Published in final edited form as:

Infect Genet Evol. 2015 April ; 31: 135–141. doi:10.1016/j.meegid.2015.01.022.

Epidemiological and Molecular Characteristics of HIV Infection among Money Boys and General Men Who Have Sex with Men in Shanghai, China

Huamei Yan^{a,†}, Yingying Ding^{a,†}, Frank Y. Wong^{b,c,d}, Zhen Ning^{a,e}, Tony Zheng^f, Eric J. Nehl^b, and Na He^{a,b,*}

^aDepartment of Epidemiology, School of Public Health, Fudan University, and The Key Laboratory of Public Health Safety of Ministry of Education, Shanghai, China

^bDepartment of Behavioral Sciences and Health Education, Rollins School of Public Health, Emory University, Atlanta, GA, USA

^cThe Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA

^dDepartment of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, GA, USA

^eShanghai Center for Disease Control and Prevention, Shanghai, China

^fShanghai Piaoxue Cultural Media Limited, Shanghai, China

Abstract

To examine and compare the epidemiological and molecular characteristics of HIV infection between money boys (MBs) and general men who have sex with men (MSM) in Shanghai, China. Using a venue-based sampling strategy, a total of 535 MSM including 226 MBs and 309 general MSM were recruited to participate in a cross-sectional survey including a face-to-face questionnaire interview and HIV testing. Genotyping of HIV-1 *pol* gene was performed for HIV-positive participants. Compared with general MSM, MBs reported more sexual partners, more alcohol and drug use and more sex after alcohol or drug use. HIV prevalence was 10.7% overall, 14.6% for MBs and 7.8% for general MSM ($p=0.011$). Two independent multiple logistic

© 2015 Published by Elsevier B.V.

*Corresponding author: Na He, M.D., Ph.D., Professor, Department of Epidemiology, School of Public Health, Fudan University, and The Key Laboratory of Public Health Safety of Ministry of Education, Shanghai 200032, China. Tel/Fax: +86-21-54237519. nhe@shmu.edu.cn.

[†]Equally contributed first authors.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Sequence data

GenBank accession numbers are KP418582 to KP418633.

Competing interests

We confirm that there are no conflicts of interest associated with this publication and there has been no significant financial support for this study that could have influenced its outcome. The manuscript has been read and approved by all authors.

regression analyses indicated that HIV infection was positively associated with non-Han ethnicity (Odds Ratio [OR]=4.79, 95% Confidence Interval [CI]: 1.08–21.28) and sex after drug use in the past 6 months (OR=3.59, 95%CI: 1.50–8.61) among MBs, and with sex after drug use in the past 6 months (OR=3.38, 95%CI: 1.10–10.34) among general MSM as well. HIV-1 pol gene was successfully amplified and sequenced for 52 (91.2%) of HIV-positive participants. Of them, 53.8% were genotyped as CRF01_AE, 36.5% as CRF07_BC and 9.6% as subtype B. Two CRF01_AE subtype-infected participants (3.8%), a 50 years old MB and a 24 years old general MSM, harbored viruses with a M46L mutation conferring resistance to protease inhibitors (PI). MSM particularly MBs in Shanghai, China were at high risk of HIV infection, underscoring an urgent need for joint intervention efforts for drug use and sexual behaviors. HIV drug resistance surveillance is also warranted although the relatively low prevalence of HIV drug resistance implies the effectiveness of current antiretroviral treatment regimen.

Keywords

HIV infection; Genotype; Drug resistance; MSM; Money boys

1. Introduction

A growing body of studies indicates that men who have sex with men (MSM) in China are at high risk of HIV infection (Wong et al., 2009; Zhang et al., 2012). Statistics also show that the proportion of newly reported HIV cases attributable to male homosexuality in China has increased sharply from 2.5% in 2006 to 13.7% in 2011 (Ministry of Health of the people's Republic of China, 2012; Hei et al., 2012). However, MSM have accounted for more than 50% of newly reported HIV cases in Shanghai, China, since 2013 (Shanghai Center for Disease Control and Prevention, 2013). Furthermore, a special group of MSM who sell sex to other MSM, i.e., 'money boys' (MBs), have been noted to be at even higher risk of HIV infection than general MSM (He et al., 2007a; 2007b; Wong et al., 2008). The rapid increase of HIV among MSM population in China is attributed to increasing acceptance of homosexuality, quickly growing social network of MSM, and also stigma and discrimination as barriers to HIV services (Feng et al., 2010a; Ye et al., 2012).

In China, the predominant HIV-1 subtypes are CRF01_AE, CRF07_BC, CRF08_BC, B' and B (Liao et al., 2010; Tao et al., 2014; Yu et al., 2011), with considerable variations by geographic region and HIV transmission mode (Chen et al., 2013; Han et al., 2013; Li et al., 2012; Tao et al., 2014). Non-B subtypes including CRF01_AE and CRF07_BC have rapidly increased among MSM in China (Shao et al., 2013; Wang et al., 2008; 2011; Zhang et al., 2007). However, such data are not available for MSM in Shanghai.

China is scaling up the Free Antiretroviral Treatment (ART) Program for HIV-infected individuals. In particular, MSM are encouraged to receive ART as soon as they are confirmed to be HIV positive, without regard to AIDS stage. This has raised concerns about emergence and transmission of HIV drug resistance (HIVDR). The limited existing literature indicates that the prevalence of HIVDR among newly diagnosed or ART-naïve HIV-infected MSM ranged from 4.5% to 14.6% (Li et al., 2013; Yang et al., 2013; Zhao et

al., 2011; 2012). However, no such research has been specifically conducted examining HIVDR among MSM including MBs in Shanghai.

To fill these gaps, a cross-sectional study was designed to examine and compare epidemiological and molecular characteristics of the HIV infection between MBs and general MSM in Shanghai. Knowledge gained from this study would be useful for developing better prevention and treatment programs of HIV in MSM population in Shanghai.

2. Materials and methods

2.1. Participants and procedures

This cross-sectional survey was conducted by using a venue-based (including bar, bathhouse and internet) sampling design to recruit study subjects in Shanghai, China from April, 2012 to March, 2013. To be eligible, participants must have been at least 18 years old, self-identified as a male, and engaged in anal and/or oral sex with another man in the past 12 months, ART-naïve (for those with known HIV-positive status) and been able to provide written consent in Mandarin. Face-to-face questionnaire interviews were administered by public health practitioners who were experienced in working with MSM and were trained in questionnaire interviews. Each questionnaire interview took approximately 30 to 45 minutes. Participants were given \$30 for reimbursement. A written consent form was obtained from each participant who also received a copy of the signed consent form. This study was approved by the Institutional Review Board (IRB) of Emory University, the United States of America and the IRB of Fudan University, China.

2.2. Measures

2.2.1. Demographics—Personal demographic characteristics included age, ethnicity, education level, marital status, occupation, monthly individual income, and self-identified sexual orientation.

2.2.2. Sexual behaviors—Participants were asked how many male and female sex partners they had in the past 30 days. They were also asked the following behaviors during the past 6 months prior to the interview: ever having anal sex and ever not using condoms during anal sex, ever having sexual sex after drinking alcohol, and ever having sex after using drugs. Other variables included age at first sex with man, history of HIV testing (ever vs. never) and receiving a HIV diagnosis (positive vs. negative).

2.3. HIV testing

Serum samples were screened for anti-HIV IgG antibody using an ELISA technique (Kehua Biotechnology Co. Ltd., Shanghai, China) according to the manufacturer's instructions. Any sample that screened positive for HIV was subject to another antibody testing with another HIV diagnostic kit using ELISA tests, the sample was then confirmed by a western blot assay (HIV BLOT 2.2; Genelabs Diagnostics Pte Ltd., Singapore).

2.4. HIV viral RNA extraction and amplification

Plasma was separated from the whole blood within two hours after collection and stored at -70°C until use. HIV Viral RNA was extracted from plasma samples using High Pure Viral Nucleic Acid Kit (Roche Inc., Mannheim, Germany) according to the manufacturer's instructions. The HIV-1 *pol* gene (protease 1–99 amino acids and part of reverse transcriptase 1–300 amino acids) was amplified by using an in-house nested reverse transcription polymerase chain reaction (RT-PCR) method. The target sequence was amplified with TaKaRa One-Step RNA PCR kit (TaKaRa Biotechnology, Dalian, China) using primers MAW26 (5'-TTGGAAATGTGGAAAG GAAGGAC-3') and RT21 (5'-CTGTATTTCTGCTATTAAGTCTTTTGATGGG-3') in a 25 μl reaction. Cycling conditions were 50°C for 30 min and 94°C for 5 min in first-round RT-PCR, followed by 35 cycles at 94°C for 30 s, 55°C for 30 s, 72°C for 2 min, and an extension at 72°C for 10 min. The nested PCR was performed using Takara Ex Taq PCR kit (TaKaRa Biotechnology, Dalian, China), using primers PRO-1 (5'-CAGAGCCAACAGCCCCACCA-3') and RT20 (5'-CTGCCAGTTC TAGCTCTGCTTC-3') in a 50 μl reaction and the cycling conditions were 94°C for 5 min in first-round RT-PCR, followed by 30 cycles at 94°C for 30 s, 63°C for 30 s, 72°C 2.5 min, and an extension at 72°C for 10 min.

2.5. Genotyping of HIVDR

Bi-directional sequences were obtained in the region of interest for all samples analyzed in this study. For quality control, mutations presented as amino acid mixtures were identified only if the corresponding nucleotide mixture was present in the sequences of both DNA strands. The sequences of those amplified fragments were edited using the software Lasergene DNASTAR (DNASTAR Inc., Wisconsin, USA). HIVDR and the susceptibility of the viruses to ARTs were interpreted with both the Stanford HIV Drug Resistance Database (<http://hivdb.stanford.edu>) and the Surveillance Drug Resistance Mutations (SDRM) list recommended by WHO (Bennett et al., 2009).

2.6. HIV-1 Subtyping

The determination of HIV-1 subtypes was accomplished by submitting the obtained *pol* sequences including the entire PR gene and a part of RT gene (1316 bp) to the HIV BLAST subtyping tool (<http://www.hiv.lanl.gov>) for phylogenetic analysis. The subsequent detailed phylogenetic analysis was done using Molecular Evolutionary Genetics Analysis (MEGA) software, version 5.1. The recommended HIV-1 subtype reference sequences available at the Los Alamos HIV sequences database (www.hiv.lanl.gov) were used. The phylogenetic reconstruction was performed using the neighbor-joining method based on the Kimura two-parameter distance model with 1000 bootstrapped data-sets.

2.7. Data analysis

SPSS version 17.0 was utilized for statistical analyses. Chi-square test or Fisher's exact were used where appropriate to compare the differences in sociodemographic characteristics and sexual behaviors between MBs and general MSM. Univariate and multivariate logistic regression were performed separately for MBs and general MSM to examine correlates of HIV-1 infection. HIVDR mutations were grouped according to whether they could

potentially confer resistance to nucleotide reverse transcriptase inhibitors (NRTI), non-nucleotide reverse transcriptase inhibitors (NNRTI) or protease inhibitors (PI). A p -value <0.05 was considered to be significant.

3. Results

3.1. Sociodemographic characteristics

A total of 535 participants including 226 MBs and 309 general MSM were included. As shown in Table 1, the majority of them were younger than 35 years (71.6%), non-Shanghai residents (76.3%), ethnic Han (94.6%), had monthly income less than 5,000 Yuan RMB (approximately US\$850, 66.5%), and were self-identified as gay (64.1%). MBs and general MSM were statistically different in age, residency status, education and monthly income ($p<0.05$).

3.2. Sexual behaviors

Thirty-eight (16.8%) MBs reported having had sex with a female partner in the past 30 days, including 5.8% (8/140) of gay-identified MBs and 34.9% (30/86) of non-gay-identified MBs (Chi-square test, $X^2=31.80$, $p<0.001$); whereas 63 (20.4%) general MSM reported having had sex with a female partner in the past 30 days, including 8.0% (16/203) of gay-identified general MSM and 44.3% (47/106) of non-gay-identified general MSM (Chi-square test, $X^2=55.60$, $p<0.001$).

The mean age at first sex with man was 20.9 years (SD: 6.0) overall and was not significantly different between MBs (20.6 $\pm$ 6.0) and general MSM (21.2 $\pm$ 6.0) (t-test = -1.22, $p=0.224$). Compared with general MSM, MBs were more likely to have a larger number of male sex partners in the past 30 days, and were more likely to report having had anal sex, sex after drinking alcohol and sex after using drugs in the past 6 months (Table 1). About 71.8% participants have tested for HIV prior to the interview, but only 7 reported a HIV-positive result.

3.3. Prevalence and correlates of HIV infection

The prevalence of HIV infection was 10.7% (57/535) overall, 14.6% (33/226) for MBs and 7.8% (24/309) for general MSM (Chi-square test, $X^2=6.41$, $p=0.011$). Table 2 presented results of logistic regression analyses. Univariate analysis indicated that among MBs, HIV infection was significantly associated with age, ethnicity, self-identified sexual orientation, and sex after using drugs in the past 6 months. Multivariate analysis indicated that after adjusting for potential confounders, HIV infection was positively associated with non-Han ethnicity (OR 4.79, 95%CI: 1.08–21.28) and sex after using drugs in the past 6 months (OR3.59, 95%CI: 1.50–8.61).

Among general MSM, univariate analysis demonstrated that HIV infection was significantly associated with monthly income and sex after using drugs in the past 6 months. After adjusted for potential confounders in the multivariate analysis, general MSM who had sex after using drugs in the past 6 months were more likely to be infected with HIV (OR3.38, 95%CI: 1.10–10.34) than others.

3.4. HIV molecular characteristics

3.4.1. HIV-1 subtypes—Of 57 HIV-1 positive participants, 52 (91.2%) including 30 MBs and 22 general MSM were successfully genotyped for the HIV-1 *pol* gene. Among them, 28 (53.8%) including 15 MBs and 13 general MSM were infected with CRF01_AE, 19 (36.5%) including 14 MBs and 5 general MSM were infected with CRF07_BC, and 5 (9.6%) including 1 MB and 4 general MSM were infected with subtype B. Phylogenetic trees of these HIV subtypes are presented in Figure 1.

3.4.2. HIVDR mutations—Among 52 participants with their HIV-1 *pol* gene sequenced, 2(3.8%) were found to harbor viruses with drug resistance mutations. Both were of CRF01_AE subtype with PI-related major mutation, M46L, which confers resistance to nelfinavir (NFV) and other protease inhibitors. One was a 50 years old money boy, and another was a 24 years old general MSM. No NRTI-or NNRTI-related drug resistance mutations were found.

Several minor mutations were detected in the protease (PR) region of the *pol* gene: L10I (3.8%), V11I (1.9%), L33F (1.9%) and A71T/V (17.3%); and several others were detected in the reverse transcriptase (RT) region of the *pol* gene: T69A (1.9%), V118I (11.5%), L210M (1.9%), V179I (11.5%) and K101Q (1.9%).

4. Discussion

HIV prevalence among general MSM in Shanghai was comparable with that in Beijing, the capital city of China, but was lower than that in Sichuan and Guangxi provinces in Southwest China (Song et al., 2013; Tao et al., 2013; Zhao et al., 2014). However, HIV prevalence among MBs was almost two times higher than that among general MSM. This was consistent with findings from previous studies in China (Bai et al., 2014; Feng et al., 2010), further suggesting that MSM especially those engaging in commercial sex are at highest risk of HIV infection.

MBs with a non-Han ethnic minority were at higher risk of HIV infection than those with Han ethnicity which is the main ethnicity of Chinese. But such differential HIV risks between different ethnicities were not observable among general MSM. This is very likely due to the fact that most general MSM in the study were local Shanghai residents whereas most MBs were non-Shanghai migrants. Some of these MBs might come from provinces where certain ethnic minorities were at a disproportionately high risk of HIV infection (Ministry of Health in People's Republic of China, 2011)

Although there is little research examining drug use and HIV infection among Chinese MSM, international research consistently documents the relationships between drug use, sexual risk taking, and the transmission of HIV and other STIs (Carey et al., 2009; Mathers et al., 2008; Van Tieu et al., 2009). In the present study, having sex after using drugs was positively associated with HIV infection among both MBs and general MSM. This underscores urgent needs of joint intervention efforts for drug use and risky sexual behaviors among MSM in China. Furthermore, given that MBs use drugs more often and have sex

more often after using drugs than general MSM (Chow et al., 2012; Nehl et al., 2014), such intervention efforts should be oriented differentially for MBs and general MSM.

The B, CRF-01AE and CRF-BC are the predominant HIV subtypes in China (Yu et al., 2011), but there are some variations in different transmission routes. For IDUs or heterosexually transmitted infections, subtype C (Chen et al., 2012a) or CRF-08BC/07BC (Chen et al., 2013) was found to be the predominant strain in Yunnan province. For Chinese MSM, studies in different regions in China showed that CRF01_AE was currently the predominant HIV subtype among MSM (Chen et al., 2013; Han et al, 2013; Li et al., 2011; 2012; Zhao et al., 2011), as our data indicated. But we found that CRF07_BC was more common than subtype B. This was also consistent with other studies indicating a decreasing trend of subtype B and increasing trend of CRF01_AE and CRF07_BC among Chinese MSM (Chen et al., 2014; Han et al., 2013; Wang et al., 2013). Prior studies have also identified some types of novel HIV-1 circulating recombinant forms (CRF) among Chinese MSM who were exposed to multiple HIV-1 variants or subtypes through risky sexual behaviors (Chen et al., 2012b; Han et al., 2013; Wei et al., 2013). We didn't identify any novel HIV-1 CRF, probably due to a relatively small sample of HIV-positive participants. However, given high prevalence of risky sexual behaviors among MSM particularly MBs, the occurrence of novel HIV-1 CRF in this high risk population is foreseeable.

Compared with other regions in China (Chen et al., 2014; Dai et al., 2014; Li et al., 2013), the prevalence of HIVDR among the newly diagnosed HIV-infected MSM in this study was relatively low, suggesting that current ART regimen be likely to remain effective for HIV-infected MSM in Shanghai. However, given the complexity of sexual behavioral networks of MSM, the occurrence of HIVDR following ART scaling up in this population cannot be neglected and warrants routine HIVDR surveillance. Furthermore, although PIs are not included in the first-line free ART and its use is very limited in China, only PI-related HIVDR was identified in the study. This might suggest a possibility of sexual promiscuity of the MSM participants with MSM from other regions or countries where PIs are used widely.

The study has certain limitations. First, subjects were recruited through venue-based sampling, which may have led to selection bias. Second, the sensitive nature of the questions related to sexual behaviors might lead to information bias due to the social desirability, for example, underreporting the number of sexual partners and over reporting the rates of condom use. Third, our data may not fully represent the molecular characteristics of HIV infection among the MSM population in Shanghai due to the relatively small number of HIV positive participants.

Despite these potential limitations, the study findings have important implications for HIV prevention intervention and treatment for MSM in Shanghai, China. First of all, although both MBs and general MSM are at high risk of HIV infection, these two groups are different in many aspects of HIV risks and are therefore subject to differential and tailored prevention and intervention efforts. Second, the prevalence of HIVDR was relatively low and the identifiable HIVDR mutation was related only to PIs which are not among the inventory of first line antiretroviral drugs in China, suggesting that current ART regimens remain effective for this population. However, given high rates of reported multiple sex partners and

high prevalence of HIV infection among the MSM population, there is urgent need of HIV prevention programs as well as drug resistance surveillance among this population.

Acknowledgements

The study was supported by grants from the U.S. National Institute of Child Health and Human Development (grant no. R01HD056956), the Chinese National Major Science & Technology Project of Infectious Diseases (grant no. 2012ZX10001007-006) and the Shanghai Municipal Health Bureau (grant no. XBR2011043).

References

- Bai X, Xu J, Yang J, Yang B, Yu M, Gao Y, Dong WM, Wu Z. HIV prevalence and high-risk sexual behaviours among MSM repeat and first-time testers in China: implications for HIV prevention. *J. Int. AIDS Soc.* 2014; 17:18848. [PubMed: 24993457]
- Bennett DE, Camacho RJ, Otelea D, Kuritzkes DR, Fleury H, Kiuchi M, Heneine W, Kantor R, Jordan MR, Schapiro JM, Vandamme AM, Sandstrom P, Boucher CA, van de Vijver D, Rhee SY, Liu TF, Pillay D, Shafer RW. Drug resistance mutations for surveillance of transmitted HIV-1 drug-resistance; 2009 update. *PLoS One.* 2009; 4:e4724. [PubMed: 19266092]
- Carey JW, Mejia R, Bingham T, Ciesielski C, Gelaude D, Herbst JH, Sinunu M, Sey E, Prachand N, Jenkins RA, Stall R. Drug use, high-risk sex behaviors, and increased risk for recent HIV infection among men who have sex with men in Chicago and Los Angeles. *AIDS Behav.* 2009; 13:1084–1096. [PubMed: 18498049]
- Chen, M.; Yao, ST.; Ma, YL.; He, X.; Wang, JB.; Cheng, CL.; Yang, J.; Su, YZ.; Li, YL.; Duan, S.; Chen, HC.; Fu, LR.; Jia, MH.; Lu, L. *Zhonghua Liu Xing Bing Xue Za Zhi.* Vol. 33. Chinese: 2012a. Distribution of HIV-1 subtypes among different populations in Dehong prefecture, Yunnan province, in 2011; p. 883-887.
- Chen M, Ma Y, Duan S, Xing H, Yao S, Su Y, Luo H, Yang L, Chen H, Fu L, Qu A, Ou CY, Jia M, Lu L. Genetic diversity and drug resistance among newly diagnosed and antiretroviral treatment-naïve HIV-infected individuals in western Yunnan: a hot area of viral recombination in China. *BMC Infect. Dis.* 2012b; 12:382. [PubMed: 23270497]
- Chen M, Yang L, Ma Y, Su Y, Yang C, Luo H, Chen H, Chen L, Yan W, Shi Y, Jia M, Lu L. Emerging variability in HIV-1 genetics among recently infected individuals in Yunnan, China. *PLoS One.* 2013; 8:e60101. [PubMed: 23555898]
- Chen M, Ma Y, Su Y, Yang L, Zhang R, Yang C, Chen H, Yan W, Shi Y, Dong L, Chen L, Jia M, Lu L. HIV-1 genetic characteristics and transmitted drug resistance among men who have sex with men in Kunming, China. *PLoS One.* 2014; 9:e87033. [PubMed: 24489829]
- Chow EP, Iu KI, Fu X, Wilson DP, Zhang L. HIV and sexually transmissible infections among money boys in China: a data synthesis and meta-analysis. *PLoS One.* 2012; 7:e48025. [PubMed: 23209551]
- Dai L, Li N, Wei F, Li J, Liu Y, Xia W, Zhang T, Guo C, Wang W, Schwartz SA, Mahajan SD, Hsiao CB, Wu H. Transmitted antiretroviral drug resistance in the men who have sex with men HIV patient cohort, Beijing, China, 2008–2011. *Viral Immunol.* 2014; 27:392–397. [PubMed: 25084305]
- Feng Y, Wu Z, Detels R. Evolution of men who have sex with men community and experienced stigma among men who have sex with men in Chengdu, China. *J Acquir Immune Defic Syndr.* 2010a; 53(Suppl 1):S98–S103. [PubMed: 20104118]
- Feng Y, Wu Z, Detels R, Qin G, Liu L, Wang X, Wang J, Zhang L. HIV/STD prevalence among men who have sex with men in Chengdu, China and associated risk factors for HIV infection. *J Acquir. Immune Defic. Syndr.* 2010b; 53(Suppl 1):S74–S80. [PubMed: 20104114]
- Han X, An M, Zhang W, Cai W, Chen X, Takebe Y, Shang H. Genome sequences of a novel HIV-1 circulating recombinant form, CRF55_01B, identified in China. *Genome Announc.* 2013; 1 e00050–12.
- Han X, An M, Zhang M, Zhao B, Wu H, Liang S, Chen X, Zhuang M, Yan H, Fu J, Lu L, Cai W, Takebe Y, Shang H. Identification of 3 distinct HIV-1 founding strains responsible for expanding

- epidemic among men who have sex with men in 9 Chinese cities. *J. Acquir. Immune Defic. Syndr.* 2013; 64:16–24. [PubMed: 23542640]
- He N, Wong FY, Huang ZJ, Ding Y, Fu C, Smith BD, Young D, Jiang Q. HIV risks among two types of male migrants in Shanghai, China: money boys vs. general male migrants. *AIDS.* 2007a; 21(Suppl 8):S73–S79. [PubMed: 18172395]
- He N, Wong FY, Huang ZJ, Thompson EE, Fu C. Substance use and HIV risks among male heterosexual and 'money boy' migrants in Shanghai, China. *AIDS Care.* 2007b; 19:109–115. [PubMed: 17129865]
- Hei, F.; Wang, L.; Qin, Q.; Wang, L.; Guo, W.; Li, D.; Ding, Z. *Zhong hua Liu Xing Bing Xue Za Zhi.* Vol. 33. Chinese: 2012. Epidemic characteristics of HIV/AIDS among men who have sex with men from 2006 to 2010 in China; p. 67-70.
- Liao L, Xing H, Shang H, Li J, Zhong P, Kang L, Cheng H, Si X, Jiang S, Li X, Shao Y. The prevalence of transmitted antiretroviral drug resistance in treatment-naïve HIV-infected individuals in China. *J. Acquir. Immune Defic. Syndr.* 2010; 53(Suppl 1):S10–S14. [PubMed: 20104099]
- Li L, Sun G, Li T, Liu Y, Chen L, Liu H, Cui W, Li H, Zhuang D, Wang Z, Li J. Multiple introductions of HIV into men who have sex with men were found in Zhengzhou City, China. *AIDS Res. Hum. Retroviruses.* 2012; 28:1147–1151. [PubMed: 22236149]
- Li L, Han N, Lu J, Li T, Zhong X, Wu H, Rayner S, Chen L, Liu Y, Wang X, Li H, Li J. Genetic characterization and transmitted drug resistance of the HIV type 1 epidemic in men who have sex with men in Beijing, China. *AIDS Res. Hum. Retroviruses.* 2013; 29:633–637. [PubMed: 23121221]
- Li L, Lu X, Li H, Chen L, Wang Z, Liu Y, Bao Z, Li T, Tian C, Liu H, Zhuang D, Liu S, Li J. High genetic diversity of HIV-1 was found in men who have sex with men in Shijiazhuang, China. *Infect. Genet. Evol.* 2011; 11:1487–1492. [PubMed: 21645646]
- Ministry of Health in People's Republic of China, Joint United Nations Programme on HIV/AIDS, World Health Organization. 2011 Estimates for the HIV/AIDS Epidemic in China. China: Beijing; 2011.
- Ministry of Health of the People's Republic of China. 2012 China AIDS Response Progress Report. China: Beijing; 2012.
- Nehl EJ, He N, Lin L, Zheng T, Harnisch JA, Ding Y, Wong FY. Drug use and sexual behaviors among MSM in China. *Subst. Use. Misuse.* 2014 [Epub ahead of print].
- Shanghai Center for Disease Control and Prevention. The obvious progress and remarkable achievement in HIV prevention in Shanghai, China. 2013 Available at: <http://www.scddc.sh.cn/b/21344.shtml>.
- Shao B, Li WJ, Liu T, Li QH, Li H, Chang ML, Huang CQ, Wang FX, Wang BY. Subtype B was the dominant strain among HIV type 1 infections except for the population of men who have sex with men in Harbin City, China. *AIDS Res. Hum. Retroviruses.* 2013; 29:1260–1264. [PubMed: 23734595]
- Song D, Zhang H, Wang J, Han D, Dai L, Liu Q, Yu F, Operario D, She M, Zaller N. Sexual risk behaviours and their correlates among gay and non-gay identified men who have sex with men and women in Chengdu and Guangzhou, China. *Int. J. STD AIDS.* 2013; 24:780–790. [PubMed: 23970588]
- Tao J, Ruan Y, Yin L, Vermund SH, Shepherd BE, Shao Y, Qian HZ. Sex with women among men who have sex with men in China: prevalence and sexual practices. *AIDS Patient Care STDS.* 2013; 27:524–528. [PubMed: 23931683]
- Tao YL, Zhao XT, Tang YF, He N. A systematic review of temporal and geographical distributions of HIV genotypes in China during 2000–2012. *Chin. J. Dis. Control Prev.* 2014; 17:1073–1082.
- Van Tieu H, Koblin BA. HIV, alcohol, and noninjection drug use. *Curr. Opin. HIV/AIDS.* 2009; 4:314–318.
- Wang W, Jiang S, Li S, Yang K, Ma L, Zhang F, Zhang X, Shao Y. Identification of subtype B, multiple circulating recombinant forms and unique recombinants of HIV type 1 in an MSM cohort in China. *AIDS Res. Hum. Retroviruses.* 2008; 24:1245–1254. [PubMed: 18834324]

- Wang W, Xu J, Jiang S, Yang K, Meng Z, Ma Y, Li M, Zhang X, Shao Y, Zhang F, Zhang X. The dynamic face of HIV-1 subtypes among men who have sex with men in Beijing, China. *Curr. HIV Res.* 2011; 9:136–139. [PubMed: 21361866]
- Wang HL, Ming L, Jang SL, Kan W, Zhang X, Shao Y, Xu J, Zhang X. The dynamics of HIV-1 subtypes among men who had sex with men from 2005–2009. *J. Patho. Biol.* 2013; 8:493–496.
- Wei H, Su L, Feng Y, He X, His J, Liang S, Shao Y. Near full-length genomic characterization of a novel HIV type 1 CRF07_BC/01_AE recombinant in men who have sex with men from Sichuan, China. *AIDS Res. Hum. Retroviruses.* 2013; 29:1173–1176. [PubMed: 23594292]
- Wiessing L, Hickman M, Strathdee SA, Wodak A, Panda S, Tyndall M, Toufik A, Mattick RP. Reference Group to the UN on HIV and Injecting Drug Use. 2008. Global epidemiology of injecting drug use and HIV among people who inject drugs: a systematic review. *Lancet.* 2007; 372:1733–1745. [PubMed: 18817968]
- Wong FY, Huang ZJ, He N, Smith BD, Ding Y, Fu C, Young D. HIV risks among gay-and non-gay-identified migrant money boys in Shanghai, China. *AIDS Care.* 2008; 20:170–180. [PubMed: 18293125]
- Wong FY, Huang ZJ, Wang W, He N, Marzzurco J, Frangos S, Buchholz ME, Young D, Smith BD. STIs and HIV among men having sex with men in China: a ticking time bomb? *AIDS Educ. Prev.* 2009; 21:430–446. [PubMed: 19842827]
- Yang J, Xing H, Niu J, Liao L, Ruan Y, He X, Feng Y, Li Z, Shao Y. The emergence of HIV-1 primary drug resistance genotypes among treatment-naïve men who have sex with men in high-prevalence areas in China. *Arch. Virol.* 2013; 158:839–844. [PubMed: 23224760]
- Ye S, Xiao Y, Jin C, Cassell H, Blevins M, Sun J, Vermund SH, Qian HZ. Effectiveness of integrated HIV prevention interventions among Chinese men who have sex with men: evaluation of a 16-city public health program. *PLoS One.* 2012; 7:e50873. [PubMed: 23300528]
- Yu X, Yuan L, Huang Y, Xu W, Fang Z, Liu S, Shao Y, Jiang S, Ma L. Susceptibility of HIV-1 subtypes B', CRF07_BC and CRF01_AE that are predominantly circulating in China to HIV-1 entry inhibitors. *PLoS One.* 2011; 6:e17605. [PubMed: 21412427]
- Zhang X, Li S, Li X, Xu J, Li D, Ruan Y, Xing H, Zhang X, Shao Y. Characterization of HIV-1 subtypes and viral antiretroviral drug resistance in men who have sex with men in Beijing, China. *AIDS.* 2007; 21(Suppl 8):S59–S65. [PubMed: 18172393]
- Zhang L, Chow EP, Wilson DP. Distributions and trends in sexual behaviors and HIV incidence among men who have sex with men in China. *BMC Public Health.* 2012; 12:546. [PubMed: 22828173]
- Zhao B, Han X, Dai D, Liu J, Ding H, Xu J, Chu Z, Bice T, Diao Y, Shang H. New trends of primary drug resistance among HIV type 1-infected men who have sex with men in Liaoning Province, China. *AIDS Res. Hum. Retroviruses.* 2011; 27:1047–1053. [PubMed: 21417755]
- Zhao J, Chen L, Cai WD, Tan JG, Tan W, Zheng CL, Cheng JQ, Yang ZR, He ML, Wang XR. HIV infection and sexual behaviors among non-commercial men who have sex with men at different venues. *Arch. Sex. Behav.* 2014; 43:801–809. [PubMed: 23982566]
- Zhao GL, Yu W, Cai YM, Tan J, Tan W, Zheng CL, Cheng JQ, Yang ZR, He ML, Wang XR. Primary drug resistance of HIV-1 infected men who have sex with men in Shenzhen, China. *Zhong hua Yi Xue Za Zhi.* 2012; 92:1165–1169.

Highlights

- HIV prevalence among MBs was almost two times higher than that among general MSM.
- CRF01_AE was currently the predominant HIV subtype among MSM in Shanghai and CRF07_BC was more common than subtype B.
- The prevalence of HIVDR was relatively low and the identifiable HIVDR mutation was related only to PIs.

Figure 1.
Neighbor-joining phylogenetic tree of *pol* gene, (■):General MSM, (▲):MB *Antiretroviral* drug resistance-associated mutations

Table 1

Sociodemographic characteristics and sexual behaviors of study participants

Variables	All (%) (n=535)	MBs (%) (n=226)	General MSM (%) (n=309)	P
Age(years)				<0.001
18–24	148(27.7)	90(39.8)	58(18.8)	
25–34	235(43.9)	83(36.7)	152(49.2)	
35–68	152(28.4)	53(23.5)	99(32.0)	
Official Residency (“ <i>hukou</i> ”)				<0.001
Local Shanghainese	127(23.7)	9(4.0)	118(38.2)	
Non-local	408(76.3)	217(96.0)	191(61.8)	
Ethnicity				0.288
Han	506(94.6)	211(93.4)	295(95.5)	
Other	29(5.4)	15(6.6)	14(4.5)	
Marital status				0.097
Never married	370(69.2)	163(72.1)	207(67.0)	
Currently married	113(21.1)	38(16.8)	75(24.3)	
Divorced/widowed	52(9.7)	25(11.1)	27(8.7)	
Education				0.001
Middle school or below	154(28.8)	82(36.3)	72(23.3)	
High school or equal	202(37.8)	110(48.7)	92(29.8)	
College or above	179(33.5)	34(15.0)	145(46.9)	
Monthly income(Yuan, RMB)				0.001
<3000	180(33.6)	57(25.2)	123(39.8)	
3000 – 4999	176(32.9)	78(34.5)	98(31.7)	
5000	179(33.5)	91(40.3)	88(28.5)	
Self-identified sexual orientation				0.372
Gay	343(64.1)	140(61.9)	203(65.7)	
Non-gay	192(35.9)	86(38.1)	106(34.3)	
No. of male sexual partners in the past 30 days				<0.001
0	50(9.3)	8(3.5)	42(13.6)	
1–3	297(55.5)	67(29.6)	230(74.4)	
4–6	70(13.1)	46(20.4)	24(7.8)	
7	118(22.1)	105(46.5)	13(4.2)	
Had anal sex in the past 6 months				0.037
No	60(11.2)	17(7.5)	43(13.9)	
Had protected anal sex	198(37.0)	93(41.2)	105(34.0)	
Had unprotected anal sex	277(51.8)	116(51.3)	161(52.1)	
Had sex after drinking alcohol in the past 6 months				0.002
No	416 (78.0)	161 (71.6)	255 (82.8)	
Yes	117(22.0)	64(28.4)	53(17.2)	
Had sex after using drugs in the past 6 months				<0.001
No	419 (78.8)	150 (66.4)	269 (87.9)	

Variables	All (%) (n=535)	MBs (%) (n=226)	General MSM (%) (n=309)	P
Yes	113 (21.2)	76 (33.6)	37 (12.1)	

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Bivariate and multivariate logistic regression analyses of correlates with HIV infection among MBs and general MSM, respectively

Variables	MBs					General MSM				
	HIV Positive		Crude OR (95%CI)	P	Adjusted OR (95%CI)	P	HIV Positive		Crude OR (95%CI)	Adjusted OR (95%CI)
	n/N	%					n/N	%		
Age(years)										
18–24	10/90	11.1	1.00		1.00		4/58	6.9	1.00	1.00
25–34	19/83	22.9	2.38(1.03–5.47)	0.042	2.42(0.91–6.43)	0.077	15/152	9.9	1.48(0.47–4.65)	2.02(0.54–7.51)
35–68	4/53	7.5	0.65(0.19–2.20)	0.491	0.73(0.15–3.54)	0.695	5/99	5.1	0.72(0.19–2.79)	0.632 0.77(0.15–4.06)
Official residency (“hukou”)										
Local Shanghai	2/9	22.2	1.00		1.00		5/118	4.2	1.00	1.00
Non-local	31/217	14.3	0.58(0.12–2.94)	0.514	0.34(0.04–2.53)	0.289	19/191	9.9	2.50(0.91–6.88)	0.077 1.1(0.30–4.04)
Ethnicity										
Han	28/211	13.3	1.00		1.00		23/295	7.8	1.00	1.00
Others	5/15	33.3	3.27(1.04–10.27)	0.043	4.79(1.08–21.28)	0.039	1/14	7.1	0.91(0.11–7.27)	0.929 0.51(0.06–4.45)
Marital status										
Currently married	4/38	10.5	1.00		1.00		4/75	5.3	1.00	1.00
Others	29/188	15.4	1.55(0.51–4.70)	0.438	0.65(0.16–2.7)	0.553	20/234	8.5	1.66(0.55–5.02)	0.370 1.81(0.49–6.62)
Education										
Middle school or below	12/82	14.6	1.00		1.00		8/72	11.1	1.00	1.00
High school or equal	13/110	11.8	0.78(0.34–1.82)	0.567	0.48(0.18–1.31)	0.153	10/92	10.9	0.98(0.36–2.61)	0.961 1.16(0.36–3.74)
College or above	8/34	23.5	1.80(0.66–4.89)	0.252	1.08(0.32–3.68)	0.905	6/145	4.1	0.35(0.12–1.04)	0.058 0.27(0.05–1.52)
Monthly income (Yuan, RMB)										
<3000	6/57	10.5	1.00		1.00		15/123	12.2	1.00	1.00
3000–4999	9/78	11.5	1.11(0.37–3.31)	0.853	1.22(0.33–4.46)	0.767	4/98	4.1	0.31(0.10–0.96)	0.041 0.31(0.09–1.13)
5000	18/91	19.8	2.10(0.78–5.65)	0.143	2.26(0.69–7.46)	0.180	5/88	5.7	0.43(0.15–1.24)	0.120 0.54(0.12–2.4)
Sexual identity										
gay	26/140	18.6	1.00		1.00		17/203	8.4	1.00	1.00
Non-gay	7/86	8.1	0.39(0.16–0.94)	0.036	0.57(0.21–1.55)	0.269	7/106	6.6	0.77(0.31–1.93)	0.582 0.62(0.22–1.77)
No. of male sexual partners in the past 30 days										

Variables	MBs						General MSM					
	HIV Positive			Crude OR (95%CI)	P	Adjusted OR (95%CI)	P	Crude OR (95%CI)	P	Adjusted OR (95%CI)	P	P
	n/N	%										
0	0/8	0.0	–	–	–	–	–	1.00	–	1.00	–	–
1–3	9/67	13.4	0.86(0.36–2.08)	0.743	1.27(0.45–3.55)	0.653	18/230	7.8	3.48(0.45–26.81)	0.231	1.94(0.22–17.02)	0.548
4–6	8/46	17.4	1.17(0.46–2.97)	0.739	1.67(0.55–5.01)	0.364	3/24	12.5	5.86(0.57–59.81)	0.136	1.29(0.1–16.45)	0.845
7	16/105	15.2	1.00	–	–	–	2/13	15.4	7.46(0.62–90.00)	0.114	1.74(0.1–30.86)	0.705
Had anal sex in the past 6 months												
No	1/17	5.9	1.00	–	–	–	0/43	0.0	–	–	–	–
Had protected anal sex	9/93	9.7	1.71(0.20–14.5)	0.621	0.75(0.07–7.74)	0.811	10/105	9.5	1.11(0.47–2.59)	0.818	1.33(0.51–3.49)	0.566
Had unprotected anal sex	23/116	19.8	3.96(0.50–31.40)	0.193	1.24(0.13–11.82)	0.851	14/161	8.7	1.00	–	1.00	–
Had sex after drinking alcohol in the past 6 months												
No	24/161	14.9	1.00	–	–	–	18/255	7.1	1.00	–	1.00	–
Yes	9/64	14.1	0.93(0.41–2.14)	0.872	0.79(0.30–2.06)	0.630	6/53	11.3	1.68(0.63–4.46)	0.297	1.26(0.43–3.76)	0.672
Had sex after using drugs in the past 6 months												
No	13/150	8.7	1.00	–	–	–	16/269	5.9	1.00	–	1.00	–
Yes	20/76	26.3	3.76(1.75–8.08)	0.001	3.59(1.50–8.61)	0.004	8/37	21.6	4.36(1.72–11.07)	0.002	3.38(1.10–10.34)	0.033

OR: Odds Ratio; CI: confidence interval.