1-23.4)	0.161	0.572
	NSYM	98	2.0 (0.5-7.1)		
	NSNYM	226	4.9 (2.7-8.5)		
CRF01_AE subtype of HIV‡	Student	26	51.4 (34.7-67.8)	0.012	0.041
	NSYM	97	34.4 (26.4-43.4)		
	NSNYM	183	41.9 (36.1-48.0)		
CRF07_BC subtype of HIV‡	Student	26	16.2 (6.8-32.7)	0.212	0.236
	NSYM	97	27.3 (20.0-36.1)		
	NSNYM	183	28.0 (22.9-33.7)		

* Eight HIV-infected subjects were not tested for recent HIV infection by BED-CEIA test. The total tested number was 436. Ninety-three HIV-infected subjects were not tested for transmitted drug resistance. The total tested number was 351. † One hundred and thirty-three subjects were not tested for HIV genotype. The total tested number was 306. TDR: transmitted drug resistance; HIV: human immunodeficiency virus; MSM: men who have sex with men; NSYM: non-student youth MSM; NSNYM: non-student non-youth MSM; CI: confidence interval.

Table 3: HIV prevalence and recent infection proportions among college student MSM in China, 2012–2013 (n = 565).

Subgroup	Subjects, n	HIV (+)	HIV prevalence (%)	No. of BED tests	BED (+)	Recent infection proportion (%)
Student age < 21 years	167	11	6.6	11	10	91.0
Student age 21–23 years	277	14	5.1	14	10	71.4
Student age 24–30 years	121	12	9.9	12	6	50.0
Total	565	37	6.6	37	26	70.3

HIV: human immunodeficiency virus; MSM: men who have sex with men.

HIV prevalence and recent infection proportion among college student MSM with different age groups

HIV prevalence was 6.6% (11/167) in the subgroup of age < 21 years, 5.1% (14/277) in the subgroup of age between 21 and 23 years, and 9.9% (12/121) in the subgroup of age between 24 and 30 years. The proportion of HIV recent infection was 91.0% (10/11) in the subgroup of age < 21 years, 71.4% (10/14) in the subgroup of 21 to 23 years, and 50.0% (6/12) in the subgroup of age 24 to 30 years [Table 3].

Associations of recent HIV infection in college student MSM, NSYM and NSNYM

The hierarchical linear modeling among college student MSM showed that the usage of recreational drug in the past six months associated with higher risk for recent infection of HIV (OR: 2.5; 95% CI: 1.0–5.9, $P = 0.038$).

NSYM with the following characteristics had an increased odds for recent infection of HIV: self-reported STI symptoms in the past year (OR: 2.3; 95% CI: 1.1–5.2, $P = 0.030$); anal bleeding (AOR: 2.2; 95% CI: 1.2–4.0, $P = 0.011$); syphilis infection (OR: 3.3; 95% CI: 1.7–6.3, $P < 0.001$).

NSNYM with the following characteristics had higher risk of recent infection of HIV: more than two male sexual partners in the past six months (OR: 1.7; 95% CI: 1.1–2.5, $P = 0.016$); had used recreational drug in the past six months (OR: 1.8; 95% CI: 1.1–2.9, $P = 0.021$). NSNYM with higher education years had lower risk of recent infection of HIV (OR: 2.0; 95% CI: 1.2–3.4, $P = 0.007$) [Table 4].

Discussion

We clarified a higher proportion of HIV recent infection and TDR among college student MSM in China during 2012 to 2013, and the propellers behind this epidemic. This study provides reference and suggestions for the evaluation of the current HIV control among youth and student MSM in China.

We revealed a higher proportion of HIV recent infection in college student MSM than the other MSM in China. This high proportion of recent infection was in accordance with the recent increase in HIV prevalence and national newly reported HIV cases among student MSM in China.^[5,34]

The HIV incidence in college student MSM found in this study was higher than that for young MSM (10.0 vs. 2.9–4.1/100 PY) in the U.S. in 2008 and 2015,^[35,36] also higher than the HIV incidence of the general MSM population (10.0 vs. 6.7/100 PY) in China in 2011.^[37] This data is valuable as the reference and evidence to the conclusion of the effect of HIV epidemic control among this subpopulation today.

We also found that the proportion of recent HIV infection decreased with age increase among college student MSM. This suggests that the HIV sero-conversion were more likely to happen at early time of the college life. Most of them would carry and transmit HIV unknowingly for a long time until diagnosis, considering the low HIV testing rate among MSM population in China. The median age of first anal intercourse for MSM in China has significantly decreased, from 33-year-old for those born during 1940–1959 to 18-year-old for those born during 1990–1996.^[38] According to our results, the first homosexual anal intercourse among college student MSM are more likely to happen before 18-year-old, compared to NSNYM. Unfortunately, sexual health education has not kept pace with the trend of decreasing age of male-male sexual behaviors debut in China, rather it has lagged behind.^[6] The higher proportion of HIV recent infections on early year of campus life among student MSM suggests that sexual health education should be provided as early as possible during college, or preferably in high school, as soon as youth become sexually active.

Independent factors associated with HIV recent infection among college student MSM were usage of recreational drug in the past six months. While anal bleeding, self-reported symptoms of STIs, syphilis infections and more male sexual partners associated with HIV recent infections in NSYM and NSNYM. The most popular recreational drug used among Chinese MSM is rush poppers,^[39] which can reduce anal pain during anal intercourse and prolong anal intercourse. Usage of recreational drug is correlated with condomless anal intercourse and group sex.^[40,41] Therefore, recreational drug increases the risk of HIV infection. Meanwhile, syphilis is the most prevalent ulcerative STI among MSM in China,^[42] and mucosa ulceration increases the risk of HIV infection. According to our results, syphilis infection significantly correlated with recent HIV infection in all three subgroups of our study participants, which underlined the important role of STIs testing and treatment in HIV control. According to above findings, HIV prevention measures targeting college student MSM should focus on intervention regarding recreational drug (particularly rush poppers) use, safe sex

Table 4: Hierarchical linear modeling of factors associated with recent HIV infection in college student, NSYM, and NSNYM in China, 2012–2013 (N = 4496).

Variable	MSM (n = 565)			NSYM (n = 1094)			NSNYM (n = 2837)		
	Recent infection, n (%)	OR (95% CI)	P	Recent infection, n (%)	OR (95% CI)	P	Recent infection, n (%)	OR (95% CI)	P
Study sites level									
Cumulative number of reported HIV/AIDS cases in the province	–	1.00 (1.00–1.00)	0.211	–	1.00 (1.00–1.00)	0.899	–	1.00 (1.00–1.00)	0.904
Proportion of homosexual transmission of above cases	–	0.97 (0.91–1.02)	0.155	–	0.99 (0.94–1.04)	0.645	–	0.97 (0.93–1.01)	0.130
Individual level Using Internet as main venue of seeking sexual partners									
Yes	22 (5.3)	2.18 (0.70–6.77)	0.179	48 (6.5)	1.19 (0.61–2.32)	0.606	60 (3.5)	0.81 (0.50–1.30)	0.378
No	4 (2.7)	1.0		17 (4.8)	1.0		35 (3.1)	1.0	
Main sexual position									
Bottom or both	13 (7.9)	1.09 (0.38–3.11)	0.870	52 (6.4)	1.23 (0.63–2.40)	0.535	74 (3.9)	2.02 (1.22–3.36)	0.007
Top	13 (5.4)	1.0		13 (4.7)	1.0		21 (2.3)	1.0	
Had anal bleeding*									
Yes	8 (6.3)	1.56 (0.59–4.14)	0.375	24 (10.9)	2.19 (1.20–4.02)	0.011	17 (4.9)	1.18 (0.66–2.12)	0.572
No	18 (4.1)	1.0		41 (4.7)	1.0		78 (3.1)	1.0	
Had CAI in last anal sex*									
Yes	21 (5.3)	1.78 (0.62–5.15)	0.285	44 (5.6)	0.90 (0.51–1.58)	0.711	64 (3.1)	0.76 (0.49–1.20)	0.237
No	5 (3.0)	1.0		21 (6.8)	1.0		31 (4.0)	1.0	
Had > 2 male sexual partners*									
Yes	11 (6.6)	1.29 (0.55–3.06)	0.560	29 (6.4)	1.00 (0.58–1.72)	0.992	52 (4.5)	1.66 (1.08–2.54)	0.016
No	15 (3.8)	1.0		36 (5.6)	1.0		43 (2.6)	1.0	
Had used recreational drug use*†									
Yes	11 (7.5)	2.47 (1.05–5.84)	0.038	28 (7.8)	1.36 (0.78–2.38)	0.278	33 (4.3)	1.82 (1.14–2.90)	0.021
No	15 (3.6)	1.0		37 (5.0)	1.0		62 (3.0)	1.0	
Had sold sex*									
Yes	2 (18.2)	0.26 (0.05–1.50)	0.131	4 (2.9)	1.28 (0.47–3.47)	0.625	7 (3.3)	1.15 (0.49–2.69)	0.752
No	24 (4.3)	1.0		61 (6.2)	1.0		88 (3.4)	1.0	
Had STI symptoms in past 12 months									
Yes	1 (2.3)	0.27 (0.03–2.32)	0.230	12 (15.6)	2.33 (1.09–5.02)	0.030	7 (4.5)	1.13 (0.50–2.56)	0.769
No	25 (4.8)	1.0		53 (5.2)	1.0		88 (3.3)	1.0	
Currently syphilis infected‡									
Yes	3 (13.0)	2.68 (0.65–10.96)	0.170	16 (16.8)	3.26 (1.70–6.25)	<0.001	14 (5.3)	1.67 (0.92–3.03)	0.094
No	23 (4.2)	1.0		49 (4.9)	1.0		81 (3.1)	1.0	

* In the past 6 months. † Recreational drugs included poppers (alkyl nitrites), ecstasy, ice (methamphetamine), amphetamine, tramadol, and ketamine. ‡ Currently syphilis infected was defined as positive for both rapid plasma reagent test and Treponema pallidum particle assay. CI: 95% confidence interval; NSYM: none student young MSM (<25 years old); NSNYM, none student none young MSM (≥25 years old); CAI: condomless anal intercourse; STI: sexually transmitted infections.

and promotion of testing. The distribution of vending machines with self-testing kits for HIV on campus is worthwhile.^[43]

The higher rate of TDR among college student MSM indicates the more negative influence on their prognosis when receiving ART. Currently, China still does not provide free TDR testing for HIV-infected patients before initiation of ART in the national level. The TDR testing is only provided for individuals who are fail to respond to ART. Our results emphasized the importance of TDR test before ART for college student MSM who are diagnosed

with HIV, as the current first-line treatment regimen in China may be ineffective for them.

This data report proportion of HIV recent infection and incidence rate among college student MSM in China, which has the importance to differential trajectories of HIV risk and transmission in terms of the life course history. As the high proportion of HIV recent infection of college student MSM five years ago to be unraveled, it has facilitated understanding of the growing HIV epidemic among college student MSM in China today. This data is valuable as the reference to the conclusion of the effect of

HIV epidemic control among this subpopulation today. It also addresses the importance of HIV and TDR testing among young MSM to support them in working toward early diagnose and adherent to early ART treatment.

The limitations of this study should also be considered. The findings are not representative of the current HIV epidemic in the country and extrapolation of the results requires caution. The relatively small sample size for drug resistance testing could have led to type two statistical errors, and a larger scale study should be implemented. The testing methodology for HIV recent infection has emerged in recent years, future study of incidence should apply latest technique such as Limiting Antigen (LAG)-Avidity EIA. Finally, data about sensitive issues, such as recreational drug use behavior and CAI, were acquired by self-reporting; therefore, we cannot exclude the influence of social expectation bias.

Overall, this data clarified a high proportion of HIV recent infection and TDR among college student MSM in China during 2012–2013. The HIV infections were more likely to happen during the early year of college life among student MSM. The TDR testing should be considered for HIV diagnosed student MSM.

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Conflicts of interest

None.

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