Risk Factors and Interventions for HIV Control in China

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Chapter 1

General introduction

1.1 HIV/AIDS epidemiology and control strategies worldwide

Acquired immune deficiency syndrome (AIDS) is caused by the human immunodefiency virus (HIV) and has been recognized as a major public health problem for many years.[1] At the end of 2012, approximately 34 million people were living with HIV globally. The worldwide prevalence is approximately 0.8% in adults aged 15- 49 years.[2] The burden of the epidemic varies considerably between countries and regions. Sub-Saharan Africa is the most severely affected area (Figure 1.1), with a prevalence of about 5% in adults and accounting for 69% of all people with HIV infection worldwide.[2] With 48,000 new HIV cases in the year 2011, it is estimated that there are 780,000 people living with HIV/AIDS in China nowadays.[3]

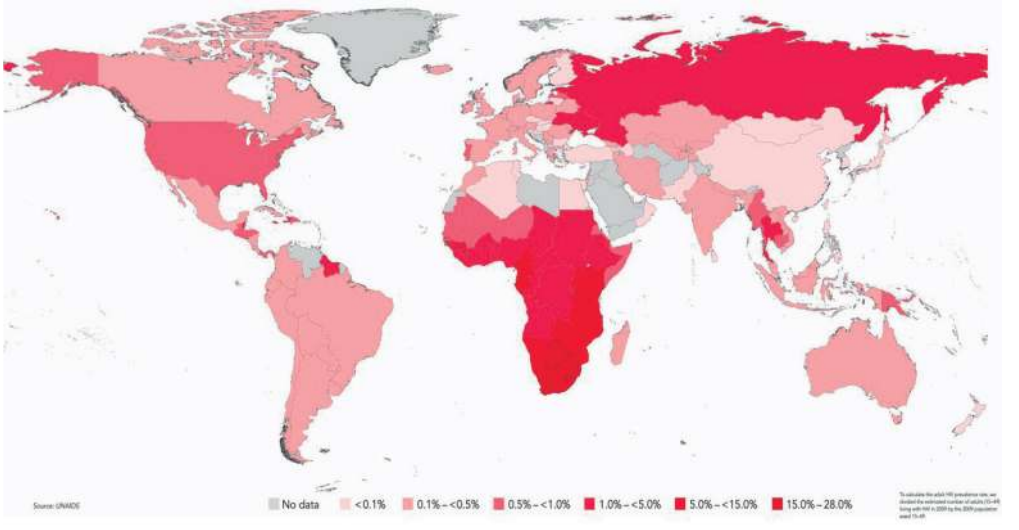

Figure 1.1. Global HIV prevalence. Source: UNAIDS.[2]

HIV was first identified by *Luc Montagnier* in 1983.[4] It is a retrovirus, consisting of two identical RNA strands.[5] The virus infects vital cells in the human immune system such as T-helper cells (specifically CD4 T cells), macrophages and dendritic cells.[6,7] It can lead to low level of CD4 T cells through a number of mechanisms such as apoptosis,[8-10] direct killing of infected cells[11,12] and killing of infected CD4 cells by CD8 cytotoxic lymphocytes that recognize infected cells.[13,14] Once the number of CD4 T cells decreases below a critical level, cell-mediated immunity is lost, and by this stage, people infected with HIV develop AIDS. In the absence of antiretroviral treatment (ART), the median time from initial infection to the development of AIDS ranges from 8 to 10 years, and the time from AIDS to death is about 2 years.[15,16]

HIV can be transmitted by unprotected sexual (both heterosexual and homosexual) practices, by needle sharing in injecting drug use, from mother to child during pregnancy, at childbirth

or through breast feeding, and by blood transfusions with infected blood.[17] In many countries, particularly in sub-Saharan Africa and the Caribbean, there are generalized epidemics with heterosexual transmission in the general population.[18,19] In several other countries, including China, the HIV epidemic is concentrated in classical high risk population groups, such as injecting drug users (IDU) and men who have sex with men (MSM).[20,21] In this thesis, we will mainly focus on sexual (heterosexual and homosexual) transmission of HIV.

Interventions to reduce sexual transmission of HIV can be categorized into: 1) biomedical interventions; 2) behavioral risk reduction interventions; 3) HIV-related service interventions; and 4) structural interventions.[21,22] Biomedical interventions reduce the efficacy of HIV transmission during intercourse, and include condoms,[23,24] male circumcision,[25-27] pre- and post-exposure prophylaxis,[28-30] vaccines,[31] microbicides,[32] and syndromic treatment for sexually transmitted infections (STIs).[33] Behavioral risk reduction interventions aim at reducing HIV risk behaviors such as having a large number of sexual partners and inconsistent condom use with commercial or casual partners.[34,35] HIV-related service interventions aim at reducing HIV risk through health services, such as HIV counseling and testing.[36,37] Structural interventions aim at reducing poverty, disparities and stigma to empower high-risk population groups for safe sexual practices.[38,39] Although various of these interventions have been implemented, they have failed to control the sexual transmission of HIV worldwide, in particular among homosexual groups.[20] In this thesis, we investigate determinants of (non-)uptake of HIV-related services by female sex workers (FSWs) and MSM from the perspective of the service provider.

1.2 The history and current status of the HIV epidemic in China

The first AIDS case in China was identified in 1985 and concerned a dying foreign tourist. The first years thereafter, HIV/AIDS cases were only identified sporadically.[40] In 1989, the first HIV epidemic was established in 146 infected heroin users in Yunnan province, on the border of China with Myanmar. Between 1989 and the mid-1990s, HIV spread steadily from Yunnan into neighboring areas and along the major drug trafficking routes, and from IDUs to their sexual partners and children.[3,40] The majority of affected people were IDUs, who accounted for about 70% of the total reported cases in the country. In the mid-1990s, the occurrence of a second major outbreak became apparent in commercial plasma donors in the central provinces of China, in particular Henan.[41,42] Many commercial plasma donors became infected with HIV through infusion of pooled contaminated blood. At the same time, HIV was also spreading more regularly through sexual transmission. By 1998, HIV had reached all 31 provinces and was in a phase of exponential growth.[43] Still, IDUs and former plasma donors were the two major groups in China affected by the HIV/AIDS epidemic in the 1990s. While the large scale blood contamination events among plasma donors were controlled within a relatively short time, the IDU population persisted to be the primary source of HIV infections in China until 2007, when heterosexual transmission for the first time became the dominant mode of HIV transmission,

accounting for nearly 45% of new infection cases.[44,45] Besides the increased proportion of heterosexual transmission, homosexual transmission also became increasingly visible since 2007. National surveillance data show that the proportion of new HIV infections attributable to sexual (both heterosexual and homosexual) transmission had increased steadily from 57% in 2007[46] to 82% in 2011.[47] Notably, this increase is seen particularly for homosexual transmission, which corresponds to an increase from 12% to 29% from 2007 to 2011.[46,47] With 48,000 new HIV cases in the year 2011, it is estimated that there are 780,000 people living with HIV/AIDS in China nowadays.[3]

1.3 Classical high-risk population groups in China

Drug users

Drug abuse, mainly of heroin, has spread quickly and has reached epidemic levels over the last decades in China.[15] The number of registered drug users increased from 0.1 million in 1991 to 1.4 million in 2010.[8] Key characteristics of Chinese drug users are the popularity of injecting drug use and sharing of needles, which ranges from around 50% to over 70% of all drug users.[49] According to national sentinel surveillance data, the estimated HIV prevalence among drug users fluctuates between 4 and 8% from 2000 to 2011.[47] This thesis does not focus on drug users, but some challenges of implementing interventions towards drug users are mentioned in the general discussion.

Former commercial plasma donors

During the mid-1990s, thousands of illegal blood and plasma donation sites were established in poor rural areas of central China. From one plasma donor, plasma was separated and red blood cells, which were often mixed with those from other commercial plasma donors, were re-infused to allow frequent donations. This unsafe collection method facilitated the outbreak of HIV in central China. The Chinese Ministry of Health reported that the total number of former commercial plasma donors living with HIV/AIDS declined from 199,000 in 2003 to 55,000 in 2005 and further to 51,000 in 2011.[47] The reduction in the estimates is due to the high mortality rate before free antiretroviral therapy (ART) became widely available for this population. In this thesis, former commercial plasma donors are not a study subject.

Female sex workers (FSWs)

FSWs are vulnerable to HIV worldwide. In China, although the prevalence of HIV among FSWs stays low at a stable level of about 0.5%, the risks of an epidemic among FSWs and a further transmission to the general population is still a major concern. It is estimated that there are between 1 and 4 million FSWs in China, in both low end (e.g. on the street, hair salons, and temporary small clubs) and high end venues (e.g. karaoke clubs, night clubs, and hotels).[50-52] Key challenges for HIV prevention efforts for FSWs are the ever-increasing prevalence of STIs and the low uptake of HIV-related services. There is evidence that through the cofactor effect, STIs such

as syphilis can increase one to fivefold the infectiousness of, and/or susceptibility to HIV.[53] In China, the prevalence of STIs among FSWs is alarmingly high. For instance, the national syphilis prevalence is estimated to be approximately 7%,[50] and as high as 14% in Guangdong province.[54] The readily spreading STIs may very well facilitate a forthcoming HIV epidemic among FSWs and their clients. Moreover, HIV-related intervention services, in particular HIV testing, aiming to reduce HIV risks, are not commonly used by FSWs in China. In 2011, the median percentage worldwide of FSWs receiving an HIV test in the last year was 49%, while in China it was only 34%.[55] In this thesis, we investigate risk factors of syphilis infection and determinants of the low uptake of HIV-related services in FSWs in Shenzhen, Guangdong province, South China.

Men who have sex with men (MSM)

The proportion of new HIV infections attributable to homosexual transmission has increased rapidly in China from 12% to 29% between 2007 and 2011.[46,47] According to the national surveillance data and a nationwide survey, the prevalence of HIV among MSM is about 5%.[47,56] In big cities, such as Shenzhen and Chongqing, the prevalence has reached about 10% since 2010.[57,58] As homosexuality is not largely accepted in China and due to traditional culture and values, many MSM have frequent sexual relationships with women to hide their homosexual orientation. There is concern that MSM will serve as key driver of the HIV epidemic and bridge the epidemic to the general heterosexual population. In this thesis, we examine the extent to which MSM may serve as a bridge for HIV transmitting to the heterosexual population by studying their HIV risk and prevention behavior. Besides those MSM who have sex with women due to culture or family pressure, there is a subgroup of MSM who have sex with women to increase their income.[59] This subgroup of MSM are male sex workers known as 'money boys' (MBs), who commercially sell sex to men, but often also to women. Due to multiple male and female sexual partners and unsafe sexual practices, MBs are a core group for HIV transmission.[60] To inform public health authorities about better HIV-related intervention services to MBs, we investigate their HIV prevention behavior (HIV testing) as compared to other MSM. Furthermore, we study sampling methods to reach MSM and design and implement an innovative (pilot) intervention study to increase acceptability to MSM.

1.4 HIV and the general population in China

Over the past decades, there have been substantial changes for population groups not belonging to the classical high risk groups in China. Firstly, the restriction on population movement was relaxed. Many people now migrate across the country in search of work, particularly from rural to urban areas. The number of this so-called 'floating population' that were not registered in the cities to which they have migrated, was estimated to be over 200 million in 2012.[61] The majority of this so-called 'floating population' comprises young male adults, who are sexually active and have limited education, relatively low social status, and limited access to health services.[62] Due to these conditions and the separation from family members, a larger proportion of the floating

population may participate in high-risk sexual behaviors, such as commercial sex, compared to the non-migrant population. Secondly, Western culture has penetrated the society, and may have exerted an influence on people's attitudes towards sexuality. It is believed that in particular the young generation such as college students has become more tolerant of commercial sex, premarital sex, casual sex, and multiple sexual partners.[63,64] Given the social developments presented above, it may be assumed that an increasing proportion of the Chinese population has opted to engage in high-risk sexual behaviors that might facilitate the spread of STIs, including HIV.

1.5 Key HIV-related health service interventions in China

Rapid scale-up of harm reduction

The Chinese government adopted many strategies in the antidrug campaign in the last decades, such as compulsory detoxification. The epidemics of drug abuse and spread of drug-related HIV/AIDS however, are not yet completely under control.[65-67] A ground-breaking step was taken in 2004. Based on scientific evidence indicating the success of the harm reduction strategy in reducing HIV/AIDS risk behavior and other negative consequences of drug dependence,[68-71] the Chinese government initiated harm reduction programs such as needle and syringe exchange programs (NEP) and methadone maintenance treatment (MMT). The first NEP trial was established in Yunnan and Guangxi, the provinces with the most severe HIV epidemics among drug users in China in 1999.[72] In practice, free clean needles were distributed and the used needles were collected. This first trial showed its potential to discourage needle and syringe sharing among drug users. Since then, NEP was scaled up with help from international agencies such as the World AIDS Foundation and non-governmental organizations.[72] In 2004, the Chinese government initiated MMT, which is a substitution treatment. The first eight MMT pilot studies demonstrated high effectiveness in reducing HIV-risk behaviors. In particular, the proportion of injecting drug use reduced from 70% to 9%, and the average frequency of injection reduced from ninety to twice per month.[73] With the enactment of the Five-Year Action Plan to Control HIV/AIDS (2006-2010), MMT was quickly expanded throughout China. By the end of March, 2011, 708 MMT clinics had been established nationwide in 28 provinces, cumulatively serving more than 306,000 clients.[74] In this thesis, some concerns regarding the implementation of harm reduction in China are discussed in the general discussion (Chapter 9).

Antiretroviral treatment (ART) and HIV testing

Since the mid 1990s, Chinese authorities have acted to improve the safety of blood supply by banning the most dangerous practices and closing illegal blood collection agencies.[75] In 2010, the government claimed that all collected blood products had been screened for HIV.[47] But the treatment of the many HIV-infected former commercial plasma donors remains a challenge. In 2003, the Chinese government put forward a "four free one care" policy which includes: 1) free antiretroviral drugs to AIDS patients who are rural residents or people with financial difficulties

living in urban areas; 2) free voluntary counseling and HIV testing; 3) free drugs to HIV infected pregnant women to prevent mother-to-child transmission, and HIV testing of newborn babies; 4) free schooling for children orphaned by AIDS; and 5) care and economic assistance to the households of people living with HIV/AIDS.[76,77] Indeed, the "four free one care" policy, in particular free ART, has greatly improved life quality and reduced mortality among those with AIDS. As a national observational cohort study revealed that the overall mortality decreased over 60% from 2002 to 2009, with treatment coverage increasing from almost zero to 63%.[78] This policy is most welcome to former commercial plasma donors and the babies they had. Unlike drug users, CSWs and MSM, former commercial plasma donors are neither illegal or against the norms, so can easily be reached by interventions. Presently, mortality is higher in drug users (16 deaths per 100 person-years) and those infected sexually (18 deaths per 100 person-years), compared to former commercial plasma donors (8 deaths per 100 person-years).[78]

Besides reducing mortality, ART can also effectively reduce HIV infectiousness and has therefore been advocated to be added to HIV prevention strategies under the name "Treatment as Prevention". Cohen *et al.* showed in a randomized controlled trial that ART reduced HIV incidence by 96%.[79] A national observational cohort in China revealed a 26% relative reduction in HIV transmission in the treated cohort under real-world conditions, with treatment non-adherence, drug resistance, etc.[80] These findings implied that early treatment should be advocated to eliminate HIV.[81] The Chinese government is committed to the "Treatment as Prevention" strategy, especially in priority populations such as MSM. How well the early treatment can be rolled out depends greatly on how frequent HIV testing is used by high-risk population groups. In China, uptake of HIV testing however, is still unacceptably low in these classical high-risk population groups. For instance, the HIV testing rates are only about 30% in CSWs[71] and 15%-56% in MSM.[82,83]

Condom promotion and peer education

Condom use is a critical element of HIV prevention.[24,84] There is evidence that effective condom use can reduce sexual transmission of HIV and other STIs by 80%.[85-87] The 100% condom use programme (CUP) is a collaborative programme between local public health authorities and sex entertainment establishments that aims to increase condom use among CSWs and their clients. In China, CUP was first implemented between 2001 and 2004.[88] Results from a demonstration of CUP in Wuhan, China, showed that condom use rates rose by over 90% during the 15-month follow-up survey.[88] However, as prostitution is strongly condemned in China,[89] CSWs are often reluctant to access sources of information on prevention.[90,91] Also, as a marginalized population, it is difficult for public health authorities to reach them, especially the street-based CSWs.[92] Peers of CSWs may act as connection between public health authorities and CSWs. There is evidence that CSWs accompanied by their peers were often more willing to accept local HIV prevention services.[93,94] Therefore, outreach programs by peers of CSWs are rolled out in China to link public health authorities and CSWs. In recent years, condom promotion and peer education programs are also added to the control efforts for MSM in China. By involving peers of MSM,

interventions initiated by public health authorities are acceptable to gatekeepers of MSM venues such as gay bars, dorms and saunas, and can decrease sexual risk behaviour among MSM.[94]

1.6 Study location in China

The HIV epidemic is geographically unbalanced in China (Figure 1.2a). Yunnan, Guangxi and Henan are the most severely affected areas, where drug users and former commercial plasma donors concentrated. It is estimated that the HIV prevalence exceeds 50% among drug users in some cities/villages in these provinces. Besides these areas, Chongqing and Guangdong are also hit relatively hard by the epidemic. The nationwide HIV prevalence among MSM is about 5%, while in Chongqing and Shenzhen (Guangdong province) the prevalence has reached 10%.

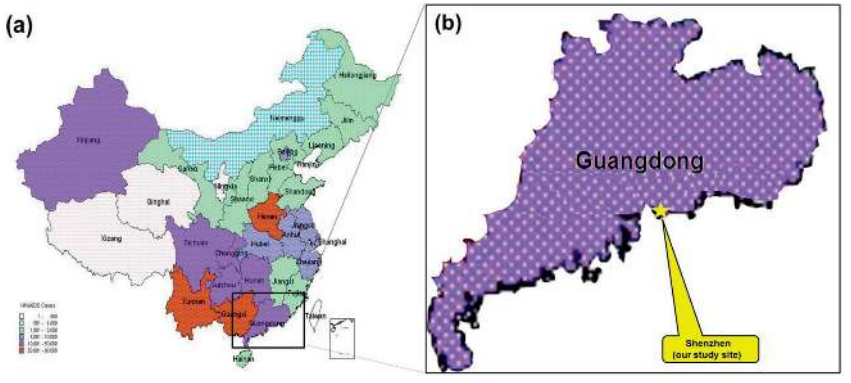

Figure 1.2. (**a**) HIV epidemic in China. Source: MOH, WHO and UNAIDS;[47] (**b**) Location of study site in Guangdong province, China.

In this thesis, all field studies were implemented in Shenzhen, Guangdong province, South China (Figure 1.2b). Shenzhen is a well-developed city that borders to Hong Kong. Driven by the flourishing economy and openness, numerous people have moved from other places to Shenzhen, from both inner rural areas of China and developed cities, in particular Hong Kong. This 'floating population' constitutes the majority of the over 10 million registered Shenzhen inhabitants, and many CSWs and MSM are part of this floating population group. It is estimated that there are more than 100,000 CSWs and about 100,000 MSM in Shenzhen. We selected Shenzhen as our study location because the local Center for Disease Control and Prevention (CDC) has collected a wealth of high-quality data on HIV control over a period of nearly 10 years, based on good collaboration with several non-governmental organizations (NGOs). Peers of CSWs and MSM from these NGOs are trained by the Shenzhen CDC, and serve as an excellent

connection between health authorities/researchers and gatekeepers of CSW/MSM venues. This connection proved very useful in reaching CSWs and MSM for field studies and interventions.

1.7 The aim and outline of this thesis

The overall aim of this thesis is to identify promising new avenues to control sexual transmission of HIV in different population groups (i.e. general population, CSWs and MSM) in China. We formulate the following specific research questions:

1. What are the trends in engaging in sexual risk behaviors among general heterosexual population groups in China?
2. What are the patterns of HIV risk and prevention behavior among CSWs in Shenzhen, China?
3. What are the patterns of HIV risk and prevention behavior among MSM in Shenzhen, China?
4. How are MSM best reached for HIV surveillance and interventions?

Chapter 2 addresses the first research question through an extensive systematic review of the English and Chinese literature.

Chapter 3 and **4** address research question 2. Using comprehensive surveillance data on CSWs between 2009 and 2012, we investigate risk factors of syphilis in **Chapter 3**, and determinants of the low uptake of services in **Chapter 4**.

Chapter 5 and **6** address research question 3. In **Chapter 5**, we compare HIV risk and prevention behaviors in men who have sex with men and women (MSMW) and men who have sex with men only (MSM-only). In **Chapter 6**, we separately explore determinants of recent HIV testing in male sex workers and other MSM.

Chapter 7 and **8** address research question 4. **Chapter 7** describes how MSM can be reached by respondent-driven sampling (RDS) and time-location sampling (TLS). We compare profiles of MSM reached by these two methods. In **Chapter 8**, we describe how an innovative intervention strategy by using joint marketing as the framework for targeting MSM was piloted.

The answers to the research questions, and overall conclusions and recommendations, are given in the general discussion, **Chapter 9**.

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Chapter 2

Trends in high-risk sexual behaviors among general population groups in China: A systematic review

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Abstract

Background: The objective of this review was to investigate whether Chinese population groups that do not belong to classical high risk groups show an increasing trend of engaging in high-risk sexual behaviors.

Methods: We systematically searched the English and Chinese literature on sexual risk behaviors published between January 1980 and March 2012 in PubMed and the China National Knowledge Infrastructure (CNKI). We included observational studies that focused on population groups other than commercial sex workers (CSWs) and their clients, and men who have sex with men (MSM) and quantitatively reported one of the following indicators of recent high-risk sexual behavior: premarital sex, commercial sex, multiple sex partners, condom use or sexually transmitted infections (STIs). We used generalized linear mixed model to examine the time trend in engaging in high-risk sexual behaviors.

Results: We included 174 observational studies involving 932,931 participants: 55 studies reported on floating populations, 73 on college students and 46 on other groups (i.e. out-of-school youth, rural residents, and subjects from gynecological or obstetric clinics and premarital check-up centers). From the generalized linear mixed model, no significant trends in engaging in high-risk sexual behaviors were identified in the three population groups.

Discussion: Sexual risk behaviors among certain general population groups have not increased substantially. These groups are therefore unlikely to incite a STI/HIV epidemic among the general Chinese population. Because the studied population groups are not necessarily representative of the general population, the outcomes found may not reflect those of the general population.

2.1 Introduction

Sexually transmitted infections (STIs) have been recognized as a major public health problem in China since they re-emerged with the introduction of the 'Open-Door Policy' in 1979.[1] STIs such as syphilis and gonorrhea were considered to have been eliminated in the 1960s by massive screening and free treatment. However, they are now among the most commonly reported notifiable diseases.[2] The rate of new syphilis cases increased from 0.09 in 1990 to 5.08 in 2000, and on to 26.86 per 100,000 population in 2010.[3] Although the trend for gonorrhea showed an increasing and declining pattern, the incidence of gonorrhea remains relatively high, with over 90,000 new cases reported in 2012.[3] The number of reported new HIV cases stayed relatively low, with almost no cases between 1990 and 2000, and subsequently an increase to 1.20 cases per 100,000 population in 2010.[3] In general, the epidemic of STIs/HIV in China has expanded over the past decades.

The resurgence of STIs can largely be explained by the demographic and social changes in China since the introduction of the 'Open-Door Policy'. Commercial sex workers (CSWs) and their clients, and men who have sex with men (MSM) are considered as the classical high risk groups of STIs. The size of these high risk groups has increased considerably in China over the past three decades. For instance, the number of CSWs is currently estimated to be between one and four million.[4-7] The flourishing commercial sex industry has provided a channel for the spread of STIs. There have also been substantial changes for population groups not belonging to the classical high risk groups. Firstly, the restriction on population movement was relaxed. Many people now migrate across the country in search of work, particularly from rural to urban areas. The number of this so-called 'floating population' that were not registered in the cities to which they have migrated, was estimated to be over 200 million in 2012.[8] The majority of this so-called 'floating population' comprises young male adults, who are sexually active and have limited education, relatively low social status, and limited access to health services.[9] Due to these conditions and the separation from family members, a larger proportion of the floating population may participate in high-risk sexual behaviors, such as commercial sex, compared to the non-migrant population. Secondly, Western culture has penetrated the society, and may have exerted an influence on people's attitudes towards sexuality. It is believed that in particular the young generation such as college students has become more tolerant of commercial sex, premarital sex, casual sex, and multiple sexual partners.[2,10]

Given the social developments presented above, it may be assumed that an increasing proportion of the Chinese population has opted to engage in high-risk sexual behaviors that might facilitate the spread of STIs, including HIV. Studies on changes in the proportion of people involved in high-risk sexual behaviors in China have predominately focused on CSWs and their clients, STI clinic attendees, men who have sex with men, former paid blood donors, and injecting drug users. Indeed, some groups showed increasing engagement in high-risk sexual behaviors and a corresponding increase in the STIs/HIV prevalence.[5,11-13] To date, however, reviews on

sexual risk behaviors among other, more general population groups are hardly available. One review provided data about sexual practices among the general population,[14] but it only included data up to 2003 and without any description of possible trends. It is therefore unclear if general population groups engage increasingly in sexual risk behaviors.

The general population cannot be considered the key driver of the STIs/HIV epidemic in China as is the case with the classical high-risk groups, but transmission of STIs/HIV will be very difficult to stop if high-risk sexual behaviors become common among the general population. To direct STIs/HIV prevention efforts, knowledge on trends in engaging in high-risk sexual behaviors, including not using condoms, among the general population is needed. The aim of this systematic review is to investigate possible trends of engaging in high-risk sexual behaviors (i.e. premarital sex, multiple sex partners, and commercial sex) by general population groups, in particular the floating population and college students. The review is structured by category of population groups and indicator of high-risk sexual behaviors.

2.2 Methods

Search strategy

We conducted a comprehensive literature search in both PubMed and its Chinese equivalent, the Chinese National Knowledge Infrastructure (CNKI). The latter is the most comprehensive database in Chinese scientific literature; it includes studies published in a wide range of periodicals, conference proceedings, and newspapers. Based on a bibliometric method, China has a core journal selection system that creates a sub-database of journals that have the latest professional information and been formally peer-reviewed.[15] Given the large number of eligible studies, we narrowed our search to the core journals selected within the CNKI, because the sub-database was likely to identify the majority of relevant studies. We retrieved studies published from January, 1980 to March, 2012, in both Chinese and English languages. The search terms included both Mesh terms: 'sexual behavior' and 'sexually transmitted diseases', and full text words: 'condoms, 'commercial sex', 'multiple sex partner', 'sexually transmitted infections' and 'China'. We used the term 'sexually transmitted infections', because the occurrence of STIs can be considered an indicator to describe consequence of relatively recent high-risk sexual behaviors. The detailed search string can be found in File S2.1.The search terms did not have any restriction about the population groups, as it is hard to find a suitable keyword for the study population groups that we target; those who do not belong to the classical high risk groups. We initially included all population groups in our literature search and excluded the groups that are at highest risk of STIs/HIV manually in the study selection process. To identify additional relevant literature, we also attempted to search Embase (detailed search string can be found in File S2.1) and retrieved appropriate articles from the reference lists of the articles included in the analysis from the initial selection.

Study selection

Studies were eligible for inclusion in this systematic review when they met the following criteria: (1) studies had to be situated in mainland China; (2) participants could not include the following high-risk populations: CSW and their clients, STI clinic attendees, men who have sex with men, commercial blood donors, and injecting drug users; (3) quantitative studies had to report on at least one of the following indicators of high-risk sexual behavior: premarital sex, commercial sex, multiple sex partners, condom use, or the prevalence of STIs; (4) studies had to be cross-sectional or longitudinal. For intervention studies, pre-intervention data was also eligible; (5) they had to be peer-reviewed, empirical studies, published in Chinese or English. Engaging in commercial sex was referred to as either having paid or been paid for sex. The prevalence of STIs was the proportion of participants that had chlamydia, syphilis, or gonorrhea (three common, reportable STIs in China), which was diagnosed based on laboratory testing. When two or more articles shared the same study data or were published in both English and Chinese sources, we excluded the articles published earlier or the ones published in the Chinese language. We did not include published surveillance data that only included information about the prevalence of HIV from the local or central government, because HIV is a chronic infection that cannot indicate recent sexual risk behaviors, but we did include studies on HIV incidence.

Data abstraction and management

We extracted the following information from all eligible studies: (1) general information: first author, publication year, study location, and study year; for studies with no information on the study year, we assumed the study year was two years earlier than the publication year; when the study year concerned multiple years, we used the midpoint; (2) study design: sampling venues, methods, demographics (age, gender, and marital status), and laboratory testing methods; (3) indicators of sexual risk behaviors: proportions of participants engaging in premarital sex, commercial sex, or sex with multiple partners; condom use, and the prevalence of STIs. For study location, we categorized the 31 provinces/autonomous regions of mainland China into five modernization (development level) classes, according to China's Modernization Report 2010[16] as follows: (first class) provinces that accomplished 95%-100% modernization; (second class) provinces with 90%-94% modernization; (third class) provinces with 85%-89% modernization; (fourth class) provinces with 80%-84% modernization; and (fifth class) provinces with less than 80% modernization (see File S2.2). The development of provinces is unequal in China, and the modernization level indicates how developed the provinces or cities are as compared to Hong Kong. Studies that concern national or multicenter data (12 studies) are considered as a separate category. The proportions of participants that used condoms were assessed as "condom use at last intercourse" and "consistent condom use during the last month to a year". Data about condom use with casual or commercial sex partners during the past one, six, twelve months was combined, because condom use in the past month to year is not so different (see Table S2.2 in File S2.3). The proportions of sexual behaviors and the prevalences of STIs were proportional to the number of responding participants of each study. We imported all the information into Excel and the eligible studies were clustered into three groups: (1) floating population; (2) college

students; (3) other groups, including young, out-of-school individuals and community residents. An overview of the extracted information can be found in File S2.3 (Table S2.1-S2.3).

Quality assessment

We adjusted a validated quality assessment tool for cross-sectional studies[17] and used the following two criteria for studies of high quality: (1) sample size larger than 200, as participants in studies with small sample size may be not representative of the target population, (2) participants mean age range from 18 to 50 years old, as people in this age group are most sexually active. Two Chinese researchers evaluated study quality, and uncertainties were resolved by discussion with two other authors. Only studies with all the above two criteria were considered of high quality and included in the statistical analysis. Information regarding research methodology of reviewed studies can be found in File S2.3 (Table S2.1-S2.3).

Statistical analysis

We first plotted the indicators of sexual risk behaviors against the study year for each subgroup, i.e. floating population, college students, and other groups (out-of-school youth, community residents, and women from gynecological or obstetric clinics). The indicators were: proportions of participants that engaged in premarital sex, commercial sex, or sex with multiple partners, condom use, and the prevalence of STIs (i.e. chlamydia, syphilis, and gonorrhea). In the figures we visually separated overlapping data points for clarification, but the calculations were based on the actual study year.

To explore potential trends over the years, we used generalized linear mixed model (GLMM), which takes into account heterogeneity of the sample size and estimate effect of the various studies by including a random effect term. In each model, we included the factor 'study year', together with possible cofactors that may be confounders, and their interaction with 'study year'. The cofactors included were: the modernization class of the province/autonomous region where the study was conducted (see Quality assessment above), sampling methods (0 = non-probability based sampling, 1 = probability based sampling), gender composition (1 = mainly females: male proportion < 40%; 2 = females and males almost equal: male proportion: 40-60%; 3 = mainly males: male proportion > 60%), age (0 = mainly young participants: mean age ≤ 30 years, 1 = mainly older participants: mean age >30 years), and marital status of the participants (1 = mainly unmarried participants: married proportion < 40%; 2 = married and unmarried participants almost equal: married proportion: 40-60%; 3 = mainly married participants: married proportion > 60%). When there was no significant factor retained, we used the univariate results from GLMM of indicators against study year (dashed lines) in the figures to illustrate the general overall pattern of the trends.

2.3 Results

Study identification and selection

Our initial search strategy identified 2547 articles from the two electronic databases. After applying the selection criteria, the full texts of 247 articles were read. 16 additional articles were identified through the reference lists of the included articles from the initial selection and 174 were eligible in our final analysis (Table S2.1-S2.3 in File S2.3). The selection process is illustrated in Figure 2.1. The 174 included studies assessed 932,931 participants in total, with male ratio ranging from 0-100% and age ranging from 14-74 years. Of the total 174 studies included, the majority had investigated the floating population and college students (55 and 73 studies, respectively). The remaining studies (n = 46) targeted other groups; in particular, the young, out-of-school population, community residents, and women recruited from gynecological or obstetric clinics.

Study characteristics

In the total of 174 studies, we could not identify studies conducted before 1999 that focused on the floating population, studies before 1995 that focused on college students, or studies before 1986 that focused on other groups. The included studies covered 25 of 31 provinces/autonomous regions in mainland China (no studies were identified that were conducted in Tibet, Qinghai, Hunan, Hainan, Xinjiang, and Ningxia provinces). The majority (78%, 43/55) of studies that focused on the floating population recruited their participants from routine venues; e.g., factories, restaurants, retail shops, and markets. All of the studies that focused on college students recruited their participants from campuses. Of the studies that focused on other groups, 76% (32/46) recruited participants from the general community. Most studies (86%, 149/174) used a probability-based sampling method; the remaining studies used convenience sampling or a quota sampling method. Furthermore, the majority of included studies only contained self-reported information. The prevalence of STIs was reported in only nine studies that focused on the floating population, two studies that focused on college students, and seventeen studies that focused on other groups. No study reported HIV incidence. Of these studies that reported STIs, blood samples were used to test syphilis and urinary samples were used to test chlamydia and gonorrhea. The majority (80%, 12/15) of studies reporting positive syphilis were based on confirmatory tests (TPPA or TPHA).

Data synthesis of floating population

The majority of the included 55 studies that focused on the floating population used similar sampling methods and recruited participants from similar venues. They differed in the gender composition, the marital status, and the modernization class of study location. Of the nine studies reporting the prevalence of chlamydia, syphilis and/or gonorrhea, three reported only one STI, two reported two STIs and four reported all three STIs (see Table S2.3 in File S2.3). Two studies reported extremely high proportion of engaging in commercial sex (Figure 2.2b) and having multiple sex partners (Figure 2.2c) among migrant truck drivers. Among other migrants, we did

not identify any significant trend of increased engagement in high-risk sexual behaviors (Figure 2.2a-c). A slight increase across the years was found in recent condom use with casual partners/ sex workers, but it was not significant (Figure 2.2d).This result would most likely indicate a decreasing risk of STIs, however, the prevalence of STIs showed no particular trend over time (Figure 2.2e). Results of the GLMM analysis can be found in File S2.4.

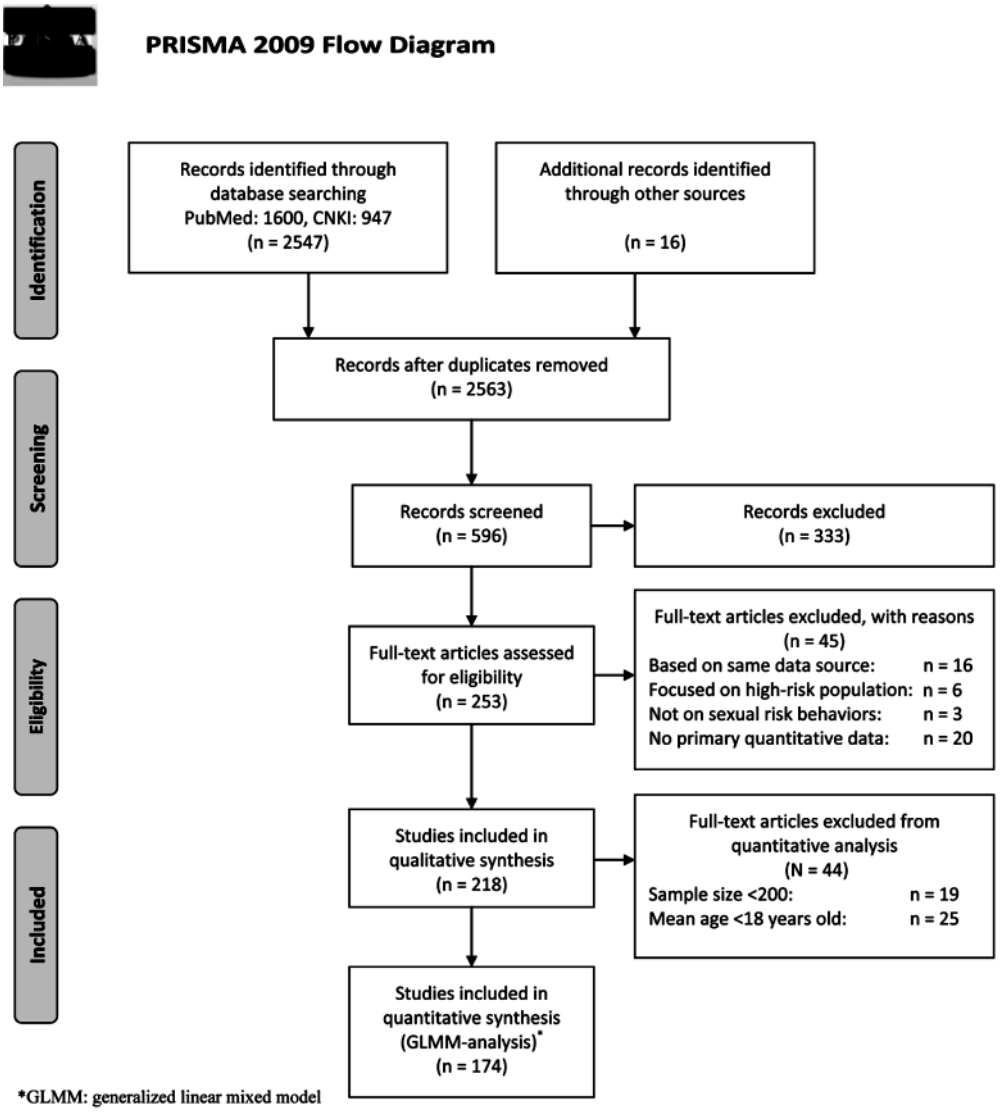

Figure 2.1. Flow chart of the literature selection process.

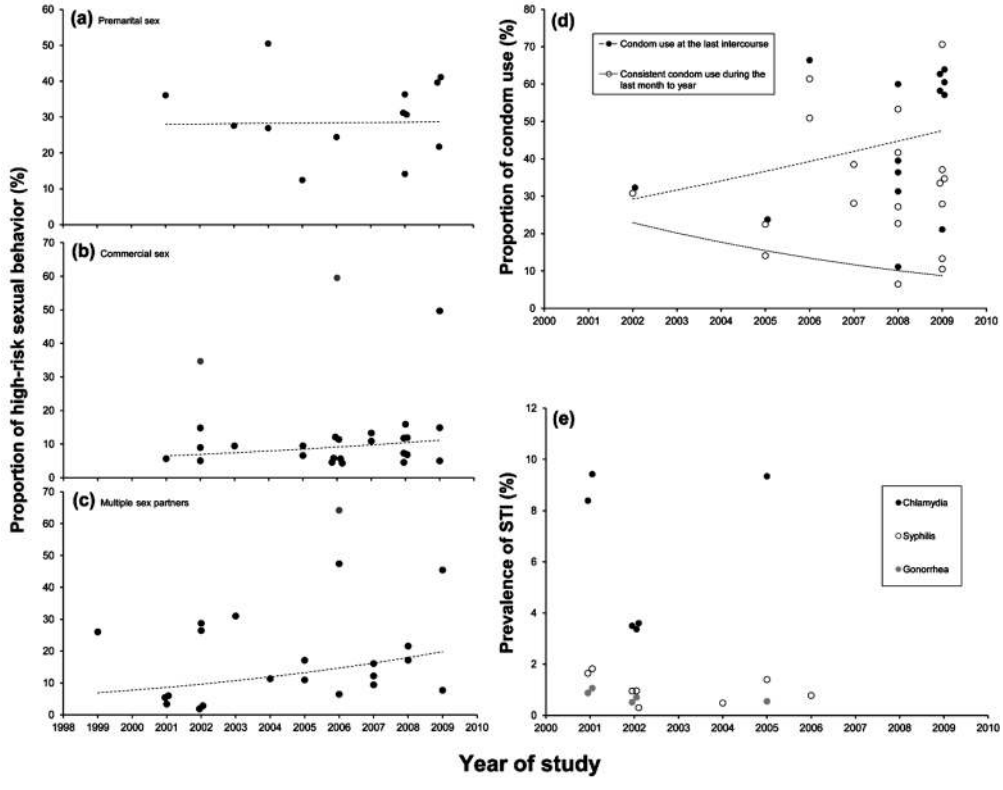

Figure 2.2. Trend analyses of indicators of high-risk sexual behavior in the floating population in China: (**a**) proportion that engaged in premarital sex; (**b**) proportion that engaged in commercial sex; (**c**) proportion that engaged in sex with multiple partners; (**d**) proportion that used condoms with casual or commercial sex partners; (**e**) prevalence of STIs. The dashed lines indicate the average trends calculated by generalized linear mixed model. The grey dots (**b** & **c**) represent studies among migrant truck drivers that were not included in the average trend analysis. Detailed information about the parameters of the dashed lines is given in File S2.4.

Data synthesis of college students

Of the studies that reported sexual risk behaviors among college students, only four presented the percentage that engaged in commercial sex, and that percentage varied widely (range 0-11%; average 5.6%; data not shown).[18-21] The majority of the included studies on college students reported the percentage that engaged in premarital sex or sex with multiple partners. A slightly increasing trend was observed only in the percentage that engaged in premarital sex (Figure 2.3a). This increasing trend was not significant in the univariate GLMM analysis (see results in File S2.4), and not significant after adjusting for modernization class and gender ($p = 0.20$ and 0.99, respectively). Studies that investigated condom use among college students recruited

participants from different universities and in different locations; however, all the included studies reported a similar proportion of students that used condoms both at last sexual intercourse and during last month to year (Figure 2.3c). Two studies presented the prevalence of STIs (one for syphilis, the other for gonorrhea) among college students, and both found a very low prevalence. In one study, none of the sampled college students was infected with syphilis;[19] in the other study, the prevalence of gonorrhea was 0.4%.[22]

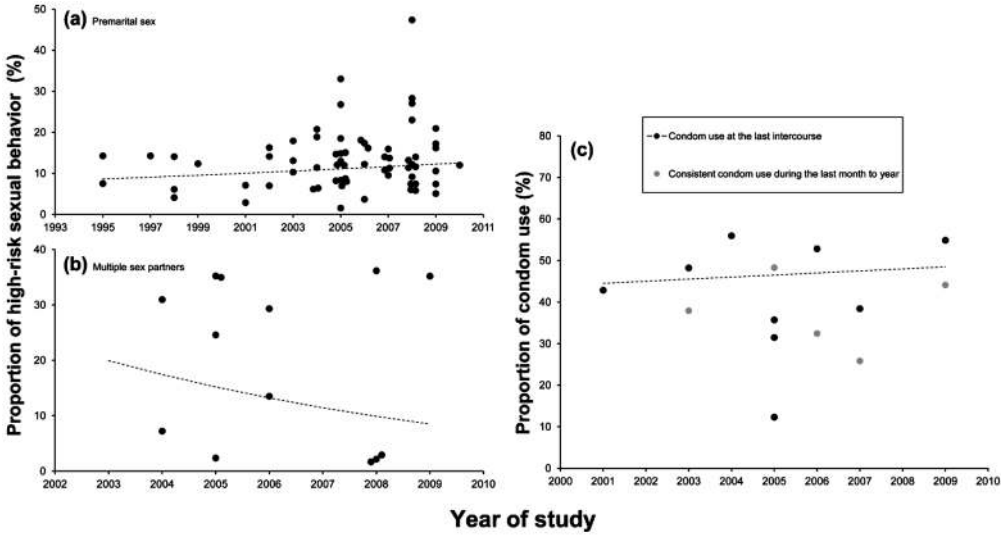

Figure 2.3. Trend analyses of indicators of high-risk sexual behavior in college student population in China: (**a**) proportion that engaged in premarital sex; (**b**) proportion that engaged in sex with multiple partners; (**c**) proportion that used condoms. The dashed lines indicate the average trends calculated by generalized linear mixed model. Detailed information about the parameters of the dashed lines is given in File S2.4.

Data synthesis of other, more general, population groups

The studies that reported information about sexual risk behaviors and condom use in other groups included out-of-school youth and community residents. No increased trends were observed in the reported proportion of out-of-school youth that engaged in premarital sex (Figure 2.4a) or in the reported proportions of community residents that engaged in commercial sex or sex with multiple partners (Figure 2.4b). Of the studies that investigated commercial sex among community residents, one 4-year longitudinal study was included. That study also reported that the proportion (0.8-2.4%) of residents that engaged in commercial sex was relatively stable over the years.[23] However, another study showed extreme results among older individuals (above 50 years old) in Yunnan; they reported a relatively high proportion (13.3%)

of individuals had engaged in commercial sex.[24] Eighteen studies reported the prevalence of chlamydia, syphilis and/or gonorrhea, twelve reported one STI, four reported two kinds of STIs, and two studies reported all the three STIs (see Table S2.3 in File S2.3). The majority of the included studies that reported information about STIs were in clinical settings. The participants were predominately women recruited from gynecological or obstetric clinics and couples that had attended premarital medical check-ups. Among the women recruited from gynecological or obstetric clinics, the average prevalence of chlamydia appeared to have increased over time (Figure 2.4c), but the only one longitudinal study on chlamydia revealed a strong decreased prevalence of chlamydia[25]. Three other studies revealed completely different patterns in the trend of syphilis prevalence: unclear, increasing and stable.[25-28]

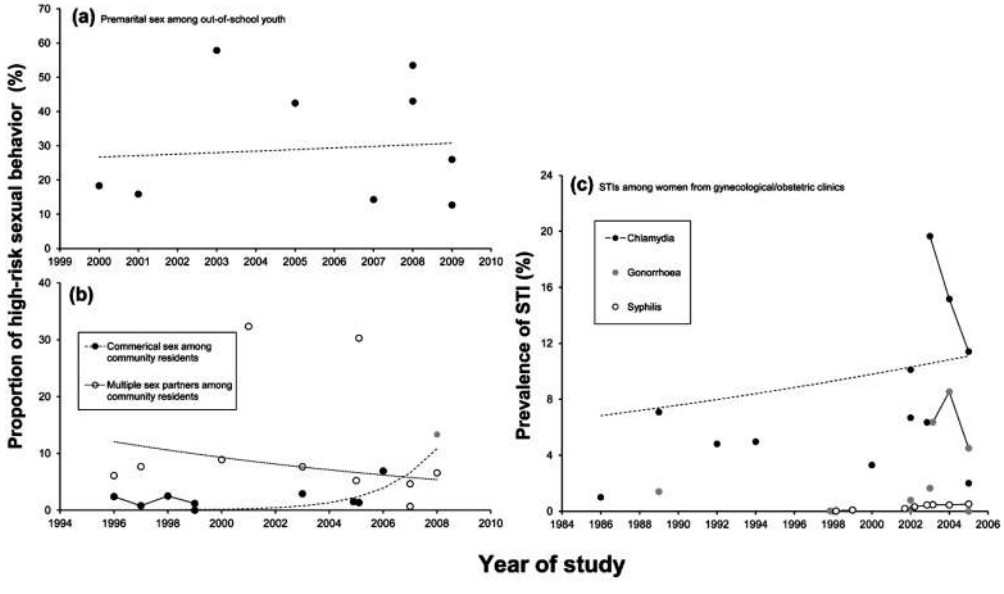

Figure 2.4. Trend analyses of indicators of high-risk sexual behavior in young, out-of-school individuals and community residents in China: (**a**) proportion that engaged in commercial sex among the community residents; (**b**) proportion that engaged in sex with multiple partners among community residents; (**c**) proportion that engaged in premarital sex among the out-of-school youth; (**d**) prevalence of STIs. The connected dots indicate longitudinal studies. The dashed lines indicate the average trends across the years. The grey dot (**b**) represents an outlier study that was not included in the average trend analysis. Detailed information about the parameters of the dashed lines was given in File S2.4.

2.4 Discussion

This is the first study that systematically reviewed literature on high-risk sexual behaviors and STI prevalence among population groups that do not belong to the classical high risk groups in China. Whereas other reviews identified an accelerating STIs/HIV epidemic among some of the classical high-risk populations (e.g. MSM) in China,[5,11,12] our review did not reveal an increased tendency to engage in high-risk sexual behaviors. The available data does not indicate a clear trend of STIs in the general population groups included in our review.

Three important limitations of this study should be noted. Firstly, in the included studies, all the information collected on engaging in premarital sex, commercial sex, sex with multiple partners, and condom use was self-reported. This may have introduced a social desirability bias, particularly in China, where sex was, and remains (to some extent) to be, a taboo topic.[2] Moreover, the taboo was more relaxed in the later than in the earlier study years. Thus, participants in the later studies may have felt less inhibited, and thus, more likely to report the truth. In fact, if this had been taken into account, we may even have found a decreased tendency to engage in high-risk sexual behaviors over time.

Secondly, we identified only a few studies conducted before 2000. This was due to the fact that the Chinese government and academic organizations did not display high interest in studying sexual risk behaviors until the mid-1990s, when an outbreak of HIV occurred in the central provinces. Then, in the late 1990s, the international and national agencies began funding research on sexual risk behaviors and STIs. Consequently, our conclusion that there has been no increase in the tendency to engage in high-risk sexual behaviors has focused only on the past decade.

Thirdly, we only identified four longitudinal studies.[23,25-27] The majority of collected data was reported in cross-sectional studies, which may be less reliable for analyzing general trends, due to issues of comparability. Nevertheless, the four included longitudinal studies revealed no particular trend consistent with an increased tendency to engage in high-risk sexual behaviors. In some cases, they suggested the opposite tendency. For instance, one longitudinal study showed a clearly decreased prevalence of chlamydia among women recruited from gynecological or obstetric clinics.[25]

We did not attempt Meta-regression because the objective of our systematic review was not to obtain a single summarized 'effect estimate' or to explore reasons for the heterogeneity of included studies in our systematic review. Nevertheless, different study designs (e.g. sampling method and demographic composition) could bias the significance of the factor 'study year'. We therefore used GLMM based on the relatively comparable category of population groups, and integrated cofactors such as sampling method, age distribution, gender and marital composition in the analysis. We did not do any further subgroup analysis, as there is only study-level data and no individual data is available.

Our findings contrasted, or were at least inconsistent, with our expectations. We did not find any other increased tendencies to engage in sexual risk behaviors among Chinese population groups that do not belong to the classical high risk groups. This reassuring observation might be explained by the continuous efforts of the Chinese government and various non-government organizations to educate people about HIV/STIs through mass media and condom promotions. Thus, although attitudes in the Chinese population have become more tolerant toward engaging in premarital sex, commercial sex, casual sex, and sex with multiple partners, the knowledge and awareness of HIV/STIs may also have increased.[29] This knowledge may have counteracted the impact of the re-flourishing commercial sex industry and discouraged high-risk sexual behaviors. In addition, a change in the demographics of the sampled population over the years may partly explain the unexpected observations among the floating population. In the early period, the floating population comprised mainly single males, who may have sought sexual services; the later floating population included migrating families and 'temporary couples'.[9] These so-called temporary couples are single migrants who meet each other in the same working area and form a temporary fixed sexual partnership. Thus, the proportion that engaged in high-risk sexual behaviors might be expected to decrease.

Our results revealed no clear increasing trend of STIs from the available data among floating population and women from gynecological or obstetric clinics (Figure 2.2e and 2.4c). This seems to conflict with the national surveillance data, which reveals a rapid increasing trend of syphilis among the whole population [11]. This phenomenon may be explained as follows: first, studies in our review focused on three population groups, who may not be very representative of the whole population. The discrepancy between our results and the surveillance data could have been caused by the paucity and diversity of the available data. Second, the increasing trend of syphilis among the general population may root from the increased prevalence of syphilis in the high-risk groups.[30] However, as an indicator to describe consequence of engaging in sexual risk behaviors, even an increasing trend of STIs not necessarily means an increasing trend of engaging in sexual risk behaviors. The increasing prevalence of STIs among high-risk groups could have caused an increase in prevalence among the general population through their sexual connections, even if the sexual risk behaviors among the general population stayed stable. Also, the discrepancy between our results and the national surveillance data concerns only the trend for syphilis. The surveillance data did not show an increasing trend for other STIs, such as gonorrhea [11], which is consistent with our results.

We reiterate that the aim of this systematic review is to investigate possible trends of engaging in high-risk sexual behaviors, and not of studying the percentage/prevalence values of STIs. The three population groups in our review may not be completely representative of the general population. Comparing percentages of engaging in high-risk sexual behaviors and prevalence of STIs between different population subgroups, or making inference of the percentage/prevalence values of STIs among the general population as a whole, should be avoided.

In conclusion, this systematic review revealed no clear increased tendency to engage in high-risk sexual behaviors, with an unclear trend pattern of STIs, among general Chinese population groups not belonging to the classical high risk groups. This may very well reflect that the sexual risk behavior of the whole general population has not increased substantially. In response to the growing STIs/HIV epidemic, the Chinese government, together with a number of international organizations, actively initiated various intervention programs, such as China-UK AIDS projects, Global Funds rounds 3 to 6.[31] These programs target not only populations at highest risk, but also other population groups (e.g. floating population).[31] Because China remains a resource-limited country, it would be problematic to find that the general population had also increased their participation in high-risk sexual behaviors. If so, the STIs/HIV epidemic will be very difficult to stop and much more resources will be needed. Our results suggest that the STIs/HIV epidemic among the general population is still under control. We recommend China prioritizes the well-known high-risk groups, and avoids diluting the effect of available resources for prevention by spreading these thinly over the whole population, because the epidemic is unlikely to spread rapidly among the general population. On the other hand, these potential risk groups should not be neglected altogether. Even with a stable trend of engaging in sexual risk behaviors, STIs/HIV can continue to spread if all prevention and treatment activities are stopped.

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File S2.1: Search Strategy

We searched Pubmed and the Chinese National Knowledge Infrastructure (CNKI) to identify relevant publications. The search terms included 'sexual behavior', 'condoms', 'sexually transmitted diseases', and 'China'. Detailed search strings for Pubmed are as follows:

(((sexual behavior[Mesh] OR sexualit*[tw] OR sex[tw]) AND (Risk tak*[tw] OR Risk behav*[tiab] OR risky[tiab]))
OR
(condoms[tw] AND (absen*[tiab] OR without[tiab] OR "not used"[tiab] OR "not using"[tiab]) OR unsafe Sex[tw])
OR
((prostitut*[tiab] OR commercial sex[tiab]))
OR
multiple partner*[tiab] OR multiple sex partner*[tiab] OR Extramarital Relations*[tw] OR premarital sex*[tiab]
OR
((sexually transmitted diseases[Mesh] OR sexually transmitted infection[tiab] OR STI*[tiab]) AND (prevalen*[tw] OR epidemi*[tw] OR occurrence*[tiab] OR inciden*))))
AND
China [tw]

We also attempted to identify additional literature from Embase, but no relevant study was added. Search strings for Embase are as follows:

((sexual behavior/exp AND 'high risk behavior'/exp OR (sex NEAR/6 Risk*):de,ab,ti)
OR
((condoms NEAR/6 (absen* OR without OR 'not used' OR 'not using')):de,ab,ti
OR
'unsafe Sex':de,ab,ti) OR (prostitut* OR 'commercial sex'):de,ab,ti OR ('multiple partners' OR 'multiple sex partners' OR (Extramarital NEXT/1 (Relation* OR sex)) OR 'premarital sex'):de,ab,ti
OR
(('sexually transmitted disease'/exp OR (('sexually transmitted' NEXT/3 infect*) OR STI*):de,ab,ti)
AND (prevalen* OR epidemi* OR occurrence*):de,ab,ti))
AND China:de,ab,ti

File S2.2: Modernization classes

We categorized the 31 provinces/autonomous regions of mainland China into five modernization (development level) classes, according to China's Modernization Report 2010 [1] as follows: (first class) provinces/autonomous regions that accomplished 95%-100% modernization; (second class) provinces/autonomous regions with 90%-94% modernization; (third class) provinces/autonomous regions with 85%-89% modernization; (fourth class) provinces/autonomous regions with 80%-84% modernization; and (fifth class) provinces/autonomous regions with less than 80% modernization. The development of provinces/autonomous regions is unequal in China, and the modernization level indicates how developed the provinces or autonomous regions are as compared to Hong Kong.

First class: Beijing, Shanghai, Tianjin, Zhejiang, Guangdong, Jiangsu

Second class: Fujian, Liaoning, Shandong, Chongqing, Hubei

Third class: Jilin, Inter Mongolia, Heilongjiang, Shanxi, Hebei, Ningxia, Shanxi, Anhui

Fourth class: Hunan, Jiangxi, Xinjiang, Gansu, Sichuan, Qinghai, Henan, Hainan

Fifth class: Guangxi, Tibet, Yunnan, Guizhou

Reference

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File S2.3

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
Floating population																	
Anderson, 2003 [1]	1999	Beijing, Shanghai	IP, RW	CS	72	< 40:80%	–	Lifetime	–	–	–	–	–	–	115	442	26.0
Detels, 2003 [2]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	Last year	–	–	–	–	–	–	79	1316	6.0
Li, 2009 [3]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	Last 6 months	–	–	–	–	–	–	244	4510	5.4
NIMH, 2007 [4]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	Last year	122	338	36.1	85	1508	5.6	51	1508	3.4
Hu, 2004 [5]	2002	Anhui	RW	PBS	49	25-44:75%	M: 84%	Last year	–	–	–	–	–	–	13	694	1.9
Li, 2004 [6]	2002	Beijing	RW	QS	66	18-30 (25)	NM: 48%	Lifetime	–	–	–	89	992	9.0	285	992	28.7
		Jiangsu	RW	QS	66	18-30 (26)	NM: 41%	Lifetime	–	–	–	172	1161	14.8	307	1161	26.4
Lou, 2005 [7]	2002	Shanghai	RW, CR	PBS	45	15-24	M/C: 26%	Last year	247	1092	22.6	55	1092	5.0	31	1092	2.8
Sun, 2004 [8]	2002	Sichuan	TD	PBS	–	–	M: 90%	Last year	–	–	–	266	767	34.7	–	–	–
Lin, 2006 [9]	2003	Beijing	RW	QS	–	18-30	NM: 77%	Lifetime	607	2201	27.6	85	900	9.4	279	900	31.0
Xie, 2006 [10]	2004	Guangdong	CR	PBS	0	15-49 (30.6)	M: 100%	Lifetime	1482	2936	50.5	–	–	–	332	2936	11.3
Zhao, 2006 [11]	2004	Guangdong	RW	CS	48	15-34 (20.6)	NM: 100%	Lifetime	359	1333	26.9	–	–	–	–	–	–
Xiao, 2007 [12]	2005	Guangdong	RW	CS	47	20-26:50%	NM: 63%	Last year	–	–	–	11	167	6.6	39	228	17.1
Zhang, 2007 [13]	2005	Guangdong	RW	PBS	0	>15(24)	NM:100%	Last 6 months	233	1872	12.4	–	–	–	97	886	10.9

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
Floating population																	
Zhao, 2005 [14]	2005	Yunnan	RW	CS	100	15-51 (28.4)	M: 70%	Last year	–	–	–	22	232	9.5	–	–	–
Gao, 2010 [15]	2006	Yunnan	RW	PBS	100	17-64 (32)	M: 63%	Last year	–	–	–	116	959	12.1	–	–	–
Li, 2007 [16]	2006	Guangdong	TD	PBS	100	21-62 (36)	M/C: 82%	Last year	–	–	–	153	257	59.5	165	257	64.2
Li, 2007 [17]	2006	8 provinces	RW	PBS	66	18-40 (29)	M: 72%	Last month	–	–	–	62	544	11.4	–	–	–
Liu, 2007 [18]	2006	Jiangxi	MR	PBS	62	16-52 (25.6)	NM: 60%	Lifetime	53	217	24.4	9	160	5.6	14	217	6.5
Li, 2008 [19]	2006	Mongolia	RW	PBS	41	16-65 (33)	M/C: 73%	Lifetime	–	–	–	44	965	4.6	–	–	–
Li, 2010 [20]	2006	Guangdong	CR	PBS	41	15-49	M: 55%	Last 3 months	–	–	–	35	812	4.3	–	–	–
Xin,2010 [21]	2006	Anhui	RW	PBS	94	16-72 (39)	NM: 20%	Last 6 months	–	–	–	63	1082	5.8	–	–	–
He, 2009 [22]	2007	Shanghai	RW	QS	44	18-34:76%	M: 61%	Last year	–	–	–	–	–	–	193	2051	9.4
He, 2009 [23]	2007	Shanghai	RW	CS	100	18-65 (33)	M: 83%	Lifetime	–	–	–	–	–	–	144	895	16.1
Li, 2009 [24]	2007	Chongqing	RW	PBS	68	18-50 (34)	M: 70%	Lifetime	–	–	–	41	377	10.9	–	–	–
Mantell, 2011 [25]	2007	Jiangsu	RW	CS	26	18-57 (23)	M: 22%	Last month	–	–	–	71	534	13.3	84	689	12.2
Chen, 2010 [26]	2008	Sichuan	CR	CS	43	20-40:53%	M: 73%	Last year	–	–	–	24	204	11.8	–	–	–
Gao, 2009 [27]	2008	Shandong	RW	CS	43	15-24 (20)	NM:96%	Lifetime	290	945	30.7	–	–	–	–	–	–
Huang, 2011 [28]	2008	Shanghai	RW	PBS	90	20-74 (39)	M: 84%	Lifetime	93	657	14.2	45	657	6.8	–	–	–
Li, 2012 [29]	2008	Shanxi	MR	PBS	53	26-45:56%	M: 88%	Lifetime	267	735	36.3	–	–	–	126	735	17.1
Lin, 2010 [30]	2008	Guangdong	RW	PBS	41	20-30: 60%	NM: 40%	Last 6 months	–	–	–	25	210	11.9	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
Floating population																	
Ren, 2011 [31]	2008	Shanghai	RW	PBS	100	16-71 (39)	M: 81%	Lifetime	468	1501	31.2	128	1757	7.3	379	1757	21.6
Tan, 2011 [32]	2008	Guangxi	RW	PBS	89	18-48 (32)	M: 51%	Lifetime	–	–	–	33	725	4.6	–	–	–
Zhang, 2010 [33]	2008	Sichuan	IP	CS	85	17-66 (35)	M/C: 86%	Last year	–	–	–	81	509	15.9	–	–	–
Li, 2011 [34]	2009	Anhui	RW	PBS	60	20-50:79%	M: 58%	Last year	281	683	41.1	83	1657	5.0	–	–	–
Wei, 2010 [35]	2009	Chongqing	RW	PBS	73	18-46 (35)	M/C: 84%	Last year	–	–	–	185	1243	14.9	–	–	–
Zhang, 2010 [36]	2009	Guangdong	RW	PBS	51	18-30	M: 33%	Lifetime	67	169	39.6	–	–	–	–	–	–
Zhang, 2011 [37]	2009	Shandong	RW	PBS	0	18-29 (21)	NM: 100%	Last 6 months	177	814	21.7	–	–	–	10	130	7.7
Zuo, 2011 [38]	2009	Guangdong	RW	PBS	100	18-59 (34)	NM: 28%	Lifetime	–	–	–	377	759	49.7	–	–	–
								Last year	–	–	–	–	–	–	345	759	45.5
College students																	
He, 1997 [39]	1995	Yunnan	3 U	PBS	53	17-27 (20)	–	Lifetime	322	2257	14.3	–	–	–	–	–	–
Wu, 1997 [40]	1995	Shanghai	2 U	PBS	54	–	–	Lifetime	73	971	7.5	–	–	–	–	–	–
Li, 1999 [41]	1997	Beijing	5 U	PBS	63	–	–	Lifetime	187	1310	14.3	26	1310	2.0	–	–	–
Tao, 1999 [42]	1998	Anhui	3 U	PBS	72	–	–	Lifetime	54	884	6.1	–	–	–	–	–	–
Wang, 2000 [43]	1998	Shanghai	8 U	PBS	–	–	–	Lifetime	122	2974	4.1	–	–	–	–	–	–
Xia, 2000 [44]	1998	Guangdong	8 U	PBS	44	–	–	Lifetime	160	1136	14.1	–	–	–	–	–	–
Zhang, 2001 [45]	1999	Beijing	1 U	PBS	49	17-26 (21)	–	Lifetime	222	1796	12.4	–	–	–	–	–	–
Cottrell, 2004 [46]	2001	Jiangsu	19 U	PBS	–	–	–	Lifetime	133	1874	7.1	–	–	–	–	–	–
Xiang, 2003 [47]	2001	Guangdong	5 U	PBS	53	–	–	Lifetime	20	694	2.9	–	–	–	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
College students																	
Yang, 2010 [48]	2001	4 provinces	–	PBS	–	–	–	Lifetime	786	11562	6.8	–	–	–	–	–	–
Fan, 2004 [49]	2002	Guangdong	1 U	PBS	46	–	–	Lifetime	63	387	16.3	–	–	–	–	–	–
Huang, 2005 [50]	2002	Hunan	6 U	CS	68	17-28 (20)	–	Lifetime	167	1182	14.1	–	–	–	–	–	–
Song, 2003 [51]	2002	Anhui	1 U	PBS	61	16-30 (20)	–	Lifetime	101	1445	7.0	–	–	–	–	–	–
Lin, 2009 [52]	2003	Guangdong	1 U	PBS	44	–	–	Lifetime	552	3080	17.9	–	–	–	–	–	–
Dong, 2005 [53]	2003	Jilin	1 U	PBS	37	–	–	Lifetime	115	1115	10.3	–	–	–	–	–	–
Ma, 2006 [54]	2003	Zhejiang	2 U	PBS	50	20-23 (20)	–	Last year	2965	22646	13.1	–	–	–	322	2015	16.0
Chen, 2005 [55]	2004	Fujian	8 U	PBS	43	–	–	Lifetime	302	4709	6.4	–	–	–	–	–	–
Guan, 2006 [56]	2004	Liaoning	9 U	PBS	–	–	–	Lifetime	186	3018	6.2	–	–	–	–	–	–
Lonn, 2007 [57]	2004	Xinjiang	1 U	PBS	39	17-24 (21)	–	Lifetime	73	352	20.7	–	–	–	–	–	–
Sun, 2006 [58]	2004	Sichuan	5 U	PBS	37	–	–	Lifetime	348	1843	18.9	–	–	–	133	1843	7.2
Yang, 2010 [48]	2004	4 provinces	–	PBS	42	–	–	Lifetime	668	10045	6.7	–	–	–	–	–	–
Zhai, 2007 [59]	2004	Beijing	2 U	PBS	42	–	–	Lifetime	130	1138	11.4	–	–	–	–	–	–
Cai, 2006 [60]	2005	Anhui	1 U	PBS	57	–	–	Lifetime	148	1227	12.1	–	–	–	29	1227	2.4
Chen, 2008 [61]	2005	Shanghai	14 U	PBS	50	15-34	–	Lifetime	764	5067	15.1	–	–	–	–	–	–
Kong, 2007 [62]	2005	Beijing	6 U	PBS	54	20-26	–	Lifetime	77	416	18.5	–	–	–	–	–	–
Li, 2007 [63]	2005	Guangdong	1 U	PBS	50	18-23 (21)	–	Lifetime	136	508	26.8	–	–	–	31	88	35.2
Li, 2007 [64]	2005	Hubei	1 U	PBS	0	16-23 (20)	–	Lifetime	42	286	14.7	–	–	–	13	42	31.0
Li, 2007 [65]	2005	Sichuan	1 U	PBS	51	17-35 (20)	–	Lifetime	40	499	8.0	–	–	–	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
College students																	
Sun, 2007 [66]	2005	Beijing	2 U	PBS	36	18-24	–	Lifetime	88	1059	8.3	–	–	–	–	–	–
Song, 2010 [67]	2005	Nationwide	84 U	PBS	47	16-24 (20)	–	Lifetime	3803	33653	11.3	–	–	–	–	–	–
Tan, 2007 [68]	2005	Hubei	1 U	PBS	49	–	–	Lifetime	18	259	6.9	0	259	0.0	–	–	–
Xu, 2007 [69]	2005	Hubei	5 U	PBS	0	16-26 (21)	–	Lifetime	118	985	12.0	–	–	–	29	118	24.6
Xu, 2007 [70]	2005	Jiangxi	1 U	PBS	42	–	–	Lifetime	11	701	1.6	–	–	–	–	–	–
Xu, 2007 [71]	2005	Guangxi	4 U	PBS	45	15-29 (21)	–	Lifetime	176	2015	8.7	–	–	–	50	143	35.0
Zeng, 2007 [72]	2005	Guangdong	2 U	PBS	64	16-24	–	Lifetime	185	1245	14.9	–	–	–	–	–	–
Zhang, 2007 [73]	2005	Sichuan	2 U	PBS	0	16-28 (21)	–	Lifetime	533	1615	33.0	–	–	–	–	–	–
Zhao, 2006 [74]	2005	Hebei	1 U	PBS	–	–	–	Lifetime	260	2000	13.0	–	–	–	–	–	–
Zhou, 2006 [75]	2005	Beijing	2 U	PBS	49	–	–	Lifetime	42	512	8.2	–	–	–	–	–	–
Liu, 2007 [76]	2006	Hebei	3 U	PBS	52	19-22	–	Lifetime	36	976	3.7	–	–	–	–	–	–
Wu, 2007 [77]	2006	Zhejiang	1 U	PBS	69	(22)	–	Last year	407	3326	12.2	45	407	11.1	55	407	13.5
Wang, 2007 [78]	2006	Hubei	1 U	PBS	70	17-26 (21)	–	Lifetime	127	786	16.2	–	–	–	–	–	–
Sun, 2010 [79]	2006	9 provinces	30 U	PBS	49	21	–	Lifetime	1707	18795	9.1	–	–	–	–	–	–
Wang, 2010 [80]	2006	6 provinces	–	–	–	–	–	Lifetime	191	4524	4.3	–	–	–	–	–	–
Xu, 2011 [81]	2006	Hubei	13 U	PBS	0	17-26 (20)	–	Lifetime	323	1862	17.3	–	–	–	–	–	–
Yan, 2009 [82]	2006	Hubei	16 U	PBS	0	16-27 (20)	NM: 100%	Lifetime	863	4769	18.1	–	–	–	253	863	29.3
Liu, 2009 [83]	2007	Zhejiang	1 U	PBS	27	–	–	Lifetime	76	477	15.9	–	–	–	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
College students																	
Peng, 2009 [84]	2007	Beijing	6 U	PBS	52	17-26 (20)	–	Lifetime	158	1151	13.7	–	–	–	–	–	–
Wang, 2009 [85]	2007	Zhejiang	2 U	PBS	44	17-26 (21)	–	Lifetime	30	315	9.5	–	–	–	–	–	–
Cheng, 2010 [86]	2007	Shanghai	CR	PBS	45	–	–	Lifetime	223	2062	10.8	–	–	–	–	–	–
Duan, 2011 [87]	2007	Shanxi	1 U	PBS	45	–	–	Lifetime	257	2276	11.3	–	–	–	–	–	–
Yang, 2010 [48]	2007	4 provinces	–	PBS	42	–	–	Lifetime	859	9824	8.7	–	–	–	–	–	–
Zhou, 2009 [88]	2007	7 provinces	49 U	PBS	47	–	–	Lifetime	10693	74258	14.4	–	–	–	–	–	–
Zhou, 2010 [89]	2007	Jiangxi	3 U	PBS	51	17-24 (20)	–	Lifetime	151	1077	14.0	–	–	–	–	–	–
Zhou, 2011 [90]	2007	7 provinces	49 U	PBS	47	18-24	–	Lifetime	7230	62326	11.6	–	–	–	–	–	–
Chen, 2009 [91]	2008	Shanghai	2 U	PBS	59	19-22	–	Lifetime	143	1232	11.6	–	–	–	–	–	–
Pan, 2009 [92]	2008	Zhejiang	1 U	PBS	60	18-23	–	Lifetime	104	744	14.0	–	–	–	–	–	–
Albrektsson, 2009 [93]	2008	Hubei	1 U	PBS	–	–	–	Lifetime	56	611	9.2	–	–	–	–	–	–
Wang, 2010 [80]	2008	6 provinces	–	–	–	–	–	Lifetime	265	4562	5.8	–	–	–	–	–	–
Wu, 2009 [94]	2008	Shandong	1 U	PBS	45	–	–	Lifetime	35	601	5.8	–	–	–	13	601	2.2
Zhang, 2009 [95]	2008	Liaoning	2 U	PBS	38	–	–	Lifetime	75	615	12.2	–	–	–	18	615	2.9
Zhang, 2010 [96]	2008	Chongqing	3 U	PBS	35	–	–	Lifetime	71	954	7.4	–	–	–	16	954	1.7
You, 2010 [97]	2008	Heilongjiang	1 U	PBS	55	17-24 (22)	C: 14.5%	Lifetime	228	843	27.0	–	–	–	–	–	–
You, 2010 [98]	2008	Heilongjiang	3 U	PBS	52	–	–	Lifetime	295	1282	23.0	–	–	–	–	–	–
Wu, 2009 [99]	2008	Henan	2 U	PBS	44	–	–	Lifetime	42	566	7.4	–	–	–	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
College students																	
Zhu, 2009 [100]	2008	Gansu	2 U	PBS	40	–	–	Lifetime	37	615	6.0	–	–	–	–	–	–
Yang, 2010 [101]	2008	Jiangxi	5 U	PBS	46	18-24	NM: 97%	Lifetime	1232	2600	47.4	–	–	–	–	–	–
Yang, 2010 [102]	2008	Sichuan	8 U	PBS	51	17-24 (21)	–	Lifetime	990	3500	28.3	–	–	–	–	–	–
Chen, 2010 [103]	2008	Guizhou	1 U	PBS	45	17-26 (21)	–	Lifetime	177	1554	11.4	–	–	–	64	177	36.2
Shi, 2010 [104]	2008	Guangxi	2 U	PBS	–	–	–	Lifetime	77	583	13.2	–	–	–	–	–	–
Chen, 2011 [105]	2009	Guizhou	2 U	PBS	44	17-24	–	Lifetime	162	1534	10.6	15	162	9.3	57	162	35.2
Wang, 2010 [80]	2009	6 provinces	–	–	–	–	–	Lifetime	275	4582	6.0	–	–	–	–	–	–
Liu, 2011 [106]	2009	Jiangsu	7 U	PBS	59	16-25	–	Lifetime	53	717	7.4	–	–	–	–	–	–
Wang, 2010 [107]	2009	Hubei	8 U	PBS	66	17-25 (20)	–	Lifetime	58	1143	5.1	–	–	–	–	–	–
Wang, 2011 [108]	2009	Chongqing	1 U	PBS	100	17-24 (21)	C: 0.5%	Lifetime	95	552	17.2	–	–	–	–	–	–
Yang, 2011 [109]	2009	Yunnan	7 U	PBS	0	18-25 (22)	–	Lifetime	124	766	16.2	–	–	–	–	–	–
Zhu, 2011 [110]	2009	Jilin	1 U	PBS	0	–	–	Lifetime	449	2143	21.0	–	–	–	–	–	–
Guo, 2011 [111]	2010	Beijing	6 U	PBS	48	16-28 (20)	–	Lifetime	125	1041	12.0	–	–	–	–	–	–
Other groups																	
Ma, 2001 [112]	1996	Yunnan	CR	PBS	–	15-69	M: 59%	Last month	–	–	–	–	–	2.4	–	–	–
Sun, 2001 [113]	1996	Jiangsu	CR	PBS	–	18-30	–	Lifetime	–	–	–	–	–	–	33	541	6.1
Liu, 1998 [114]	1997	Anhui	CR	PBS	50	15-45	M: 83%	Lifetime	202	886	22.8	–	–	–	68	886	7.7
	1997	Yunnan	CR	PBS	–	15-69	M: 59%	Last month	–	–	–	–	–	0.8	–	–	–
	1998	Yunnan	CR	PBS	–	15-69	M: 59%	Last month	–	–	–	–	–	2.5	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
Other groups																	
Xia, 2004 [115]	1999	Hainan	CR	PBS	0	18-49 (34)	M: 95%	Lifetime	89	606	14.7	0	606	0.0	–	–	–
	1999	Yunnan	CR	PBS	–	15-69	M: 59%	Last month	–	–	–	–	–	1.2	–	–	–
Parish, 2003 [116]	2000	Nationwide	CR	PBS	–	20-64	–	Last year	–	–	–	–	–	–	211	2373	8.9
Wang, 2002 [117]	2000	Shanghai	OY	PBS	61	17-24	NM: 100%	Lifetime	239	1304	18.3	–	–	–	–	–	–
Yu, 2003 [118]	2001	Gansu	CR	PBS	74	20-49	–	Lifetime	–	–	–	–	–	–	275	850	32.4
Zhang, 2004 [119]	2001	Jilin	OY	PBS	50	15-24	NM: 100%	Lifetime	172	1083	15.9	–	–	–	–	–	–
Liu, 2005 [120]	2003	Anhui	OY	CS	50	17-37 (24)	NM: 100%	Lifetime	350	605	57.9	–	–	–	59	605	9.8
Tang, 2009 [121]	2003	Sichuan	CR	PBS	0	20-49 (34)	M: 100%	Lifetime	–	–	–	–	–	–	153	2000	7.7
Yang, 2007 [122]	2003	Yunnan	CR	PBS	45	18-55	M: 88%	Lifetime	–	–	–	138	4759	2.9	–	–	–
Chang, 2007 [123]	2005	Liaoning	OY	PBS	54	15-24 (21)	NM: 92%	Lifetime	248	584	42.5	70	248	28.2	–	–	–
Fu, 2011 [124]	2005	Yunnan	CR	PBS	53	16-55 (35)	M: 79%	Last 4 years	–	–	–	8	591	1.4	179	591	30.3
Ji, 2007 [125]	2005	Anhui	CR	PBS	33	25-55	M: 93%	Last year	–	–	–	30	1997	1.5	–	–	–
Niu, 2007 [126]	2005	Henan	CR	PBS	48	18-60 (34)	M: 85%	Last year	94	852	11.0	–	–	–	41	784	5.2
Zhao, 2006 [127]	2005	Nationwide	CR	PBS	63	15-64	M: 0%	Lifetime	113	709	15.9	–	–	–	–	–	–
Pan, 2011[128]	2006	Nationwide	CR	PBS	–	15-49	–	Lifetime	719	2066	34.8	95	1377	6.9	–	–	–
Hong, 2009 [129]	2007	Anhui	CR	PBS	0	18-49 (31)	M: 100%	Lifetime	–	–	–	–	–	–	5	737	0.7
Qin, 2009 [130]	2007	Anhui	CR	PBS	0	18-49 (36)	M: 100%	Last year	–	–	–	–	–	–	87	1873	4.6
Xiong, 2010 [131]	2007	Hubei	OY	PBS	45	23-40	M: 80%	Lifetime	8	56	14.3	–	–	–	–	–	–

Table S2.1: Studies reporting sexual risk behaviors among population groups that do not belong to the classical high risk groups in China. Each section (row in grey) represents different study population groups *(Continued)*.

First author, publication year	Study design								Sexual risk behaviors								
									Premarital sex			Commercial sex			Multiple sex partners		
	Study year	Study location	Study base*	Sample method#	Male (%)	Age range (Mean)	Marital status¶	Time span	n	N	%	n	N	%	n	N	%
Other groups																	
Li, 2010 [132]	2008	Shanxi	CR	PBS	40	18-60 (40)	M: 84%	Lifetime	–	–	–	–	–	–	109	1660	6.6
Li, 2010 [133]	2008	Yunnan	CR	CS	100	(58)	M: 78%	Last month	–	–	–	22	165	13.3	–	–	–
Ma, 2010 [134]	2008	Gansu	OY	PBS	64	15-24 (20)	M/C: 33%	Last year	123	230	53.5	–	–	–	46	123	37.4
Xuan, 2010 [135]	2008	Henan	OY	PBS	–	14-28	NM: 39%	Lifetime	37	86	43.0	–	–	–	27	222	12.2
He, 2011 [136]	2009	4 provinces	CR	PBS	45	20-35	NM: 100%	Lifetime	411	1631	25.2	–	–	–	–	–	–
Pan, 2011 [137]	2009	Sichuan	OY	PBS	65	14-28 (21)	–	Lifetime	157	604	26.0	20	604	3.3	26	310	8.4
Zhang, 2011 [138]	2009	Shanghai	OY	PBS	50	15-24 (19)	NM: 100%	Lifetime	765	6023	12.7	–	–	–	–	–	–

* RWs: routine workers from venues: e.g. factories, restaurants, retail shops and markets; TD: truck drivers; CR: community residents; IP: in transit individuals; MR: migrant workers returned to rural areas; U: university/universities; OY: out-of-school youth; PC: participants recruited from clinical settings, i.e. gynecological or obstetric clinics and premarital medical check-up centers.

CS: convenience sampling; QS: quota sampling; PBS: probability-based sampling (i.e. cluster sampling, stratified sampling, multi-stage sampling).

¶ M: married; NM: never married; C: cohabiting.

Table S2.2: Studies reporting condom usage among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations.

First author, publication year	Study design						Condom usage					
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Type of sexual partners	Time span	n	N	%
Floating population												
Chen, 2006 [139]	2000	Anhui	TD	CS	100	15-51 (28)	M: 72%	Unspecified	Last time	149	418	35.6
NIMH, 2007 [4]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	Unspecified	Last 3 months	129	1204	10.7
Li, 2004 [6]	2002	Beijing	RW	QS	66	18-30 (25)	NM: 48%	Unspecified	Last three times	211	992	21.3
	2002	Jiangsu	RW	QS	66	18-30 (26)	NM: 41%	Unspecified	Last three times	289	1161	24.9
Liu, 2004 [140]	2002	Guangdong	RW	QS	0	16-25 (19)	M: 74%	Unspecified	Last time	7	192	3.6
Sun, 2004 [8]	2002	Sichuan	TD	PBS	–	–	M: 90%	Commercial	Last year	82	266	30.8
								Casual	Last time	53	164	32.3
Lin, 2006 [9]	2003	Beijing	RW	QS	–	18-30	NM: 77%	Unspecified	Last three times	212	900	23.6
Zheng, 2006 [141]	2004	Beijing	RW	CS	100	18-40 (28)	M: 65%	Unspecified	Last year	30	648	4.6
Zheng, 2006 [142]	2004	Shanxi	CR	CS	89	18-50 (30)	–	Unspecified	Last time	131	394	33.2
									Last year	76	394	19.3
Ding, 2006 [143]	2005	Chongqing	CR	PBS	53	13-58 (29)	NM: 51%	Casual	Last year	11	78	14.1
Xiao, 2007 [12]	2005	Guangdong	RW	CS	47	20-26: 50%	NM: 63%	Casual	Last year	29	129	22.5
Zhang, 2007 [13]	2005	Guangdong	RW	PBS	0	> 15 (24)	NM: 100%	Unspecified	Last 6 months	98	233	42.1
Zhao, 2005 [14]	2005	Yunnan	RW	CS	100	15-51 (28.4)	M: 70%	Commercial	Last time	5	21	23.8
Gao, 2010 [15]	2006	Yunnan	RW	PBS	100	17-64 (32)	M: 63%	Commercial	Last time	77	116	66.4
									Last year	59	116	50.9
Li, 2007 [16]	2006	Guangdong	TD	PBS	100	21-62 (36)	M/C: 82%	Commercial	Last year	94	153	61.4
Li, 2008 [144]	2006	Tianjin	RW	PBS	66	16-65 (32)	M: 67%	Unspecified	Last year	261	551	47.4
Li, 2008 [19]	2006	Mongolia	RW	PBS	41	16-65 (33)	M/C: 73%	Commercial	Last year	16	44	36.4
Li, 2010 [20]	2006	Guangdong	CR	PBS	41	15-49	M: 55%	Unspecified	Last year	426	812	52.5

Table S2.2: Studies reporting condom usage among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design						Condom usage					
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Type of sexual partners	Time span	n	N	%
Floating population												
He, 2009 [22]	2007	Shanghai	RW	QS	44	18-34: 76%	M: 61%	Unspecified	Last month	334	1756	19.0
Mantell, 2011 [25]	2007	Jiangsu	RW	CS	44	18-57 (23)	M: 22%	Casual	Last month	70	182	38.5
								Unspecified	Last time	209	370	56.5
Zhang, 2008 [145]	2007	Shandong	MR	PBS	54	15-69 (36)	–	Casual	Last 3 months	36	128	28.1
Chen, 2010 [26]	2008	Sichuan	CR	CS	43	20-40: 53%	M: 73%	Commercial	Last time	–	–	60.0
								Casual	Last time	–	–	31.3
Liang, 2009 [146]	2008	Guangdong	RW	QS	39	< 35: 91%	–	Casual	Last year	113	249	45.4
Lin, 2010 [30]	2008	Guangdong	RW	PBS	39	20-30: 60%	NM: 40%	Casual	Last 6 months	5	12	41.7
Meng, 2010 [147]	2008	Jilin	RW	PBS	90	18-48 (34)	M: 70%	Casual	Last time	36	325	11.1
								Casual	Last year	21	325	6.5
Ren, 2011 [31]	2008	Shanghai	RW	PBS	100	16-71 (39)	M: 81%	Unspecified	Last 3 months	115	980	11.7
								Casual	Last 3 months	16	30	53.3
Tan, 2011 [32]	2008	Guangxi	RW	PBS	89	18-48 (32)	M: 51%	Unspecified	Last 6 months	130	785	16.6
Wei, 2010 [148]	2008	Henan	RW	CS	–	17-40: 85%	M: 54%	Unspecified	Last time	59	380	15.5
Zhang, 2010 [33]	2008	Sichuan	IP	CS	85	17-66 (35)	M/C: 86%	Commercial	Last time	32	81	39.5
								Commercial	Last year	22	81	27.2
								Casual	Last time	24	66	36.4
								Casual	Last year	15	66	22.7

Table S2.2: Studies reporting condom usage among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design						Condom usage					
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Type of sexual partners	Time span	n	N	%
Floating population												
Du, 2011 [149]	2009	Chongqing	RW	PBS	85	20-50: 86%	M/C: 87%	Commercial	Last time	20	35	57.1
								Commercial	Last year	13	35	37.1
								Casual	Last time	4	19	21.1
								Casual	Last year	2	19	10.5
Li, 2011 [34]	2009	Anhui	RW	PBS	60	20-50: 79%	M: 58%	Commercial	Last time	53	83	63.9
								Commercial	Last year	24	86	27.9
S un, 2011 [150]	2009	2 provinces	RW	PBS	56	15-24 (21)	M: 21%	Unspecified	Last time	211	333	63.4
Wang, 2011 [151]	2009	Shanghai	RW	PBS	96	16-65 (40)	M/C: 84%	Casual	Last 3 months	12	17	70.6
Wei, 2010 [35]	2009	Chongqing	RW	PBS	73	18-46 (35)	M/C: 84%	Commercial	Last time	112	185	60.5
								Commercial	Last year	62	185	33.5
								Casual	Last time	57	98	58.2
								Casual	Last year	34	98	34.7
Zhang, 2010 [36]	2009	Guangdong	RW	PBS	51	18-30	M: 33%	Casual	Last year	11	83	13.3
									Last time	52	83	62.7
College students												
Cottrell, 2004 [46]	2001	Jiangsu	19 U	PBS	–	–	–	Unspecified	Last time	57	133	42.9
Ma, 2006 [54]	2003	Zhejiang	2 U	PBS	50	–	–	Unspecified	Last time	1217	2524	48.2
									Last year	764	2015	37.9
Chen, 2005 [55]	2004	Fujian	8 U	PBS	43	–	–	Unspecified	Last time	169	302	56.0
Cai, 2006 [60]	2005	Anhui	1 U	PBS	57	–	–	Unspecified	Last month	71	147	48.3

Table S2.2: Studies reporting condom usage among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design						Condom usage					
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Type of sexual partners	Time span	n	N	%
College students												
Li, 2007 [65]	2005	Sichuan	1 U	PBS	51	17-35 (20)	–	Unspecified	Last time	–	–	12.3
Tan, 2007 [68]	2005	Hubei	1U	PBS	49	–	–	Unspecified	Last time	–	–	35.7
Xu, 2007 [71]	2005	Guangxi	4 U	PBS	45	15-29 (21)	–	Unspecified	Last time	45	143	31.5
Wu, 2007 [77]	2006	Zhejiang	1 U	PBS	69	M:22	–	Commercial	Last year	12	37	32.4
								Unspecified	Last time	215	407	52.8
Zhou, 2010 [89]	2007	Jiangxi	3 U	PBS	51	17-24 (20)	–	Unspecified	Last time	58	151	38.4
									Last 3 months	39	151	25.8
Wang, 2011 [108]	2009	Chongqing	1 U	PBS	100	17-24 (20.6)	C: 0.5%	Unspecified	Last time	45	82	54.9
									Last month	30	68	44.1
Other groups												
Sun, 2001 [113]	1996	Jiangsu	CR	PBS	–	18-30 (24)	–	Unspecified	Last time	23	270	8.5
Wang, 2000 [152]	1998	Sichuan	CR	PBS	100	16-35	–	Casual	Last year	38	99	38.4
Chen, 2006 [153]	2002	Fujian	PC	CS	0	M:27	M: 100%	Unspecified	Last time	33	362	9.1
Tang, 2009 [121]	2003	Sichuan	CR	PBS	0	20-49 (34)	M: 100%	Unspecified	Last 3 months	118	2000	5.9
Zhang, 2007 [154]	2004	Hebei	CR	PBS	0	20-52 (37)	M: 100%	Unspecified	Last year	222	2178	10.2
Fu, 2011 [124]	2005	Yunnan	CR	PBS	53	16-55 (34.6)	M: 79%	Casual	Last 4 years	20	90	22.2
Ji, 2007 [125]	2005	Anhui	CR	PBS	33	25-55	M: 93%	Commercial	Last year	35	149	23.5
Niu, 2007 [126]	2005	Henan	CR	PBS	48	18-60 (34)	M: 85%	Unspecified	Last year	37	784	4.7
Xu, 2007 [155]	2006	Anhui	CR	PBS	51	15-49 (33)	–	Casual	Last time	20	30	66.7

Table S2.2: Studies reporting condom usage among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design						Condom usage					
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Type of sexual partners	Time span	n	N	%
Other groups												
Ye, 2008 [156]	2007	Anhui	CR	PBS	0	18-49 (35.6)	M:100%	Unspecified	Last year	13	382	3.4
Li, 2010 [133]	2008	Yunnan	CR	CS	100	M:58	M:78%	Commercial	Last month	5	22	22.7
								Unspecified	Last month	13	165	7.9
Ma, 2010 [134]	2008	Gansu	OY	PBS	64	15-24 (20)	M/C:33%	Commercial	Last time	32	46	69.6
Zhou, 2010 [157]	2008	Shanghai	CR	PBS	58	18-60 (39)	M:81%	Unspecified	Last time	354	1744	20.3

* RWs: routine workers from venues: e.g. factories, restaurants, retail shops and markets; TD: truck drivers; CR: community residents; IP: in transit individuals; MR: migrant workers returned to rural areas; U: university/universities; OY: out-of-school youth; PC: participants recruited from clinical settings, i.e. gynecological or obstetric clinics and premarital medical check-up centers.

CS: convenience sampling; QS: quota sampling; PBS: probability-based sampling (i.e. cluster sampling, stratified sampling, multi-stage sampling).

¶ M: married; NM: never married; C: cohabiting.

Table S2.3: Studies reporting STIs among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations.

First author, publication year	Study design							STDs											
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Chlamydia				Syphilis				Gonorrhea			
								TM§	n	N	%	TM§	n	N	%	TM§	n	N	%
Floating population																			
Detels, 2003 [2]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	LCR	124	1316	9.4	RPR, TPPA	24	1316	1.8	LCR	14	1316	1.1
NIMH, 2007 [4]	2001	Fujian	RW	PBS	48	18-40	M/C: 78%	PCR	124	1478	8.4	TPPA	25	1520	1.6	PCR	13	1485	0.9
He, 2005 [158]	2002	Shanghai	RW	CS	100	16-66 (33.6)	M: 92%	LCR	34	972	3.5	TPHA	8	841	0.9	LCR	5	972	0.5
Hu, 2004 [5]	2002	Anhui	RW	PBS	49	25-44: 75%	M: 84%	PCR	12	333	3.6	RPR	1	333	0.3	–	–	–	–
Ye, 2003 [159]	2002	Shanghai	RW	–	100	20-35	–	LCR	38	1128	3.4	TRUST, TPPA	10	1041	1.0	LCR	8	1128	0.7
Hesketh, 2005 [160]	2004	Zhejiang	RW	PBS	51	14-67 (24)	M/C: 52%	–	–	–	–	VDRL, TPPA	20	4148	0.5	–	–	–	–
Ge, 2007 [161]	2005	Shanghai	RW	PBS	81	17-63 (36)	–	–	–	–	–	RPR, TPHA	8	571	1.4	–	–	–	–
Zhao, 2005 [14]	2005	Yunnan	RW	CS	100	15-51 (28.4)	M: 70%	PCR	17	182	9.3	–	–	–	–	PCR	1	182	0.6
Li, 2007 [16]	2006	Guangdong	TD	PBS	100	21-62 (36)	M/C: 82%	–	–	–	–	TRUST	2	257	0.8	–	–	–	–
College students																			
Zhang, 2007 [73]	2005	Sichuan	2 U	PBS	0	16-28 (21.2)	–	–	–	–	–	–	–	–	–	–	7	1615	0.4
Wu, 2007 [77]	2006	Zhejiang	1 U	PBS	69	(22)	–	–	–	–	–	RPR	0	1608	0.0	–	–	–	–
Other groups																			
Hodgson, 1988 [162]	1986	Zhejiang	PC	CS	0	18-55	NM: 7%	DFA	10	1000	1.0	–	–	–	–	–	–	–	–
Ni, 1990 [163]	1989	Beijing	PC	CS	0	–	–	DFA	43	607	7.1	–	–	–	–	–	–	–	–
Yang, 1990 [164]	1989	Liaoning	PC	–	0	–	–	–	–	–	–	–	–	–	–	LCR	7	500	1.4
Jiang, 1994 [165]	1992	Liaoning	CR	–	39	19-59	–	DFA	12	249	4.8	–	–	–	–	–	–	–	–
Li, 1997 [166]	1994	Yunnan	CR	PBS	0%	–	M: 100%	DFA	33	664	5.0	–	–	–	–	–	–	–	–

Table S2.3: Studies reporting STIs among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design							STDs										
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Chlamydia				Syphilis				Gonorrhea			
								TM§	n	N	%	TM§	n	N	%	TM§	n	N	%
Other groups																			
Wu, 2000 [167]	1997	Fujian	PC	PBS	50	–	–	–	–	–	–	TRUST, TPPA	–	–	1.2	–	–	–	–
	1998	Fujian	PC	PBS	50	–	–	–	–	–	–	TRUST, TPPA	–	–	1.7	–	–	–	–
	1999	Fujian	PC	PBS	50	–	–	–	–	–	–	TRUST, TPPA	59	2872	2.1	–	–	–	–
Deng, 2000 [168]	1998	Guangdong	PC	PBS	0	–	–	–	–	–	–	VDRL, TPHA	1	4400	0.0	–	1	4400	0.0
	1999	Guangdong	PC	PBS	0	–	–	–	–	–	–	VDRL, TPHA	4	4545	0.1	–	–	–	–
Parish, 2003 [116]	2000	Nationwide	CR	PBS	52	20-64	–	LCR	78	2373	3.3	–	–	–	–	–	–	–	–
Hesketh, 2005 [169]	2001	Zhejiang	PC	PBS	50	–	–	–	–	–	–	TPHA	49	8910	0.6	–	–	–	–
	2001	Shanxi	PC	PBS	50%	–	–	–	–	–	–	TPHA	16	4562	0.4	–	–	–	–
	2001	Yunnan	PC	PBS	50%	–	–	–	–	–	–	TPHA	24	3742	0.6	–	–	–	–
Yu, 2003 [118]	2001	Gansu	CR	PBS	74%	20-49	–	–	–	–	–	TRUST	30	850	3.5	–	–	–	–
Chen, 2006 [153]	2002	Fujian	PC	CS	0	(27)	M: 100%	PCR	51	504	10.1	TPPA	1	504	0.2	PCR	4	504	0.8
Cheng, 2007 [170]	2002	Shenzhen	PC	PBS	0	–	–	–	–	–	–	TRUST, TPPA	189	58785	0.3	–	–	–	–
	2003	Shenzhen	PC	PBS	0	–	–	–	–	–	–	TRUST, TPPA	555	118235	0.4		–	–	–
	2004	Shenzhen	PC	PBS	0	–	–	–	–	–	–	TRUST, TPPA	637	141619	0.5	–	–	–	–
	2005	Shenzhen	PC	PBS	0	–	–	–	–	–	–	TRUST, TPPA	827	159017	0.5	–	–	–	–
Wen, 2003 [171]	2002	Shanghai	CR	PBS	0	36-49: 80%	M: 100%	DFA	109	1631	6.68	–	–	–	–	–	2	1631	0.12
He, 2007 [172]	2003	Hubei	PC	PBS	0	(27)	M: 100%	PCR	102	519	19.7	–	–	–	–	PCR	33	519	6.4
	2004	Hubei	PC	PBS	0	–	–		64	422	15.2	–	–	–	–	–	36	422	8.5
	2005	Hubei	PC	PBS	0	–	–		43	377	11.4	–	–	–	–	–	17	377	4.5
Tang, 2009 121	2003	Sichuan	CR	PBS	0	20-49 (34)	M: 100%	LCR	127	2000	6.4	RPR, TPHA	9	2000	0.5	GC	33	2000	1.7

Table S2.3: Studies reporting STIs among population groups that do not belong to the classical high risk groups in China. Each section represents different study populations *(Continued)*.

First author, publication year	Study design							STDs										
	Study year	Study location	Study base*	Sampling method#	Male (%)	Age range (Mean)	Marital status¶	Chlamydia				Syphilis				Gonorrhea			
								TM§	n	N	%	TM§	n	N	%	TM§	n	N	%
Other groups																			
Hesketh, 2005 [169]	2004	Zhejiang	CR	CS	47	16-71 (33)	M/C: 80%	–	–	–	–	VDRL, TPHA	15	2197	0.7	–	–	–	–
Franceschi, 2007 [173]	2005	Shanxi	CR	PBS	0%	20-44	–	PCR	8	399	2.0	–	–	–	–	PCR	0	399	0.0
Dai, 2012 [174]	2009	Sichuan	CR	PBS	45%	15-49: 73%	M/C: 83%	–	–	–	–	RPR, TPHA	2	4950	0.0	–	–	–	–

* RWs: routine workers from venues: e.g. factories, restaurants, retail shops and markets; TD: truck drivers; CR: community residents; IP: in transit individuals; MR: migrant workers returned to rural areas; U: university/universities; OY: out-of-school youth; PC: participants recruited from clinical settings, i.e. gynecological or obstetric clinics and premarital medical check-up centers.

CS: convenience sampling; QS: quota sampling; PBS: probability-based sampling (i.e. cluster sampling, stratified sampling, multi-stage sampling).

¶ M: married; NM: never married; C: cohabiting.

§TM: testing methods. Chlamydia infection was tested based on nucleic acid hybridization by Ligase Chain Reaction (LCR), or nucleic acid amplification by Polymerase Chain Reaction (PCR), or Direct Fluorescent Antibody test (DFA); syphilis infection was tested based on Toluidine Red Unheated Serum Test (TRUST), or Treponema Pallidum Particle Agglutination assay (TPPA), or Venereal Disease Research Laboratory test (VDRL), or Rapid Plasma Reagin test (RPR), or Treponema Pallidum Hemagglutination Assay (TPHA); gonorrhea infection was tested based on similar methods as Chlamydia, i.e. LCR, PCR, or Gonorrhea Culture (GC).

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File S2.4: Results of generalized linear mixed model analysis (GLMM). We relate the proportion/prevalence (P_i) of each indicator of high-risk sexual behavior to year of study by the function as follows: logit (P_i) = α+ β * (Year of study-2000) + γ_i, where γ_i ~N (0, σ^2). γ_i is a random effect term, which takes into account heterogeneity of study designs of the various studies. Dashed lines in the Fig. 2-4 reflect average proportion/prevalence trends, which only consider α and β. Parameters of α, β, and σ^2 are shown in the following table:

Indicator of high-risk sexual behavior		α	(95% CI)	β	(95% CI)	p-value	σ^2
Floating population							
Premarital sex	Fig. 2.2a	-0.94	(-1.75, -0.14)	0.00	(-0.12, 0.13)	0.94	0.31
Commercial sex	Fig. 2.2b	-2.75	(-3.52, -1.98)	0.07	(-0.04, 0.19)	0.20	0.43
Multiple sex partners	Fig. 2.2c	-2.48	(-3.21, -1.75)	0.12	(-0.03, 0.26)	0.10	0.92
Condom use at the last intercourse	Fig. 2.2d	-1.11	(-3.28, 1.07)	0.11	(-0.16, 0.39)	0.39	0.75
Condom use during the last month to year	Fig. 2.2d	-0.89	(-3.92, 2.14)	-0.16	(-0.56, 0.24)	0.40	2.24
College students							
Premarital sex	Fig. 2.3a	-2.22	(-2.49, -1.96)	0.03	(-0.02, 0.07)	0.19	0.39
Multiple sex partners	Fig. 2.3b	-0.90	(-3.68, 1.89)	-0.16	(-0.61, 0.28)	0.44	1.87
Condom use at the last intercourse	Fig. 2.3c	-0.24	(-1.13, 0.65)	0.02	(-0.14, 0.18)	0.77	0.14
Other, more general groups							
Premarital sex among out-of-school youth	Fig. 2.4a	-1.01	(-2.44, 0.42)	0.02	(-0.20, 0.25)	0.82	0.84
Commercial sex among community residents	Fig. 2.4b	-6.50	(-10.64, -2.36)	0.59	(-0.29, 1.46)	0.12	0.96
Multiple sex partners among community residents	Fig. 2.4b	-2.28	(-3.32, -1.24)	-0.07 -0.07	(-0.28, 0.14)	0.45	1.33
Chlamydia among women recruited from gynlogical clinics	Fig. 2.4c	-2.57	(-3.10, -2.04)	0.07	(-0.01, 0.15)	0.069	0.55

Chapter 3

Prevalence and risk factors of syphilis infection among female sex workers in Shenzhen, China: An observational study (2009-2012)

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Abstract

Background: Syphilis has made a remarkable come-back in China since 1980. Female sex workers (FSWs) are of particular concern because they themselves are under higher risk and they serve as the bridge of transmitting STDs to other people. To investigate prevalence and risk factors of syphilis infection, we conducted an observational study among FSWs in Shenzhen, China (2009- 2012).

Methods: We performed questionnaire-based interviews for socio-demographics, behaviors and syphilis testing results from 1653 FSWs recruited by venue-based sampling. Logistic regression was used to assess risk factors of syphilis infection.

Results: The overall syphilis prevalence was 4.7%, showing a slightly decreasing trend. Factors significantly associated with syphilis infection were inconsistent condom use (OR = 1.87, $p = 0.015$), illicit drug use (OR = 5.45, $p < 0.001$), and older age in years (OR = 1.08, $p < 0.001$). Venues where FSWs were recruited and duration of commercial sex work were not significantly associated with syphilis infection ($p > 0.05$).

Conclusions: Syphilis is still common among FSWs in Shenzhen, China. Current comprehensive prevention programs (e.g. condom promotion and peer education) should be continued to maintain and where possible increase safe sexual practices and to reduce illicit drug use among FSWs. Expanding point-of-care syphilis screening programs may be an important strategy for early diagnosis. We recommend timely and effective treatment programs to be linked to such screening programs.

3.1 Introduction

Syphilis has made a remarkable come-back in China since the establishment of the 'Open-Door Policy' in 1980.[1,2] While the rapid economic development has improved public health conditions, the resulting economic disparities, internal migration and re-establishment of the commercial sex industry have greatly facilitated the spread of syphilis and other sexually transmitted diseases (STDs).[3,4] After the near eradication of syphilis during the 1970s, the prevalence of syphilis has increased rapidly and nowadays it ranks as the third most prevalent notifiable infectious disease in China, with about 400,000 new reported cases in 2011.[5,6] Congenital syphilis has also reemerged, with very few cases in the 1990s but 139 reported cases of congenital syphilis per 100,000 live births in 2009.[6]

Populations at high risk of unsafe sexual practices, such as female sex workers (FSWs), are of particular concern with regard to STDs. It is estimated that there are between one and four million FSWs in China, in both lower end (i.e., on the street, hair salons, and temporary small clubs) and higher end venues (i.e., karaoke clubs, night clubs, and hotels).[3,7,8] The prevalence of syphilis is alarmingly high among FSWs, especially in more economically developed provinces where the commercial sex industry is common.[5,9] The median syphilis prevalence is estimated to be approximately 7% among FSWs nationwide,[3] with a prevalence as high as 14% in Guangdong province in 2008,[10] indicating that unsafe sexual practices are common among FSWs and that syphilis is spreading readily.

As the HIV epidemic in China continues to expand, especially through heterosexual transmission,[11] syphilis among FSWs is also of concern with regard to the HIV epidemic. Although the HIV prevalence remains relatively low and stable among FSWs (around 0.5%),[3,11] the high prevalence of syphilis can facilitate the HIV epidemic by increasing about 1 to 5 times of the infectiousness and/or susceptibility through the cofactor effect.[12] Also, as a 'bridging population', FSWs can increase risks of transmitting HIV in the general population through their clients. Thus, tracking the prevalence and associated risk factors of syphilis infection among FSWs is necessary for improved understanding and control of the syphilis and HIV epidemic.

In China, sentinel surveillance surveys are conducted annually among high-risk populations, including FSWs. The sentinel surveillance system integrates serological surveillance of syphilis, and behavioral surveillance of socio-demographic and behavioral characteristics of the targeted populations.[13] The surveillance system database provides continuous and comprehensive information for investigating predictors of syphilis infection. As a special economic zone in Guangdong province, Shenzhen, which has over 10 million inhabitants,[14] is not only one of the fastest growing and modern cities, but also one of the areas hit hardest by a syphilis epidemic. There are between 60,000 and 100,000 FSWs in Shenzhen,[15] and the prevalence of syphilis in this group was approximately 9% between 2001 and 2006.[16] Most previous studies of syphilis among FSWs in China have a relatively small number of participants, and only report single prevalence

figures.[17-21] We know of no study that synthesized data over time and recorded trends of syphilis among FSWs. In this study, we present the surveillance results for the period from 2009 to 2012 and investigate the risk factors of syphilis infection among FSWs in Shenzhen, China.

3.2 Methods

Survey design and participants

Trained public health officials from Shenzhen Center for Disease Control and Prevention (Shenzhen CDC) conducted surveillance surveys with consistent recruiting procedures and questionnaires for the period 2009 to 2012. Participants were recruited by a venue-based sampling method in three steps, as follows: categorizing venues; selecting venues; and selecting FSWs. In the first step, all accessible venues were categorized into three subgroups: high-end establishments, low-end establishments and street-based venues, according to the national surveillance guidelines.[22] In general, guesthouses/hotels and nightclubs were categorized as high-end establishments; karaoke/dance halls and saunas were categorized as low-end establishments; hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets were categorized as street-based venues. FSWs may go from one site to another, but usually within a certain subgroup of venues and mobility across subgroups is not common.[23] In the second step, three venues were randomly selected within each subgroup. When gatekeepers of the selected venues refused to participate, we randomly selected and invited gatekeepers from the remaining venues. In the third step, a maximum of 25 participants were recruited from the selected venues with more than 25 eligible FSWs; from venues with ≤ 25 eligible FSWs, all were recruited. The second and third steps were repeated until at least 400 valid questionnaires were obtained, and then the sampling process stopped. Eligibility criteria required that participants be ≥ 16 years old (legal age of consent in China), female, and reported having had commercial sex in the last three months. For validity of results, participants were required to have answered at least 80% of all the questions with logical consistency. To guarantee validity, trained staff explained the purpose of the survey at the venues, and explained the questionnaire to FSWs if they were unclear about certain questions. Validity of questionnaires was assessed by trained staff at the venues and once identified, invalid questionnaires were deleted. Because FSWs were guided by trained staff at venues, invalid questionnaires were rare (less than 1%). Verbal informed consent was obtained from all participants before the anonymous questionnaire interview and free syphilis testing. All participants were assured confidentiality. The survey protocols were reviewed and approved by the institutional review board of Shenzhen CDC.

Socio-demographic and behavioral measures

We used questionnaire-based interviews to obtain information about socio-demographic and behavioral information. Questionnaires used in our study were the national standard questionnaires used for HIV surveillance, and it took about 30 minutes to finish. Socio-demographic information was: age, marital status, residency, education, duration of current

commercial sex work and location of previous work. Behavioral information was: condom use during the last intercourse, condom use in the last month, and illicit drug use in the last year. For illicit drug use, we asked respondents to report if they had ever consumed or ever injected any illicit drugs (e.g. heroin, marijuana, and methamphetamine). HIV-related knowledge was assessed from answers to eight core questions.[24] A high knowledge level was defined as having answered six or more questions correctly.

Serologic measures

After each questionnaire interview, a blood sample was collected for syphilis testing. In accordance with the Chinese national HIV sentinel surveillance guidelines,[25] blood samples were first screened for treponemal antibodies using an enzyme-linked immunosorbent assay (ELISA, Wantai Biotechnical Company, Beijing, China). Specimens with positive ELISA were further tested by rapid plasma regain (RPR Rongsheng Biotechnical Company, Shanghai, China) or toluidine red unheated serum test (TRUST, Rongsheng Biotechnical Company, Shanghai, China) to determine positivity and titers of non-treponema-specific antibodies. Active syphilis was defined as ELISA positive and titers of non-treponema-specific antibodies ≥ 1:8.[22,26]

Data analysis

All data from valid questionnaires and laboratory results were double entered into Excel, and double checked by two public health officials from Shenzhen CDC. Conflicts were solved by retrieving the original test results and surveys for these cases. We calculated annual prevalence of syphilis and plotted the prevalence figures derived from this study and a different surveillance database from Shenzhen Center for Chronic Disease Control (Shenzhen CCDC) against calendar year to assess any trend. In Shenzhen, surveillance surveys of syphilis prevalence among FSWs were conducted by Shenzhen CCDC from 2001 to 2010 and Shenzhen CDC since 2009. While Shenzhen CCDC recruited FSWs from reeducation centers; we recruited FSWs from community venues. Hong *et al.* published data from Shenzhen CCDC of prevalences of syphilis for the years from 2001 to 2006 only.[16] In this study, we synthesized all the available data from Shenzhen CCDC and Shenzhen CDC to assess the trend over the years covered by both databases. Data from our surveillance surveys were pooled together to investigate risk factors of syphilis infection. As FSWs are highly mobile, and the duration of working as FSWs is generally short, the probability that the same FSWs are sampled repeatedly is small. We first performed univariate logistic regression analysis of syphilis infection. The variables attaining $p < 0.20$ significance in univariate analysis were included in the multivariate regression analysis. Only variables achieving $p < 0.05$ significance were retained in the final model using backward stepwise elimination. Age was used as a continuous variable in the univariate and multivariate logistic regression. Categories of age was only used to describe prevalence of syphilis in different age stratums. Impact of risk factors were expressed as odds ratios (OR) with 95% confidence interval (CI). All statistical analysis was performed using Stata software (version 12.0).

3.3 Results

A total of 1653 FSWs; 424 in 2009, 429 in 2010, 400 in 2011, and 400 in 2012, were enrolled into the consecutive surveillance surveys. Refusal rates of gatekeepers ranged from 8-12% over the years. Approximately 5% of FSWs refused to participate in the study, due to the requirement of providing blood samples for testing of syphilis. The prevalence of syphilis infection was 4.5%, 6.8%, 5.3% and 2.0% in 2009, 2010, 2011 and 2012, respectively. Thus, the prevalence figures were almost half of that in the earlier years from 2001 to 2006 (Figure 3.1).

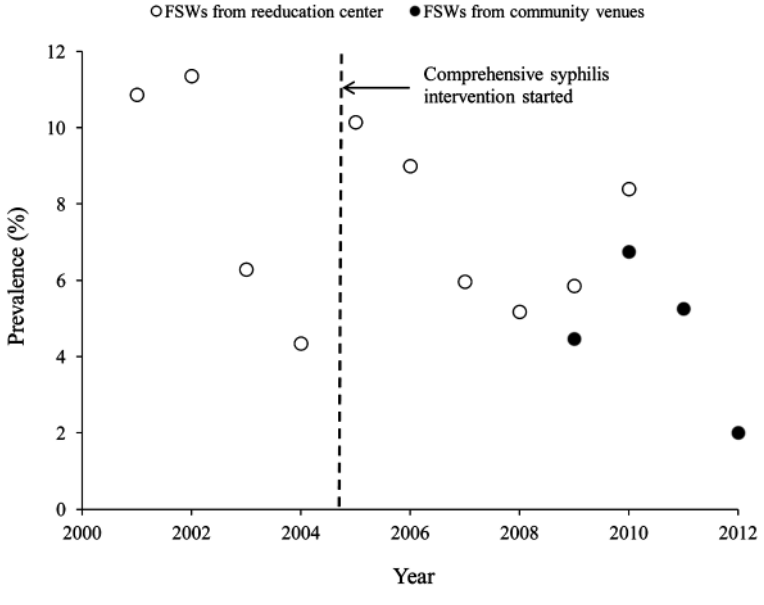

Figure 3.1. **Prevalence of syphilis in female sex workers plotted against years.** Open symbols indicate the prevalence derived from surveillance data of Shenzhen Center for Chronic Disease Control and Prevention (Shenzhen CCDC);[16,27] filled symbols indicate the prevalence derived from data of Shenzhen Center for Disease Control and Prevention (Shenzhen CDC, our study). There was severe SARS epidemic in Shenzhen between 2003 and 2004. Infected FSWs or those with more risky sexual behaviors may migrate to other places, so that the prevalences in 2003 and 2004 were low. Comprehensive syphilis intervention refers to interventions for syphilis control and prevention (condom promotion and peer education) among female sex workers, which have been initiated since July, 2004 in Shenzhen.[28]

Table 3.1. Factors associated with syphilis infection among 1653 FSWs in Shenzhen, China, derived from univariate and multivariate logistic regression.

				Univariate		Multivariate	
Risk factor	**Sample size**	**Syphilis cases**	**Prevalence (%)**	**Crude odds ratio**	**P-value**	**Odds ratio**	**P-value**
All	1653	77	4.7				
Venues*							
High-end establishments	418	23	5.5	1.00			
Low-end establishments	654	21	3.2	0.57	0.068		
Street-based venues	581	33	5.7	1.03	0.92		
Age (categories, years)							
<20	208	3	1.4				
21-24	705	22	3.1				
25-29	372	17	4.6				
>30	368	35	9.5				
Age (continuous, , in a year)				1.08	**<0.001**	1.08	**<0.001**
Marital status					**0.016**		
Never married	998	33	3.3	1.00			
Married	421	29	6.9	2.16	0.003		
Cohabiting	146	10	6.8	2.15	0.040		
Separated/widowed	84	5	6.0	1.85	0.21		
Missing	4	0	0.0				
Residency							
Guangdong province	227	11	4.8	1.00			
Non-Guangdong provinces	1426	66	4.6	0.95	0.89		
Education (years)							
<=9	1072	51	4.8	1.00			
>9	581	26	4.5	0.94	0.80		
Duration of current sex work (year) #							
>=1	683	47	6.9	1.00			
<1	970	30	3.1	0.43	**<0.001**		
Location of previous sex work					0.73		
Non-Guangdong provinces	398	21	5.3	1.00			
Guangdong province	1189	53	4.5	0.84	0.50		
No previous sex work	58	2	3.4	0.64	0.56		
Missing	8	1	12.5				
Level of HIV-related knowledge							
Low	458	19	4.1	1.00			
High	1195	58	4.9	1.18	0.54		

Table 3.1. Factors associated with syphilis infection among 1653 FSWs in Shenzhen, China, derived from univariate and multivariate logistic regression *(Continued)*.

				Univariate		Multivariate	
Risk factor	**Sample size**	**Syphilis cases**	**Prevalence (%)**	**Crude odds ratio**	**P-value**	**Odds ratio**	**P-value**
Condom use during the last intercourse					0.41		
No	248	13	5.2	1.00			
Yes	1194	58	4.9	0.92	0.80		
Refuse to answer	203	6	3.0	0.55	0.24		
Missing	8	0	0.0				
Condom use in the last month					**0.009**		
Consistent	855	30	3.5	1.00		1.00	
Inconsistent	561	39	7.0	1.87	0.004	1.87	**0.015**
Refused to answer	230	8	3.5	0.99	0.98	1.33	0.51
Missing	7	0	0.0				
Illicit drug use					**<0.001**		
No	1564	62	4.0	1.00		1.00	
Yes	67	13	19.4	5.83	**<0.001**	5.45	**<0.001**
Refused to answer	21	2	9.5	2.55	0.22	3.11	0.15
Missing	1	0	0.0				

* High-end establishments include nightclubs and guesthouse/hotels; low-end establishments include saunas and karaoke/dance halls, street-based venues include hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets.
# Duration of current sex work refers to the duration of working as a FSW currently in Shenzhen.

Table 3.1 shows syphilis prevalence by socio-demographic and behavioral characteristics. In univariate analysis, the prevalence increased sharply with age ($p < 0.001$), with a prevalence of 1.4% among age group younger than 20 years versus 9.5% among age group older than 30 years. The prevalence in FSWs who were married, cohabiting, separated or widowed was higher than that in those who were never married ($p = 0.016$). The syphilis prevalence was over two times higher among persons that had worked as FSWs in Shenzhen for one or more years, as compared to those that had worked as FSWs in Shenzhen for less than one year (6.9% versus 3.1%, $p < 0.001$). FSWs who reported inconsistent condom use in the last month had a syphilis prevalence twice as high as those who reported consistent condom use (7.0% versus 3.5%, $p = 0.004$). The higher prevalence among those with inconsistent condom use was particularly the case for the 25-29 years old group, while the prevalences do not differ so much for other age groups (Figure 3.2). The syphilis prevalence among FSWs who reported illicit drug use in the last year was nearly five times higher than among those who reported no illicit drug use (19.4% versus 4.0%, $p < 0.001$). The difference in syphilis prevalence between FSWs from higher risk venues and lower risk venues was below the cut-off level for inclusion in multivariate analysis

(p = 0.16). In multivariate analysis, the remaining significant factors associated with syphilis prevalence were older age, inconsistent condom use in the past month, and illicit drug use in the past year. Homogeneity testing by including age*condom use in the last month as an interaction term in the final multivariate analysis does not confirm effect modification (p = 0.20).

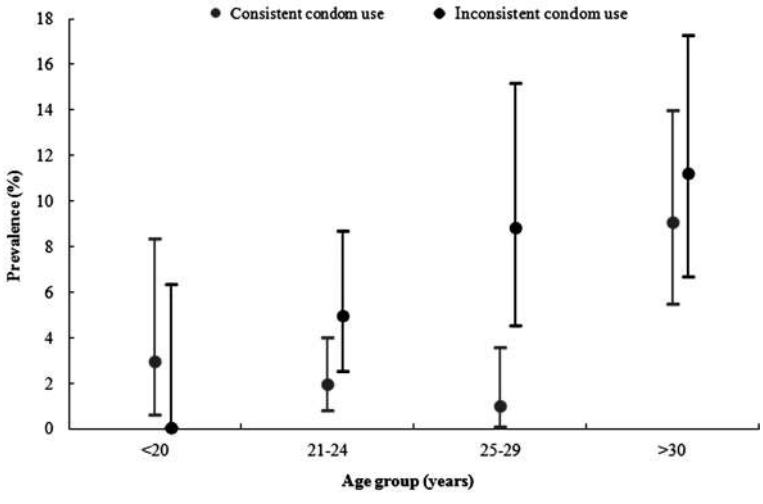

Figure 3.2. Prevalence of syphilis (with 95% confidence interval) in female sex workers of different age groups by the status of condom use in the last month. Open symbols indicate the prevalence of syphilis among those reported consistent condom use in the last month; filled symbols indicate the prevalence of syphilis among those reported inconsistent condom use in the last month.

3.4 Discussion

The overall prevalence of syphilis among FSWs from 2009 to 2012 was 4.7%, indicating that syphilis is common among FSWs in Shenzhen, but it is nearly half compared to the years 2001-2006 (9%). To our knowledge, this is the first study that shows a decreased trend of syphilis among FSWs in China. In addition, our study confirms risk factors identified in previous studies:[17-21] older FSWs, those who used condoms inconsistently, and those with a history of illicit drug use were at a higher risk of being infected.

The prevalence of syphilis in Shenzhen reported by our study is higher than many other areas in China, such as Shandong, where the reported prevalence among FSWs is approximately 3%.[29,30] However, it is much lower as compared to the reported prevalence figures by Shenzhen CCDC, but this can partly be explained by differences in the groups of FSWs included in the surveys. The data from Shenzhen CCDC were from FSWs recruited in re-education centers,[16] while we recruited FSWs from community venues. In China, commercial sex is illegal and FSWs will be

sent to a re-education center when arrested by public security officers. These arrested FSWs may have engaged in more risky sexual behaviors, reflected in a higher prevalence of syphilis. However, if we compare the consistent surveillance surveys from Shenzhen CCDC, the overall mean prevalence prior to 2006 (9%) is still higher than that after 2006 (6%). Thus, it is likely that the prevalence in FSWs in Shenzhen indeed has declined. Comprehensive interventions for syphilis control and prevention among high-risk groups have been initiated since July, 2004 in Shenzhen.[28] These programs, which included condom promotion and peer education, may have helped to relieve the burden of the syphilis epidemic among FSWs.

Regardless the progress made in reducing the prevalence of syphilis in Shenzhen in the past years, the prevalence among subgroups of FSWs remains high, in particular among those over 30 years old (9%), irrespective of condom use status. As our testing method cannot differentiate between recent and old persistent infection, it is possible that part of the positive results among these older FSWs are actually the result of old infections that occurred several years ago, but are still active. The extremely high prevalence among FSWs over 30 years old and the probability that those infections actually occurred several years ago indicate that regular screening with early case-finding programs should be advocated. As a marginalized population, FSWs have limited access to health services,[8] apart from the fact that effective syphilis testing is often not available in many basic medical facilities in China.[31] This situation suggests that priorities should be set to expand point-of-care syphilis screening programs. Furthermore, it needs to be emphasized that timely and effective treatment programs should be linked to such screening programs. Case management also needs to be improved for those already diagnosed as infected FSWs to reduce complications of syphilis and infectiousness and/or susceptibility of HIV.

We found that inconsistent condom use was a significant risk factor of syphilis infection. The overall odd ratio (OR = 1.9) was similar to that reported in Sichuan (OR = 1.7),[21] but smaller than that reported in Guangxi (OR = 5.3).[17] As Figure 3.2 illustrates, the effect of condom use in our study was only high in the age group of 25-29 years: with 8.7% versus 1.0%, which correspond to an odds ratio of 9.4. For the 21-24 and over 30 years old group, condom use was shown to be only slightly protective against syphilis infection. For those FSWs younger than 20 years old, the prevalence was even slightly higher among those who reported consistent condom use. Information bias or some unstudied factors (e.g. number of clients per day) may explain the 'non-protectiveness' of consistent condom use among the younger FSWs. Nevertheless, as the homogeneity test does not confirm any effect modification ($p = 0.20$), the interaction pattern between condom use, age and syphilis infection is still unclear, and further research is needed. Furthermore, it should be noted that only 52% (855/1653) FSWs reported consistent condom use in the last month in our study, peer education and condom promotion programs should be continued to help them to maintain or where possible increase safe sexual practices.

In our study, the prevalence of syphilis was strongly associated with illicit drug use. This is consistent with other studies in China.[29,32] The prevalence reached 19% of the 67 FSWs who

reported illicit drug use in the past year. This alarmingly high prevalence of syphilis among those who ever used illicit drugs calls for attention from the health authorities. Inconsistent condom use could help explain why the prevalence among those who ever used illicit drugs was higher than that among those who never used substance. However, even after adjusting for the status of condom use, illicit drug use was still highly correlated with syphilis infection ($p < 0.001$). Having a larger number of sex partners may play an important role in increasing their probability to contract syphilis infection. Therefore, more detailed studies on the different sexual risk behaviors (e.g. number of clients per day) between FSWs who use illicit drugs and those who do not use are needed to explore the reasons for the high syphilis prevalence and to direct interventions.

Moreover, FSWs who use illicit drug are often more likely to engage in sharing needles, have a larger number of sex partners, and use condoms inconsistently than those who never use illicit drugs.[33] These behavioral characteristics together with co-infection of syphilis, will place them under a much higher risk of HIV infection. Fortunately, only 4% (67/1653) FSWs in our study reported illicit drug use in the last year, which is much lower than other areas in China, like Shandong and Yunnan, where percentages as high as 45% have been reported.[29,30,32,34] The low proportion of illicit drug use places FSWs under a lower risk of HIV infection, and indeed, we did not identify any HIV cases during our study period.

The low proportion of illicit drug use among FSWs in Shenzhen could be due to reporting bias or strong police repression of illicit drug use, but it is, more likely, due to the active outreach and education programs by the local CDC. At all the accessible venues, posters and education materials are provided, and this may have helped to raise the risk awareness of FSWs for using illicit drugs. The proportion of FSWs reported ever used illicit drugs in the last year was reported to be about twice as high in the study by *Li. et al* of 2006[35] as in our study of 2009-2012 (8% vs 4%). Peer education may also have been effective in reducing the probability of illicit drug use by FSWs and where needed link them to professional services, e.g. methadone maintenance treatment programs.

Several limitations of our study need to be addressed. Firstly, as some of the data collected were based on self-reporting, risk factors such as condom and illicit drug use may have been misclassified, thereby introducing information bias. Secondly, FSWs included in our surveys were from venues whose gatekeepers were cooperative. These gatekeepers may be better educated and provide FSWs with a supportive environment for safe sexual practices. Since research has found that gatekeepers' support is highly associated with consistent condom use,[36] results from our studies may be biased and syphilis prevalence may be under-estimated. Thirdly, because we used a convenience venue-based sampling method, the representativeness and generalization of the results to the FSW population at large should be interpreted cautiously. To improve the representativeness, we sampled FSWs from various venues and attempted as much as possible to include hard-to-reach FSWs, such as those based on the streets. However, certain subgroups

of underground FSWs may still be under-sampled or neglected (e.g. the internet-based FSWs). Fourthly, we recruited all FSWs from venues with less than 25 FSWs. These small venues are usually low-end establishments or street-based venues, such as foot bathing shops and roadside restaurants. It is likely that we have recruited FSWs from such small venues with a higher probability than those FSWs from bigger high-end establishments. The recruiting methods may thus have introduced selection bias and the syphilis prevalence may be over-estimated, as FSWs from low-end establishments and street-based venues usually report more often unsafe sexual practices.[23,35] Finally, this study was cross-sectional, so causal inferences cannot be made.

In conclusion, although our study showed a high prevalence of syphilis among FSWs in Shenzhen, China, it has probably declined compared to the earlier years. The prevalence was particularly high among FSWs who use condoms inconsistently, who have a history of illicit drug use and are in the oldest age groups. Comprehensive interventions (e.g. condom promotion and peer education) should be continued to increase the overall condom use and reduce illicit drug use. Detailed studies focused on FSWs who used illicit drug are needed to explore reasons of the very high prevalence of syphilis and to direct interventions. Point-of-care outreach screening programs for early diagnosis and timely treatment should be initiated. These programs will help to relieve the epidemic of syphilis, also to the benefit of other STDs, in particular HIV.

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Chapter 4

Determinants of the low uptake of HIV-related intervention services by female sex workers in Shenzhen, China: An observational study (2009-2012)

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Abstract

Objectives: Female sex workers (FSWs) are highly vulnerable to HIV but make little use of HIV-related intervention services provided by the Chinese government. We investigated determinants of the low uptake of HIV services by FSWs in Shenzhen, Guangdong province.

Methods: We interviewed 1656 FSWs, recruited by venue-based sampling, about socio-demographics, behaviors and uptake of HIV-related intervention services and identified determinants of no uptake of HIV testing; condom promotion; and peer education through logistic regression. Similarly, we assessed the association between uptake of these services and condom use and HIV-related knowledge.

Results: The overall uptake of HIV testing, condom promotion, and peer education by FSWs was 21.5%, 47.8% and 28.0%, respectively. Young age and shorter duration of working in Shenzhen were statistically significantly correlated with no uptake of all three services. Uptake of these services was positively associated with consistent condom use and good HIV-related knowledge.

Conclusion: The uptake of HIV-related intervention services by FSWs is low in Shenzhen. As their uptake is positively associated with condom use and HIV-related knowledge, it is necessary to intensify these services, focusing on young and recently started FSWs.

4.1 Introduction

The cumulative number of HIV/AIDS cases was estimated at 780,000 by the end of 2011 in China.[1] Since 2007, risk of HIV/AIDS has shifted from injecting drug use and illegal plasma donation to sexual contacts.[1] Heterosexual transmission of HIV through female sex workers (FSW) is of particular concern. Estimations on the number of FSW in China range from one to four million, in both lower end (i.e., on the street, hair salons, and temporary small clubs) and higher end venues (i.e., karaoke clubs, night clubs, and hotels).[2-5] In view of the large number of sexual partners, unsafe working conditions,[4,6] and high prevalence of sexually transmitted diseases (STDs),[3,7] FSWs are at high risk for HIV infection. Also, as the 'bridging population', they can fuel a heterosexual HIV epidemic from injecting drug users to the general population through their clients. For these reasons, FSWs are considered a key population in China with whom it is essential to work if the epidemic is to be stopped.

To curb transmission, the Chinese government has rolled out a number of HIV-related intervention services targeting FSWs, such as voluntary HIV counseling and testing (VCT), condom promotion, and peer education. These services are recommended by WHO and present substantial public benefits. Regular testing, for instance, allows for early detection of infection and timely access to social services and medical care. Timely treatment helps to reduce mortality and infectiousness.[8,9] Also, knowledge of serostatus may bring about safer sexual behavior.[10] While their scopes differ, these services overlap each other in their contents and achieve synergy in promoting safe sexual contacts. For example, the main aim of peer education is to improve knowledge on HIV and to encourage FSWs they should insist on condom use. At the same time, outreach workers of peer education often provide FSWs with condoms and encourage them to seek counseling and HIV testing. In return, counselors also routinely distribute condoms and educate FSWs on aspects of HIV and skills of condom use negotiation.

However to date, the uptake of these HIV-related intervention services, in particular HIV testing, is rather low in China. The median percentage of FSWs who received an HIV test in the last year is 49% worldwide in 2011, while in China it is only 34%.[11] The aim of this study is to identify possible determinants of the low uptake of HIV-related intervention services by FSWs in Shenzhen, Guangdong province, China.

4.2 Methods

Survey design and participants

Four consecutive surveillance surveys with consistent recruiting procedures and questionnaires were conducted by the same group of trained public health officials from the Shenzhen Center for Disease Control and Prevention (Shenzhen CDC) in 2009, 2010, 2011 and 2012. Participants were recruited by a venue-based sampling method in three steps, as follows: (1) categorizing

venues, (2) selecting venues, and (3) selecting FSWs. In the first step, staff from Shenzhen CDC categorized all accessible venues into three subgroups of different risk level: high, medium and low, according to the national surveillance guidelines.[12] Categorization was based on number of FSWs and frequencies of unsafe sexual contacts at these venues. In general, guesthouse/hotels and nightclubs were categorized as venues of low risk; karaoke/dance halls and saunas as venues of medium risk; hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets as venues of high risk. In the second step, nine venues were randomly selected, with three venues from each subgroup. In the third step, a maximum of 25 participants were recruited from the selected venues with more than 25 eligible FSWs; from venues with ≤ 25 eligible FSWs, all were recruited. The second and third steps were repeated until at least 400 valid questionnaires were obtained, and then the sampling process stopped. Eligibility criteria required that participants be ≥ 16 years old (legal age of consent in China), female, and reported having had commercial sex in the last three month. For validity of results, participants were required to have answered at least 80% of all the questions with logical consistency. To guarantee validity, trained staff explained the purpose of the survey at the venues, and explained the questionnaire to FSWs if they were unclear about certain questions. Validity of questionnaires was assessed by trained staff at the venues and once identified, invalid questionnaires were deleted. Because FSWs were guided by trained staff at venues, invalid questionnaires were rare (less than 1%). Verbal informed consent was obtained from all participants before the anonymous questionnaire interview. All participants were assured confidentiality. Refusal rates of gatekeepers ranged from 8-12% over the years and approximately 5% of FSWs refused to participate in the study. The survey protocols were reviewed and approved by the institutional review board of Shenzhen CDC.

Data collection

We used questionnaire-based interviews to obtain information about socio-demographics, substance use in the last year, history of STDs, and uptake of (1) HIV testing (2) condom promotion (including VCT) and (3) peer education in the last year. Questionnaires used in our study were the national standard questionnaires used for HIV surveillance,[13] and it took about 30 minutes to finish. Socio-demographic information was age, marital status, residency, education, duration of current commercial sex work in Shenzhen and location of previous commercial sex work, if any. History of STDs refers to being diagnosed as having any notifiable STD[14] in the last year. To assess the impact of these HIV-related intervention services, we also assessed HIV-related knowledge and asked about condom use during the last intercourse. HIV-related knowledge was assessed from answers to eight core questions.[15] A high knowledge level was defined as having answered correctly six or more questions. All questionnaire data were double entered into Excel, and double checked by two public health officials from Shenzhen CDC. Conflicts were solved by retrieving the original surveys for these cases.

Data analysis

As there are thousands of commercial sex venues in Shenzhen and FSWs are highly mobile, and tend to have a short career as a FSW, the probability that the same FSWs have been sampled over the four years repeatedly of our study is small. Data from the four surveillance surveys were therefore pooled together to investigate determinants of no uptake of (1) HIV testing (2) condom promotion (including VCT) and (3) peer education in the last year. We first performed univariate logistic regression analysis of no uptake of service and possible determinants. The variables attaining $p < 0.20$ significance in univariate analysis were included in the multivariate regression analysis. Only variables achieving $p < 0.05$ significance were retained in the final model using backward stepwise elimination. Impact of determinants were expressed as odds ratios (OR) with 95% confidence interval (CI).

As uptake of the three services is correlated with each other, we also performed reduced rank regression (RRR) as a complementary analysis of the logistic regression. RRR, also known as maximum redundancy analysis, is a dimension-reduction technique. It determines linear functions of predictors (here: socio-demographic and behavioral determinants) by maximizing the explained variation in outcomes (here: uptake of HIV-related services). It has been widely used in nutrition epidemiology to construct dietary patterns.[16,17] In brief, RRR reduces dimensions (number of outcome variables) by introducing a latent variable or variables.[16,17] In our study, the three outcome variables (i.e. uptake of HIV testing, uptake of condom promotion, uptake of peer education) were reduced to two latent variables in two steps. In the first step, one latent variable was introduced to explain the largest proportion of variance of outcomes by two linear functions: (1) $Y_j = \alpha_{j1} + \beta_{j1}L_1 + \varepsilon_{j1}$, (2) $L_1 = \gamma_1 + \delta_{i1}X_i$. The first linear function is optimized, while restricted by the second one. The dimension (j =1, 2, 3) of outcome variables (Yj) was reduced in the first linear function by introducing one latent variable (L_1). The second linear function is to identify possible predictors (X_i) that are correlated with the latent variable, so that they are also correlated with outcome variables. In the second step, another latent variable was added to explain the residual variance of outcomes, which means that outcomes were predicted given the overall uptake of services pattern defined by the first step. Another two linear functions were used: (1) $Y_j = \alpha_{j2} + \beta_{j1}L_1 + \beta_{j2}L_2 + \varepsilon_{j2}$, (2) $L_2 = \gamma_2 + \delta_{i2}X_i$. The values of βs and δs were expressed as axes in a biplot [18].

Furthermore, to assess the association between uptake of these HIV-related services and consistent condom use and good HIV-related knowledge, we conducted another two sets of logistic analysis of condom use and HIV-related knowledge, respectively. Uptake of HIV-related services, together with other socio-demographic and behavioral factors was included as possible determinants of condom use and HIV knowledge in these logistic regressions. RRR analysis and biplot was performed using Canoco (version 4.5). All other statistical analyses was performed using Stata software (version 12.0).

4.3 Results

Characteristics of the participants

Of the 1656 participants, 25.2% were recruited from venues of low risk, 39.5% from venues of medium risk and 35.3% from venues of high risk. The mean age was 26 years (range: 16-61), with most of them were under the age of 30 years (77.8%). 60.4% had never married, 86.3% were non-Guangdong residents, 64.9% had no more than nine years' education, 71.9% previously worked as FSWs in Guangdong, 4.0% reported substance use and 6.3% reported STD history in the last year (Table S4.1).

Determinants of no uptake of HIV-related intervention services

The overall uptake of HIV testing, condom promotion, and peer education by FSWs was 21.5%, 47.8% and 28.0%, respectively. In multivariate analysis, younger FSWs ($p < 0.05$) and those who had worked as FSWs in Shenzhen shorter than one year ($p < 0.001$) were more likely to report no uptake of all three services. Furthermore, FSWs who were substance using were less likely to report no uptake of HIV testing (AOR = 0.51, $p = 0.012$). FSWs from venues of high risk (AOR = 0.68, $p < 0.001$), those who were substance using (AOR = 0.42, $p = 0.003$) and those who were not Guangdong residents (AOR = 0.70, $p = 0.023$) were less likely to report no uptake of condom promotion. FSWs who had previously worked as FSWs outside Guangdong were more likely to report no uptake of peer education (AOR = 1.33, $p = 0.037$). Adjusted odds ratios and 95% confidence intervals of the determinants of no uptake of the three services by multivariate logistic regression are summarized in Table S4.1. Frequency data and results of univariate logistic regression analyses of determinants of no uptake of HIV testing, condom promotion and peer education are shown in Table S4.2-Table S4.4.

Similar findings regarding the determinants by the RRR analysis are shown in the biplot (Figure S4.1). The x axis of the biplot explains the tendency of uptake of all the three services, the y axis discriminates between each of the services. For instance, it shows that FSWs who were older in age and worked as FSWs in Shenzhen longer were more likely to uptake all the three services. FSWs who previously worked in Guangdong were more likely to uptake peer education, but not the other two services. FSWs from high-risk venues were more likely to uptake condom promotion, and not the other two services.

The association between uptake of HIV-related intervention services and condom use and level of HIV-related knowledge

Overall, 82.7% (1196/1445) of those who responded to this question reported condom use during the last sexual intercourse, and 72.3% (1197/1656) of FSWs showed a high level of HIV-related knowledge. In multivariate analysis, uptake of HIV testing (adjusted odds ratio, AOR = 1.81, $p = 0.002$) and peer education (AOR = 1.89, $p = 0.007$) was significantly associated with condom use. Uptake of HIV testing (AOR = 1.45, $p = 0.005$) and condom promotion (AOR = 1.33, $p = 0.024$)

was significantly associated with a high level of HIV-related knowledge, after adjusting for socio-demographics, substance use and STD history (Table 4.2).

Table 4.1. Determinants of no uptake of HIV-related intervention services in the last year by 1656 female sex workers in Shenzhen, China: derived from multivariate logistic regression. Determinants not testing significantly are: marital status, education, and STD history. Univariate results are shown in supplementary materials (Table S4.2-S4.4). AOR: adjusted odds ratio.

Determinants	HIV testing		Condom promotion@		Peer education	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Venues*						
Low risk venues			1.00			
Medium risk venues			0.93	0.71- 1.20		
High risk venues			0.68	0.52- 0.89		
Age (continuous in years)	0.97	0.95- 0.99	0.97	0.95- 0.99	0.95	0.93- 0.97
Residency						
Guangdong province			1.00			
Other provinces			0.70	0.52- 0.95		
Duration of current sex work (months)						
>12	1.00		1.00		1.00	
6-12	1.89	1.30- 2.70	2.08	1.54- 2.78	2.33	1.61- 3.23
1-6	2.04	1.52- 2.78	2.44	1.92- 3.13	2.08	1.56- 2.70
<1	1.89	1.22- 2.86	3.23	2.27- 4.76	2.04	1.37- 3.03
Location of previous sex work						
Guangdong province					1.00	
Other provinces					1.33	0.76- 1.31
No previous sex work					1.60	0.81- 3.17
Substance use						
No	1.00		1.00			
Yes	0.51	0.30- 0.86	0.42	0.24- 0.74		

@ Condom promotion also includes voluntary HIV counseling and testing.
* Low risk venues include nightclubs, and guesthouse/hotels; medium risk venues include karaoke/dance halls and saunas; high risk venues include hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets.

Table 4.2. Association between uptake of HIV-related intervention services and (1) condom use during the last sexual intercourse; (2) HIV-related knowledge by 1656 female sex workers in Shenzhen, China: derived from multivariate logistic regression. The association has been adjusted for socio-demographics (e.g. age, marital status, education and residency), substance use and STD history. AOR: adjusted odds ratio.

Uptake of HIV-related services	Used a condom		High-level of HIV-related knowledge#	
	AOR	95% CI	AOR	95% CI
HIV testing	1.81*	1.18- 2.79	1.45*	1.11- 1.89
Condom promotion@	1.08	0.79- 1.48	1.68*	1.19- 2.38
Peer education	1.89*	1.27- 2.82	1.33	0.97- 1.82

* $p < 0.05$
# HIV-related knowledge was assessed from answers to eight core questions.[15] A high knowledge level was defined as having answered correctly six or more questions.
@ Condom promotion also includes voluntary HIV counseling and testing.

4.4 Discussion

Low uptake of HIV-related services by FSWs is a common issue in China. Our study is one of the first studies investigating determinants of such low uptake of services. Our results revealed low uptake of HIV-related intervention services by FSWs in Shenzhen, China, between 2009 and 2012 – notably by those of younger age and with shorter duration of commercial sex work in Shenzhen. In addition, factors such as type of venue, substance use and place of residence also were determinants of uptake of the individual services.

Overall, 21.5%, 47.8% and 28.0% of FSWs in Shenzhen made use of HIV testing, condom promotion, and peer education services, respectively. These uptake rates are disappointingly low, especially given the fact that China has adopted the WHO recommended strategy of decentralization of HIV care services.[19] By 2012, in Shenzhen there are over 100 hospitals and health centers (including 35 free HIV voluntary consulting and testing sites), which offer HIV-related intervention services, both at the city level and community level, and cover all 6 districts in Shenzhen. However, as there is strong stigma attached to commercial sex work and HIV, FSWs usually stay as a hidden population. This low uptake may be due to the poor link between the services providers and FSWs. Commercial sex work is condemned from across society in China.[20] Although the healthcare workers tried hard to reach FSWs by peer outreach programs, FSWs may still be very reluctant to go to these governmental-based intervention services. It is clear that programs to reduce stigma and dialogue between health service authorities and public security are urgently needed. These uptake rates are also fairly low compared to the 31.4%, 80.8% and 59.6%, respectively, reported for Shandong between 2006 and 2008.[21] One reason for this discrepancy may be the specific composition of the Shenzhen population. As a special economic zone in southern China, Shenzhen is a city with a large 'floating population' where migrants and temporary residents constitute more than 80% of its over 10 million inhabitants.[22] The majority of the floating population only have limited access to health services.[23] For instance, 86% of the

participants in our study are non-Guangdong residents, while only 55% of the participants in the study by Liao M, *et al.*[21] are non-Shandong residents. The large floating population presents a great challenge to the health service system in Shenzhen, facing the task of improving their education, socio-economic status and access to health services.

Our study revealed that younger age and shorter duration of current commercial sex work in Shenzhen were determinants of the low uptake of all the HIV-related services. It would seem reasonable to assume that uptake rates will increase with longer duration of commercial sex work. However, this is not necessarily true in China, where FSWs face high levels of condemnation from across society.[20] Compared to younger FSWs, older FSWs tend to work in venues of higher risk of being identified by public securities such as streets[24] and thus may be very reluctant to use any government-based services. Moreover, older FSWs may have migrated in Shenzhen from other cities and the new working environment may reduce their likelihood of knowing sites providing HIV-related services. Nevertheless, our results show that older FSWs seem to have understood that using HIV-related services would not increase their likelihood of being condemned. Still, the uptake rate was only substantial higher for FSWs who had worked in Shenzhen for longer than 1 year. The uptake rates did not differ much for FSWs who had worked in Shenzhen less than 1 month, 1-6 months and 6-12 months. As FSWs usually have a short career, this finding emphasizes HIV-related services must be promoted more effectively, especially targeted at FSWs who are younger and are new in Shenzhen.

For determinants of the low uptake of each of the three HIV-related services, other than young age and short duration of current commercial sex work, we propose two explanations: a lower perceived risk of getting STDs/HIV or more attention from the health authorities to FSWs at higher risk. For instance, we found that FSWs from low risk venues were less likely to uptake condom promotion. They may underestimate the risk of infection. On the other hand, those FSWs from medium or high risk venues may consider themselves under high risk of getting HIV, and thus are more likely to uptake the condom promotion service. It is also possible that the authorities will try their best to provide condoms and counseling particularly for FSWs from medium or high risk venues. Further research is needed to disentangle the mechanisms of the low uptake of HIV-related services among subgroups identified in this study and to find out what interventions could promote the uptake.

Among the 67 substance-using FSWs, no uptake of services was less common as compared to FSWs with no substance use history. However, the no uptake rates of HIV testing (62.7%) and peer education (56.7%) were still quite high and only no uptake rate of condom promotion (29.9%) was relatively low among them. This suggests that condom promotion provided at venues or by peer outreach workers is more acceptable to those FSWs than HIV testing service. It may because they perceive little risk of HIV or fear to be tested. As substance-using FSWs are particularly at high risk of HIV, regular HIV testing should be promoted with more intensity. We recommend to first intensify peer education services by selecting some peer workers with

substance use history, since the uptake rate of peer education was also relatively low and it may be more acceptable than advocating HIV testing directly.

In Shenzhen, the HIV rate among FSWs is still much lower than that among other high risk populations, e.g. men who have sex with men. However, it is feared that the high STDs burden among FSWs can potentially fuel a heterosexual HIV epidemic among the general population.[25,26] To curb the transmission, the Shenzhen CDC together with outreach workers rolled out a number of HIV-related services, the effectiveness of which so far was unknown. Our study shows that uptake of HIV-related services can positively influence condom use and HIV-related knowledge. Thus, there is every reason to continue these services and – in view of the relative low uptake rates found – to intensify the efforts.

Several limitations of our study need to be addressed. Firstly, as some data were self-reported, determinants such as substance use and STD history may have been under-reported, thereby introducing information bias. Secondly, because we used a convenience venue-based sampling method, the representativeness and generalization of the results to the FSW population at large should be interpreted cautiously. To improve the representativeness, we sampled FSWs from various venues and took care to include hard-to-reach FSWs, such as those based on the streets. However, certain subgroups may still be under-sampled (e.g. the internet-based FSWs). Thirdly, this study was cross-sectional, so causal inferences cannot be made. Finally, our questionnaire included only socio-demographic and behavioral determinants of the uptake of HIV-related services by FSWs. Socio-psychological factors (e.g. fear of discrimination, perceived risk of STDs/HIV) and structural factors (e.g. accessibility, quality of staff, discrimination) that might undermine the uptake were not considered. We recommend future studies to take these potential factors into account.

In conclusion, our study showed low uptake of HIV-related services by FSWs in Shenzhen, China. As uptake of these services is positively associated with condom use and HIV-related knowledge, it is necessary to intensify these HIV-related services, with an emphasis on FSWs who are younger and have recently started working in Shenzhen. Future studies should explore reasons why HIV-related services uptake patterns differ between subgroups of FSWs and how the uptake could be promoted.

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Table S4.1. Socio-demographics, substance use and STD history among female sex workers in Shenzhen, China, from 2009-2012.

	2009		2010		2011		2012		Total	
Factors	**n=426**	**(%)**	**n=430**	**(%)**	**n=400**	**(%)**	**n=400**	**(%)**	**N=1656**	**(%)**
Venues										
Low risk venues	61	14.3	169	39.3	100	25.0	88	22.0	418	25.2
Medium risk venues	248	58.2	108	25.1	110	27.5	188	47.0	654	39.5
High risk venues	117	27.5	153	35.6	190	47.5	124	31.0	584	35.3
Age (categories, years)										
< 20	121	28.4	105	24.4	74	18.5	63	15.8	363	21.9
21-24	175	41.1	125	29.1	131	32.8	122	30.5	553	33.4
25-29	86	20.2	78	18.1	89	22.3	119	29.8	372	22.5
> 30	44	10.3	122	28.4	106	26.5	96	24.0	368	22.2
Marital status										
Never married	274	64.3	268	62.3	229	57.3	230	57.5	1001	60.4
Married	76	17.8	83	19.3	120	30.0	142	35.5	421	25.4
Cohabiting	60	14.1	40	9.3	28	7.0	18	4.5	146	8.8
Seperated/widowed	14	3.3	37	8.6	23	5.8	10	2.5	84	5.1
Missing	2	0.5	2	0.5	0	0.0	0	0.0	4	0.2
Residency										
Guangdong province	63	14.8	42	9.8	53	13.3	68	17.0	226	13.6
Other provinces	363	85.2	388	90.2	347	86.8	332	83.0	1429	86.3
Education (years)										
<=9	284	66.7	269	62.6	257	64.3	264	66.0	1074	64.9
> 9	142	33.3	161	37.4	143	35.8	136	34.0	582	35.1
Duration of current work (months)										
> 12	123	28.9	203	47.2	202	50.5	156	39.0	684	41.3
6-12	70	16.4	48	11.2	82	20.5	64	16.0	264	15.9
1-6	165	38.7	129	30.0	72	18.0	136	34.0	502	30.3
< 1	62	14.6	47	10.9	44	11.0	44	11.0	197	11.9
Missing	6	1.4	3	0.7	0	0.0	0	0.0	9	0.5
Location of previous work										
Guangdong province	317	74.4	354	82.3	178	44.5	242	60.5	1191	71.9
Other provinces	96	22.5	76	17.7	92	23.0	135	33.8	399	24.1
No previous work	5	1.2	0	0.0	30	7.5	23	5.8	58	3.5
Missing	8	1.9	0	0.0	0	0.0	0	0.0	8	0.5

Table S4.1. Socio-demographics, substance use and STD history among female sex workers in Shenzhen, China, from 2009-2012 *(Continued)*.

	2009		2010		2011		2012		Total	
Factors	**n=426**	**(%)**	**n=430**	**(%)**	**n=400**	**(%)**	**n=400**	**(%)**	**N=1656**	**(%)**
Substance use										
No	404	94.8	385	89.5	381	95.3	397	99.3	1567	94.6
Yes	11	2.6	39	9.1	14	3.5	3	0.8	67	4.0
Refused to answer	10	2.3	6	1.4	5	1.3	0	0.0	21	1.3
Missing	1	0.2	0	0.0	0	0.0	0	0.0	1	0.1
Self-reported STD history in the last year										
No	402	94.4	374	87.0	372	93.0	387	96.8	1535	92.7
Yes	20	4.7	48	11.2	23	5.8	13	3.3	104	6.3
Refused to answer	3	0.7	7	1.6	5	1.3	0	0.0	15	0.9
Missing	1	0.2	1	0.2	0	0.0	0	0.0	2	0.1

Table S4.2. Determinants of no uptake of HIV testing service by 1654 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio.

Determinants	**Sample size**	**No uptake of HIV testing**	**Proportion (%)**	**OR**	**P-value**
All	1654	1298	78.5		
Study year					
2009	425	347	81.6		
2010	429	300	69.9		
2011	400	328	82.0		
2012	400	323	80.8		
Venues*					0.450
Low risk venues	418	335	80.1	1.00	
Medium risk venues	652	514	78.8	0.92	0.610
High risk venues	584	449	76.9	0.82	0.218
Age (categories, years)					
< 20	363	307	84.6		
21-24	552	451	81.7		
25-29	371	290	78.2		
> 30	368	250	67.9		
Age (continuous, in a year)				0.95	**<0.001**

Table S4.2. Determinants of no uptake of HIV testing service by 1654 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio *(Continued)*.

Determinants	Sample size	No uptake of HIV testing	Proportion (%)	OR	P-value
Marital status					**0.004**
Never married	1001	807	80.6	1.00	
Married	421	307	72.9	0.65	0.001
Cohabiting	145	120	82.8	1.15	0.54
Separated/widowed	83	60	72.3	0.63	0.070
Missing	4	4	100.0		
Residency					
Guangdong province	226	188	83.2	1.00	
Other provinces	1428	1110	77.7	0.70	0.064
Education (years)					
<=9	1072	841	78.5	1.00	
> 9	582	457	78.5	1.00	0.97
Duration of current work (months)					**<0.001**
> 12	683	480	70.3	1.00	
6-12	264	220	83.3	2.11	<0.001
1-6	501	426	85.0	2.40	<0.001
< 1	197	166	84.3	2.26	<0.001
Missing	9	6	66.7		
Location of previous work					0.28
Guangdong province	1190	935	78.6	1.00	
Other provinces	398	308	77.4	0.93	0.62
No previous work	58	50	86.2	1.71	0.13
Missing	8	5	62.5		
Substance use					**0.008**
No	1565	1237	79.0	1.00	
Yes	67	42	62.7	0.45	0.002
Refused to answer	21	18	85.7	1.59	0.46
Missing	1	1	100.0		
Self-reported STD history in the last year					
No	1533	1205	78.6	1.00	
Yes	104	76	73.1	0.74	0.19
Refused to answer	15	15	100.0		
Missing	2	2	100.0		

* Low risk venues include nightclubs, and guesthouse/hotels; medium risk venues include karaoke/dance halls and saunas; high risk venues include hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets.

Table S4.3. Determinants of no uptake of condom promotion service by 1653 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio.

Determinants	Sample size	No uptake of condom promotion	Proportion (%)	OR	P-value
All	1653	863	52.2		
Study year					
2009	423	295	69.7		
2010	430	160	37.2		
2011	400	148	37.0		
2012	400	260	65.0		
Venues *					**<0.001**
Low risk venues	418	241	57.7	1.00	
Medium risk venues	651	375	57.6	1.00	0.99
High risk venues	584	247	42.3	0.54	<0.001
Age (categories, years)					
< 20	362	220	60.8		
21-24	552	319	57.8		
25-29	371	194	52.3		
> 30	368	130	35.3		
Age (continuous, in a year)				0.94	**<0.001**
Marital status					**<0.001**
Never married	999	560	56.1	1.00	
Married	420	192	45.7	0.66	<0.001
Cohabiting	146	83	56.8	1.03	0.86
Separated/widowed	84	26	31.0	0.35	<0.001
Missing	4	2	50.0		
Residency					
Guangdong province	225	142	63.1	1.00	
Other provinces	1428	721	50.5	0.60	**<0.001**
Education (years)					
<=9	1072	558	52.1	1.00	
> 9	581	305	52.5	1.02	0.86
Duration of current work (months)					**<0.001**
> 12	683	252	36.9	1.00	<0.001
6-12	264	154	58.3	2.39	<0.001
1-6	501	314	62.7	2.87	<0.001
< 1	196	137	69.9	3.97	<0.001
Missing	9	6	66.7		

Table S4.3. Determinants of no uptake of condom promotion service by 1653 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio *(Continued)*.

Determinants	Sample size	No uptake of condom promotion	Proportion (%)	OR	P-value
Location of previous work					0.84
Guangdong province	1188	620	52.2	1.00	
Other provinces	399	208	52.1	1.00	0.98
No previous work	58	28	48.3	0.86	0.58
Missing	8	7	87.5		
Substance use					**0.001**
No	1564	833	53.3	1.00	
Yes	67	20	29.9	0.37	<0.001
Refused to answer	21	9	42.9	0.66	0.35
Missing	1	1	100.0		
Self-reported STD history in the last year					0.10
No	1532	810	52.9	1.00	
Yes	104	44	42.3	0.65	0.038
Refused to answer	15	7	46.7	0.78	0.63
Missing	2	2	100.0		

* Low risk venues include nightclubs, and guesthouse/hotels; medium risk venues include karaoke/dance halls and saunas; high risk venues include hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets.

Table S4.4. Determinants of no uptake of peer education service by 1652 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio.

Determinants	Sample size	No uptake of peer education	Proportion (%)	OR	P-value
All	1652	1190	72.0		
Study year					
2009	422	322	76.3		
2010	430	250	58.1		
2011	400	303	75.8		
2012	400	315	78.8		
Venues *					**<0.001**
Low risk venues	418	300	71.8	1.00	
Medium risk venues	651	499	76.7	1.29	0.073
High risk venues	583	391	67.1	0.80	0.11
Age (categories, years)					
< 20	361	291	80.6		
21-24	551	422	76.6		
25-29	372	271	72.8		
> 30	368	206	56.0		
Age (continuous, in a year)				0.94	**<0.001**
Marital status					**<0.001**
Never married	998	744	74.5	1.00	
Married	421	292	69.4	0.77	0.045
Cohabiting	146	109	74.7	1.01	0.98
Separated/widowed	84	44	52.4	0.38	<0.001
Missing	3	1	33.3		
Residency					
Guangdong province	227	178	78.4	1.00	
Other provinces	1425	1012	71.0	0.66	**0.016**
Education (years)					
<=9	1072	778	72.6	1.00	
> 9	580	412	71.0	0.93	0.51
Duration of current work (months)					**<0.001**
> 12	684	416	60.8	1.00	
6-12	263	212	80.6	2.68	<0.001
1-6	500	399	79.8	2.55	<0.001
< 1	196	158	80.6	2.68	<0.001
Missing	9	5	77.8		

Table S4.4. Determinants of no uptake of peer education service by 1652 female sex workers in Shenzhen, China: derived from univariate logistic regression. OR: odds ratio *(Continued)*..

Determinants	Sample size	No uptake of peer education	Proportion (%)	OR	P-value
Location of previous work					**0.037**
Guangdong province	1188	835	70.3	1.00	
Other provinces	398	304	76.4	1.37	0.020
No previous work	58	45	77.6	1.47	0.84
Missing	8	6	75.0		
Substance use					**0.003**
No	1563	1132	72.4	1.00	
Yes	67	38	56.7	0.50	0.006
Refused to answer	21	19	90.5	3.62	0.085
Missing	1	1	100.0		
Self-reported STD history in the last year					
No	1531	1106	72.2	1.00	
Yes	104	67	64.4	0.70	0.088
Refused to answer	15	15	100.0		
Missing	2	2	100.0		

* Low risk venues include nightclubs, and guesthouse/hotels; medium risk venues include karaoke/dance halls and saunas; high risk venues include hair salons/foot bathing shops, temporary sublets/roadside restaurants and streets.

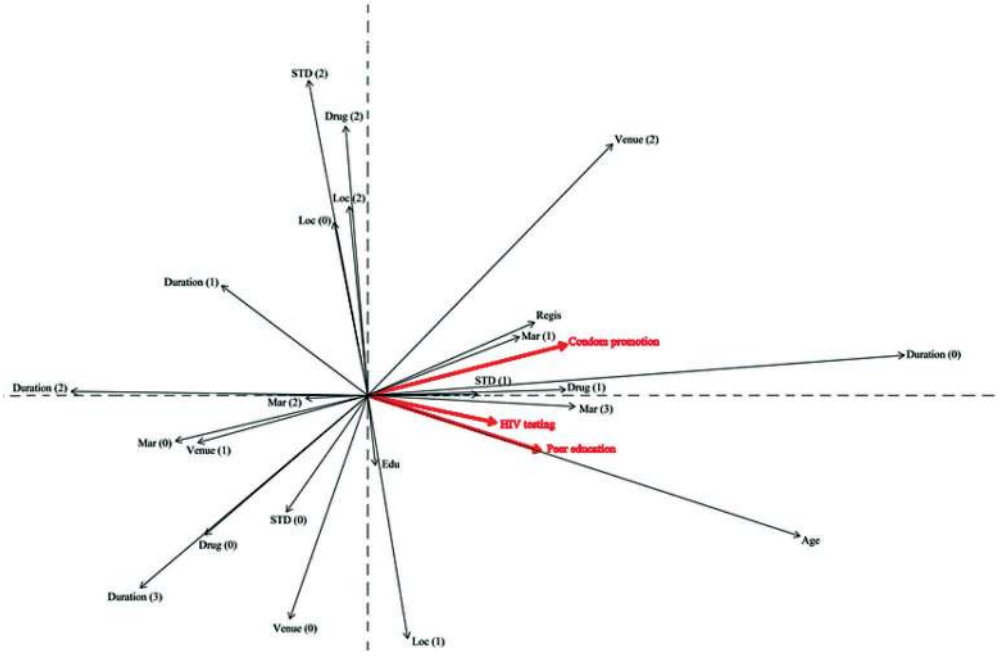

Figure S4.1. Biplot of socio-demographic and behavioral determinants of uptake of three HIV-related intervention services (HIV testing, condom promotion, and peer education) by female sex workers in Shenzhen, Guangdong Province, China. The black arrows represent the predictors (socio-demographic and behavioral determinants), and the red arrows represent the outcomes (uptake of each of the three services). Each arrow represents a category for predictors with more than two categories. Binary predictors and outcomes are represented by one arrow, because the other arrow would just be in the opposite direction with the same length. The horizontal direction of arrows indicates the tendency of uptake of the three services. The vertical direction of arrows discriminates between tendencies of uptake of each of the services. The length of arrows indicates how well predictors or outcomes are represented by the two-dimensional plane, i.e. a long arrow implies a predictor or outcome variable that is represented well. The angle between arrows indicates the correlation between the corresponding variables, i.e. a small angle implies a high correlation. Thus, a relatively long black arrow which has a relatively small angle with the red arrows implies an important determinant of uptake of HIV-related services. For an explanation of the predictors, see next page.

Predictors (socio-demographic and behavioral determinants) are as follows:

Venue: venues where females sex workers were recruited
Venue (0): low risk venues, i.e. nightclubs and guesthouse/hotels
Venue (1): medium risk venues, i.e. karaoke/dance halls and saunas
Venue (2): high risk venues, i.e. hair salons/foot bathing shops, temporary sublets/ roadside restaurants and streets

Mar: marital status
Mar (0): never married
Mar (1): married
Mar (2): cohabiting
Mar (3): separated/widowed

Regis: *hukou* registration, provinces where people were registered as permanent residents
Regis: *hukou* registered in provinces other than Guangdong province

Edu: education level
Edu: more than 9 years of education

Duration: duration of current commercial sex work (months)
Duration (0): >12
Duration (1): 6-12
Duration (2): 1-6
Duration (3): < 1

Loc: location of previous commercial sex work
Loc (0): provinces other than Guangdong
Loc (1): Guangdong province
Loc (2): no previous commercial sex work

Drug: substance use history
Drug (0): no use
Drug (1): ever used
Drug (2): refused to answer

STD: STD history
STD (0): no history
STD (1): reported ever had STD
STD (2): refused to answer

Chapter 5

HIV risk and prevention behaviors in men who have sex with men and women: a respondent-driven sampling study in Shenzhen, China

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Abstract

Men who have sex with men and women (MSMW) may expand the HIV epidemic from men who have sex with men to the female population. From a respondent-driven sampling survey in Shenzhen, China, we quantified the burden of HIV/syphilis and studied patterns of risk and prevention behaviors in 107 MSMW, and compared these with those of 542 men who have sex with men only (MSM-only). HIV prevention behaviors and consistent condom use with male partners did not differ between the two groups. However, HIV risk behaviors were more common among MSMW than MSM-only. Moreover, among MSMW, the HIV prevalence was as high as 6% and consistent condom use was extremely low with female partners in MSMW. We conclude that there is risk of HIV transmission from MSMW to the female population. Special efforts are needed to convince MSMW they should refrain from HIV risk behaviors.

Introduction

The HIV epidemic continues to expand in China, seeing that approximately 780,000 people were living with HIV by the end of 2011 versus 650,000 in 2005.[1] In the past two decades, the epidemic was confined mainly to injecting drug users. However, sexual transmission has become the predominant mode of HIV transmission since 2007. National surveillance data have shown a rapid increase in the proportion of new HIV infections attributable to sexual transmission, from 57% in 20072 to 82% in 2011,[1] and within this category, the proportion of homosexual transmission increased from 21% to 35% over this period.[1,2] The HIV prevalence among men who have sex with men (MSM) is alarmingly high. A survey in 2008 among 47, 231 MSM from 61 cities showed it was about 5%.[3] Since 2010 the prevalence has reached about 10% in big cities such as Shenzhen and Chongqing.[4,5]

As in many Asian countries, homosexuality is not largely accepted in China. Chinese culture dictates that men get married and carry on their family names through a 'regular' marriage at around 35 years of age. If not, they may be suspected of being odd or MSM. Thus, many MSM have sexual relationships with women to hide their homosexual orientation. An estimated 50-70% of Chinese MSM have had sex with women in their lifetime and about 17% are married to a woman.[6] Systematic reviews in China have shown that 36% of MSM consistently used condoms with male partners in the last 6 months and that 62% used a condom at last sex with male partners; the corresponding figures for MSM who also have sex with women (MSMW) are 26% and 41%.[6,7] The lower condom use with female partners, together with the high HIV prevalence, implicates that MSMW could act as an important bridge in transmitting HIV to the female population.

Although the Chinese government has enacted a series of policies to curb the HIV epidemic, such as the 'Plan for HIV/AIDS Prevention and Control among MSM, 2007-2010',[8] prevention efforts at the local level have tended to consider MSMW and men who have with men only (MSM-only) as a homogenous population, without special attention to MSMW. Only a few studies have documented practices of MSM who have sex with women,[9-12] and HIV risks in MSMW are still under-documented in China.

Previous studies in societies where homosexuality is stigmatized, such as in Latin America and India, revealed that MSMW are less likely than MSM-only to engage in risk behaviors (e.g. commercial sex, receptive anal sex).[13-15] Still, MSMW may be at higher risk of HIV infection than MSM-only, because they may tend to hide their sexual orientation and same-sex behavior, and consequently will not turn to prevention services.

Programs to control the HIV epidemic in China could be more effective if we would know to what extent MSMW serve as a bridge for transmitting HIV to the female population. In this study, therefore, we investigated HIV risk and prevention behaviors, and burden of HIV and

syphilis in MSMW in comparison with MSM-only in Shenzhen, China. The aim of this study is to identify whether MSMW are likely to spread HIV – and if so to what extent – from the MSM network to the female population.

Methods

Study setting and participants

We conducted the study in Shenzhen, a developed city in southern China, which borders on Hong Kong. Compared to other cities in mainland China, people in Shenzhen, especially the young generation, tend to be more open in accepting homosexuality.[16] It is estimated that there are more than 100,000 MSM in Shenzhen, who congregate in bars, massage centers, saunas and public parks.[16]

To be eligible for the study, respondents had to satisfy the following criteria: (1) ≥ 18 years old, (2) male, (3) self-reported anal or oral sex with one or more men in the last 6 months in Shenzhen. Regardless of marital status and self-identified sexual orientation, men were classified as MSMW if they reported also to have had sex with a woman in that period. If not, they were classified as MSM-only.

Respondent-driven sampling

Participants were recruited by means of respondent-driven sampling (RDS) between May and December 2010. RDS is widely used in the recruitment of hidden populations, such as MSM.[17-19] It can reduce biases that are common in traditional chain-referral and other sampling methods,[18,20,21] and thus is considered an effective sampling method with statistical rigor. In brief, recruitment starts with identification of potential 'seeds', who are then asked to recruit their peers, who in turn further refer those they know and so on. The sample composition reaches equilibrium within a number of recruitment waves, irrespective of the characteristics of the initial seeds.[20] By reaching equilibrium, the sample composition and characteristics are stable and will not change much with further referral of peers.

Ten seeds, diversified by age (below 20, 20-25, 26-30 and above 30 years), education, and marital status, were selected based on a group discussion with MSM peers from a local non-government organization that has collaborated with the Shenzhen Center for Disease Control and Prevention (Shenzhen CDC) for nearly 10 years. These MSM peers were instructed to identify seeds who were popular (i.e. having many network connections) and probably knew some MSMW. Each seed was given three coded coupons to hand over to potential participants. Men who presented the coupons and who were deemed to be eligible were asked to provide informed consent and were enrolled. In turn, each new enrolled participant was given three coded coupons to extend the recruitment chain. All enrolled participants completed an anonymous computer-assisted questionnaire and confidential HIV and syphilis tests at our interview site. Based on our

previous experience of recruiting MSM by RDS,[22] we chose one community-based clinic run by Shenzhen CDC in cooperation with the local non-government organization as our interview site. The address, phone number, and office hours of the site were printed on coupons. By way of incentive, each individual received 50 RMB (about 6 Euros) for his own participation and a further 10 RMB (about 1.2 Euros) for each participant whom he recruited. In order to avoid duplication of participation, new potential participants were asked to have their fingerprints scanned, which were checked against our database of previous participants to ensure that they were new to this study.

Each eligible participant was invited to complete the questionnaire and for blood testing for HIV. Verbal consent was obtained. Participants were given the option to only do the questionnaire if they did not want to take a blood test. We offered 50 RMB (6 Euros) to those who completed both the questionnaire and the HIV test. Participants testing HIV negative were informed by internet and participants testing HIV positive were informed by phone and referred to healthcare services. Confidentiality and anonymity were strictly observed in this study. The study was approved by the review board of Shenzhen CDC.

Data collection

We used palmtop computers to collect the questionnaire information about socio-demographics and behaviors, HIV and condom use knowledge. The questionnaire used in this study was previously validated.[16] Trained peer recruiters by Shenzhen CDC explained the study, distributed the questionnaires and clarified questions if necessary. Completing the questionnaire took about 30 minutes.

We collected information about the following socio-demographic characteristics: current age, age of first sex experience, education, hukou registration (provinces/cities where they were registered as permanent residents), hometown, duration of living in Shenzhen, income, marital status, living arrangement and sexual orientation. On the basis of the 2008 National MSM surveillance[23] Sichuan, Chongqing, Yunnan, and Guizhou were defined as hometowns with a high HIV prevalence, i.e. above 10%. The other 27 provinces/cities in mainland China were defined as hometowns with a low HIV prevalence.

We also collected information about the following behaviors: (1) HIV risk behaviors, including sold or bought sex, having had multiple (≥ 2) anal sex partners, having had one-night stand male partners, having had group sex in the last 6 months, having used alcohol before or during sex in the last 6 months, and having used illicit drugs in the last 6 months; (2) HIV prevention behaviors, including having been tested for HIV and having used HIV-related services, i.e. condom distribution, peer education or HIV counseling.

Participants were also asked to describe any anal sex role (insertive, receptive or both), average number of sexual intercourse in a month (with boyfriends for MSM-only and with boyfriends and girlfriends/wives for MSMW) and condom use with different types of sexual partners (e.g. boyfriends, girlfriends, one-night stand male and female partners, etc.), if they had such sexual partners in the last 6 months. Consistent condom use was defined as using condoms every time during sexual intercourse. Status of condom use was determined for anal and vaginal intercourse separately, according to the sexual partners they had. We also tested knowledge about HIV and about condom use. Level of knowledge about HIV was considered high if at least 6 out of 9 questions were correctly answered; level of knowledge about condom use was considered high if at least 4 out of 5 questions were correctly answered, as previously described.[16] All the variables were categorical, except present age and age of first sex experience.

Laboratory test for HIV and syphilis

HIV and syphilis testing was performed in accordance with standardized laboratory procedures provided by the National Center for Disease Control and Prevention of China. HIV was tested using a rapid test (Determine HIV-1/2/O; Abbott Laboratories, Illinois, USA) and ELISA (Wantai Biotech Inc, Beijing) for screening and Western blot (Genlabs Diagnostics, Singapore) for confirmation. Syphilis was tested using a rapid plasma regain method (Rongsheng Biotech Inc, Shanghai, China) for qualitative screening and the *Treponema pallidum* particle agglutination assay (Fujirebio Inc, Japan) for confirmation.

Data analysis

Analysis of data collected by RDS should be adjusted for respondents' social network size (i.e. the larger a social network, the greater the likelihood that someone might be recruited by other participants in his social network) and recruitment patterns. Size of a MSM's social network was considered to be reflected by the number of other MSM they knew by name, by nickname, or by face, and who were 18 years or older, lived in Shenzhen and whom they could reach during one month. The data were analyzed in four steps. In the first step, we exported individualized weights of MSMW (outcome variable) from RDS Analysis Tool (RDSAT, version 7.1) to SPSS (version 20.0). In the second step, we compared the weighted socio-demographic characteristics and knowledge about HIV and condom use between MSMW and MSM-only by the Wald test for continuous variables and chi-square tests for categorical variables. In the third step, we conducted (weighted) logistic regression to assess the association between each HIV risk/prevention behavior and being MSMW (used as the dependent variable). In multivariate logistic regression, we adjusted odds ratios (OR) for socio-demographic variables that could be risk factors (or confounders) for having sex with women based on results in the second step. All important socio-demographic variables (with $p < 0.10$ in the second step) were included, with the variable with the smallest p value chosen as the first variable to be adjusted in the multivariate model. In the final step, we compared condom use status in contacts with different types of sexual partners, and burden of HIV and syphilis between MSMW and MSM-only.

Results

Of the initial 10 seeds, 7 produced at least one wave of recruitment, with the longest chain reaching 22 waves and recruiting 273 participants. The shortest chain recruited only one participant (Table S1). Apart from the initial seeds, 639 participants (coupon return rate: 639/1869 = 34%) who completed both the questionnaire and the serological testing were recruited, resulting in a total sample of 649 participants (i.e., including the 10 seeds). The composition of key socio-demographics (education, marital status and age) stabilized after wave 3 (Table S2). The absolute discrepancy (0.2%) between the sample proportion of MSMW (107/649 = 16.5%) and the corresponding equilibrium proportion (16.7) was much smaller than a tolerance of 2%, indicating that our sample has stabilized to reach equilibrium.[20]

Socio-demographics and HIV knowledge

Of the total 649 MSM, 107 reported having had sex with women in the last 6 months and were classified as MSMW. The remaining 542 were classified as MSM-only. MSMW were older (mean age: 30 ± 7 vs. 28 ± 7 years, $p = 0.033$), less educated ($p < 0.001$) and living in Shenzhen longer ($p < 0.001$) than MSM-only. Nearly half (46.6%) of MSMW were married at the time of study, and 24.5% of them were living with female partners or their wives. The majority (60.2%) of MSMW identified themselves as bisexuals, whereas most (78.6%) of MSM-only identified themselves as homosexuals. Most of the participants had a high level of knowledge about HIV and about condom use (91% and 88%, respectively), and this was comparable between MSMW and MSM-only. Other socio-demographics such as *hukou* registration and income did not differ significantly between MSMW and MSM-only. Detailed information can be found in Table 1.

HIV risk and prevention behaviors

Overall, HIV risk behaviors, namely selling sex to men (OR = 2.85, $p = 0.011$), having multiple (≥ 2) anal sex partners (OR = 1.68, $p = 0.022$), using illicit drugs (OR = 4.76, $p = 0.001$), and using alcohol before or during sex (OR = 2.01, $p = 0.004$) were more common among MSMW than among MSM-only (Table 2). On the other hand, taking a receptive anal sex role (OR = 0.42, $p = 0.004$), and taking both receptive and insertive anal sex roles (OR = 0.48, $p = 0.008$) were less common in MSMW than in MSM-only. There was no significant difference in engaging in HIV prevention behaviors between MSMW and MSM-only (Table 2).

After controlling for important socio-demographic characteristics (shown in Table 1), the association between sex with men and women, and most of the HIV risk behaviors (mentioned above) remained significant. Only selling sex to men was not significant anymore ($p = 0.080$). On the other hand, the association between sex with men and women, and having group sex, which was marginally significant in univariate analysis ($p = 0.070$), became significant ($p = 0.046$) after adjusting for socio-demographics. The association between sex with men and women, and engaging in HIV prevention behaviors remained not significant (Table 2).

Table 5.1. Socio-demographics and HIV knowledge of 107 men who have sex with men and women (MSMW) and 542 men who have sex with men only (MSM-only) in Shenzhen, China.

Characteristic	MSMW (N = 107)	MSM-only (N = 542)	P-value
Age, years (mean ± sd) [a]	(30 ± 7)	(28 ± 7)	**0.005**
Age of first sex experience with a man (mean ± sd) [a]	(25 ± 6)	(25 ± 5)	0.62
Education level[b], %			**<0.001**
Junior high school or lower	25.2	10.8	
Senior high school	40.8	37.4	
College or above	34.0	51.8	
Hukou registration, %			0.78
Shenzhen	12.7	14.4	
Other cities in Guangdong province	19.6	21.6	
Other provinces	67.6	64.0	
Hometown with high HIV prevalence, %			0.49
No	85.4	87.9	
Yes	14.6	12.1	
Duration of living in Shenzhen[b], %			**<0.001**
< 1 year	24.3	35.9	
1-2 years	2.9	12.3	
> 2 years	72.8	51.8	
Monthly income (RMB), %			0.13
≤ 3000	63.1	52.6	
3001-5000	22.3	26.7	
> 5000	14.6	20.7	
Marital status[b], %			**<0.001**
Unmarried	53.4	83.9	
Married	46.6	16.1	
Living arrangements[b], %			**<0.001**
Living with male partners	17.6	17.8	
Living with female partners or wife	24.5	2.4	
Living with family (no wife) or roommates	22.5	29.3	
Living alone	35.3	50.5	
Self-identified sexual orientation[b], %			**<0.001**
Homosexual/gay	26.2	78.6	
Bisexual	60.2	15.0	
Heterosexual or unsure	13.6	6.4	

Table 5.1. Socio-demographics and HIV knowledge of 107 men who have sex with men and women (MSMW) and 542 men who have sex with men only (MSM-only) in Shenzhen, China *(Continued)*.

Characteristic	MSMW (N = 107)	MSM-only (N = 542)	P-value
Self-perceived HIV risk, %			0.69
Very low	83.3	79.7	
Moderate	14.7	18.1	
Very high	2.0	2.2	
Knowledge about HIV, %			0.87
Low	8.8	9.3	
High	91.2	90.7	
Knowledge about condom use, %			0.15
Low	7.8	12.8	
High	92.2	87.2	

[a] The two results were from the Wald tests. The other results in this table were from chi-square tests.
[b] These significant variables were considered to be included as possible confounders in the multivariate analysis in Table 2.

More than 60% of both MSMW and MSM-only reported consistent condom use with most types of male partners (Figure 1). Proportions of men reporting consistent condom use differed between MSMW and MSM-only regarding male sex workers, i.e. condom use with male sex workers was only 16.7% for MSMW versus 81.0% for MSM-only (p = 0.004). (Figure 1) The mean monthly number of sexual intercourse with their boyfriends reported by MSMW and MSM-only was not significantly different (6 vs. 5; p = 0.24).

Thirty-two of the 107 MSMW (30%) were married and reported having had sex with their wives, and 47 (44%) of them were not married and reported having had sex with their girlfriends in the last 6 months. The remaining 28 MSMW did not have regular female partners (wives/girlfriends) but reported having had sex with other female partners (e.g. FSWs). MSMW who had wives had less sex than MSMW who had girlfriends (5 vs. 12 intercourse per month, p = 0.043). Consistent condom use was similar with their girlfriends and wives (41% vs. 38%; p = 0.24). Moreover, 61 of the 107 MSMW (57%) reported having had sex with their boyfriends in the last 6 months. The mean number of monthly intercourse with their boyfriends was not significantly different from that with their girlfriends (6 vs. 12; p = 0.068) and wives (6 vs. 5 intercourse per month, p = 0.65). Consistent condom use was much higher with their boyfriends than that with their girlfriends (75% vs. 41%, p < 0.001) and wives (75% vs. 38%, p < 0.001). Furthermore, the proportion of consistent condom use with one-night stand female partners was also lower than that with one-night stand male partners (Figure 1). There were no significant differences in proportions of consistent condom use with commercial sex partners (Figure 1).

Table 5.2. The association between HIV risk/prevention behavior and being men who have sex with men and women (MSMW) among 649 MSM in Shenzhen, China, derived from weighted univariate and multivariate logistic regression. Adjusted OR were calculated after controlling for possible confounders.[a]

Characteristic	Total sample	MSMW (%)	Univariate OR (95% CI)		P-value	Adjusted OR (95% CI)		P-value
HIV risk behaviors (in the last 6 months)								
Ever sold sex to another man								
No	620	97 (15.6)	1.00			1.00		
Yes	29	10 (34.5)	2.85	(1.28- 6.35)	**0.011**	2.37	(0.90- 6.22)	0.080
Ever bought sex from male sex workers								
No	600	100 (16.7)	1.00			1.00		
Yes	49	7 (14.3)	0.81	(0.35- 1.91)	0.63	1.43	(0.51- 4.04)	0.50
Multiple (≥ 2) anal sex partners								
No	287	36 (12.5)	1.00			1.00		
Yes	362	71 (19.6)	1.68	(1.08- 2.61)	**0.022**	1.84	(1.05- 3.20)	**0.032**
Ever had one-night stand male partners								
No	267	36 (13.5)	1.00			1.00		
Yes	382	71 (18.6)	1.30	(0.83- 2.03)	0.25	1.43	(0.81- 2.53)	0.22
Ever had group sex								
No	590	91 (15.4)	1.00			1.00		
Yes	59	16 (27.1)	1.80	(0.95- 3.40)	0.070	2.22	(1.02- 4.84)	**0.046**
Anal sex role[b]					0.002			0.002
Insertive	269	58 (21.6)	1.00			1.00		
Both	177	21 (11.9)	0.48	(0.28- 0.83)	0.008	0.36	(0.18- 0.69)	0.002
Receptive	156	16 (10.3)	0.42	(0.23- 0.75)	0.004	0.36	(0.17- 0.73)	0.005
Ever used illicit drugs								
No	631	99 (15.7)	1.00			1.00		
Yes	18	8 (44.4)	4.76	(1.84- 12.36)	**0.001**	5.86	(1.77- 19.37)	**0.004**
Ever used alcohol before or during sex								
No	523	75 (14.3)	1.00			1.00		
Yes	126	32 (25.4)	2.01	(1.25- 3.24)	**0.004**	3.27	(1.76- 6.10)	**<0.001**
HIV prevention behaviors (in the last year)								
Used HIV-related services								
No	192	29 (15.1)	1.00			1.00		
Yes	457	78 (17.1)	1.13	(0.71- 1.81)	0.60	1.30	(0.72- 2.36)	0.39
Tested for HIV								
No	389	66 (17.0)	1.00			1.00		
Yes	260	41 (15.8)	0.89	(0.57- 1.38)	0.61	0.94	(0.55- 1.61)	0.81

[a] In the final multivariate logistic regression, we calculated the odds ratios only adjusted for education, duration of living in Shenzhen, living arrangement and sexual orientation. Age and marital status were not included, as they did not remain significant.

[b] The total does not add up with 649 MSM, as 12 MSMW and 30 MSM-only did not respond to the question.

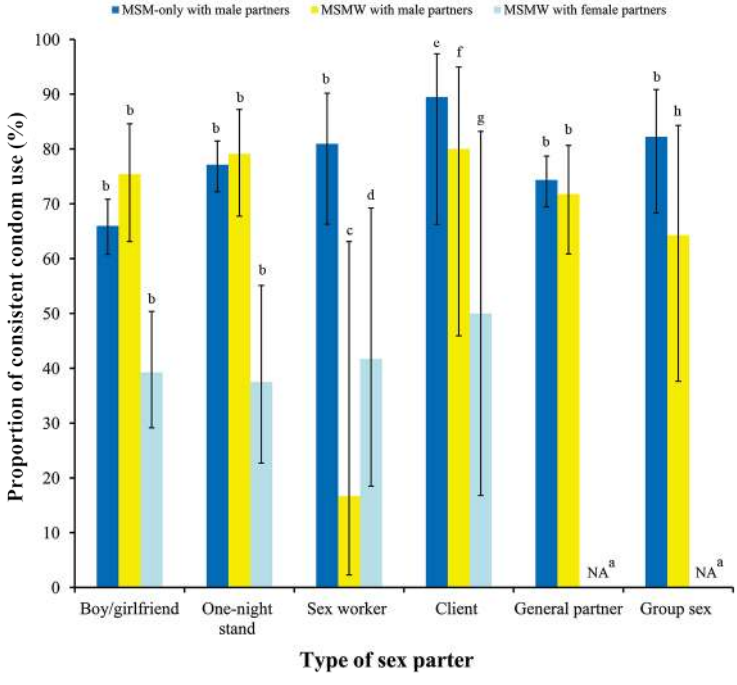

Figure 5.1. Proportion (with 95% CI) of respondents who have sex with both men and women (MSMW) and those who have sex with men only (MSM-only) reporting consistent condom use with different types of sexual partners.

[a] NA = not applicable, because MSMW refused to answer these questions.
[b] All these results of confidence intervals of condom use were based on information from at least 30 participants.
[c] 6 MSMW answered questions regarding condom use with male sex workers.
[d] 12 MSMW answered questions regarding condom use with female sex workers.
[e] 19 MSM-only answered questions regarding condom use with male clients.
[f] 10 MSMW answered questions regarding condom use with male clients.
[g] 6 MSMW answered questions regarding condom use with female clients.
[h] 14 MSMW answered questions regarding condom use with group male sex partners.

Condom use with different types of sexual partners of MSMW and MSM-only

More than 60% of both MSMW and MSM-only reported consistent condom use with most types of male partners (Figure 1). Proportions of men reporting consistent condom use differed between MSMW and MSM-only regarding male sex workers, i.e. condom use with male sex workers was only 16.7% for MSMW versus 81.0% for MSM-only (p = 0.004). (Figure 1) The mean monthly number of sexual intercourse with their boyfriends reported by MSMW and MSM-only was not significantly different (6 vs. 5; p = 0.24).

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Burden of HIV and syphilis of MSMW and MSM-only

The burden of HIV and syphilis was comparable between MSMW and MSM-only: 5.9% of MSMW and 8.8% of MSM-only were HIV positive ($p = 0.33$) and 16.5% of MSMW and 20.0% of MSM-only were syphilis infected ($p = 0.42$).

Discussion

To the best of our knowledge, this is the first study using a powerful sampling method (RDS) to reach the hidden population of MSMW in China. About 16% of the sample in this study were MSMW, and they were more likely to engage in HIV risk behaviors than MSM-only. Thus, the risk of HIV transmission from these men to the female population is high. HIV-related intervention services should consider MSMW as a separate subgroup of MSM and special efforts are needed to promote safer sexual practices.

We categorized MSMW and MSM-only by their recent (last 6 months) sexual practices, rather than by marital status or self-identified sexual orientation. As there is evidence that married MSM may have no or little sexual intercourse with their wives,[14] and MSM may misidentify their sexual orientation,[13] categorizing MSMW based on their marital status or self-identification may both over- or underestimate the true proportion of MSM who have sex with women. For instance, 65% of the 163 married MSM reported to have had no sex with women in the last 6 months. Among the participants reporting having had sex with a woman in the last 6 months, only 26% (9% married and 17% unmarried) identified themselves as homosexuals. Among the participants reporting having sex with men only, 15% identified themselves as bisexuals. As the aim of this study was to investigate the probability of HIV transmission from MSMW to

females, we believed that categorizing participants based on their behavior and not on their sexual identity or marital status would provide a clearer picture of transmission potential.

Previous research in India and Latin America concluded that MSMW displayed less risky behavior than MSM-only: fewer MSMW reported a receptive anal sex role and other HIV risk behaviors.[13-15] In our study, MSMW reported less receptive anal sex than MSM-only, but were more likely to report engaging in other HIV risk behaviors such as using alcohol/illicit drugs and having multiple or group sex partners. We explain the inconsistency between our study and previous studies as follows: in Shenzhen, most of male sex workers sell sex to both males and females to increase their income, while in India most male sex workers (often are male-to-female transgender, known as *hijra*) sell sex only to males.[24] Thus, male sex workers were classified as MSM-only in India, while in our study they were classified as MSMW. Previous research shows that male sex workers are more likely to have multiple/group sex partners, and more likely use alcohol/illicit drugs than other MSM.[16] Furthermore, a considerable proportion (30%) of MSMW in our study reported having used alcohol before or during sex and 7% reported having used illicit drugs. The use of alcohol and other drugs could possibly have increased the likelihood of engaging in risky sexual activities such as having multiple sex partners.[25] However, information about alcohol and drug use is not available in other studies about MSMW, making it impossible to compare our study with other studies.

Judged from their HIV risk behaviors, MSMW in our study may be at high risk of HIV infection, although there is evidence that the insertive partner in anal intercourse has a lower risk of getting HIV than the receptive partner.[26,27] The test results in the present study revealed that the HIV and syphilis infection rates in MSMW (6% and 17%) were indeed as high as that in MSM-only (9% and 20%). These results suggest that MSMW and MSM-only have similar transmission risks to their sexual partners. The more common risk behaviors among MSMW compared to MSM-only cannot be fully explained by the differences in their socio-demographics, e.g. MSMW were more likely to have a low education level and to be married than MSM-only (see Table 1). We recommend future studies to take into account possible psychological factors. For instance, MSMW who are less open about their sexuality may have less peer/family support and more self-perceived stigma than MSM-only. It is possible that MSMW are more likely to engage in HIV risk behaviors because of lack of support.

Besides the high risk of HIV infection for MSMW themselves, the risk of HIV transmission from MSMW to the female population is also high. Over 70% of MSMW in the present study also had had sex with their girlfriends or wives in the last 6 months, and the mean number of sexual intercourse with their girlfriends or wives was similar to that with their boyfriends. However, only very few consistently used condoms with their girlfriends or wives. And the low condom use with regular female partners in MSMW was common in both HIV-positive and HIV-negative MSMW (33% vs. 44%, $p = 0.69$), showing that HIV positive MSMW did not take action to protect their female partners. The above practices can be explained as follows: first,

under the traditional Chinese culture and values, MSMW may have sex with their regular female partners under the pressure of having a child. Second, these regular female partners of MSMW may not realize that these men also engage in sexual intercourse with men, or if they do may not be aware of the high risk involved. Last but not least, MSMW may not perceive sex with their regular female partners to be risky. The frequent sexual intercourse, inconsistent condom use, together with the high HIV infection rate of MSMW, indicate a significant risk of HIV transmission from MSMW to their girlfriends or wives. In addition, 11% of MSMW reported sex with female sex workers as well in the last 6 months. These female sex workers, therefore, could very well serve as a bridge for transmitting HIV further to the heterosexual population.

Previous qualitative studies suggest that MSMW are less likely to seek prevention and treatment services than MSM-only, who are more open about their sexuality.[28-30] As results of our study indicate that MSMW can facilitate the expansion of HIV epidemic in both the high-risk and the general population, it would be worrisome if they indeed make little use of HIV-related services. Fortunately, MSMW in our study reported comparable rates of HIV prevention behaviors as MSM-only, and about 70% (75/107) of MSMW have used at least one kind of HIV-related intervention services. Such HIV-related intervention services were specific to MSM and often provided at gay venues in Shenzhen. The comparable HIV prevention behaviors in MSMW and MSM-only suggest that they have been treated as a homogeneous group when allocating HIV prevention resources. As the selected HIV risk behaviors are more common in MSMW than in MSM-only, we recommend that public health authorities should target MSMW separately, and convince them to refrain from HIV risk behaviors, to consistently use condoms with females and to uptake HIV-related services more often, such as HIV testing. There is evidence that peer norms are key determinants of individual behaviors in MSM, including MSMW.[22,31] Outreach education programs by peers of MSMW may be an important strategy to reach MSMW.

Of note, MSM-only were significantly younger than MSMW in our study (mean age: 28 vs. 30 years, $p = 0.033$). This finding is consistent with results of the two prior studies on MSMW in China.[9,10] Given that family pressure for getting married and having a child increases with age in China, there is concern that some of MSM-only may eventually have sexual relationships or get married with women later in their life. As a substantial proportion of the MSM population is MSMW and there is a chance that MSM-only will have sex with women, it may be necessary to educate the whole MSM community about the importance of consistent condom use with female partners, at least with casual female partners. Such education programs should be culture-tailored, and sensitive to the MSM community. It may be very difficult in China to increase consistent condom use by MSMW with their girlfriends or wives, because the desire for having a child will compete with the concern to protect their partners from HIV infection. The cultural context is likely to remain of influence in the bridging effect of HIV transmission from MSMW to the female population.

Although this is a rigorous RDS study, several limitations should be addressed. Firstly, only 34% of the 1869 coupons distributed were returned. The representativeness and generalization of the results may be limited as there are large variations in sizes of the referral chains. Nevertheless, the coupon return rate is within the lower end of the range of the rates in RDS surveys around the world, which is 30% to 83%.[32] Secondly, self-reported data may have been subject to recall bias. Also, sensitive issues such as condom use may have been over-reported and illicit drug use may have been under-reported, thereby introducing information bias. Also, information bias may lead to misclassification of MSMW and_MSM-only, because MSM may deny their sexual behaviors with women. However, as we used palmtop computer-assisted questionnaires instead of face-to-face interviews to collect information, information bias should have been minimized. Thirdly, results of odd ratios could have been more precise if the sample sizes of MSMW and MSM-only were more balanced. Finally, this study was cross-sectional, so causal inferences cannot be made.

In conclusion, MSMW form an important distinct subgroup of the MSM population. Although numbers of MSMW and MSM-only in this study differed, leading to less precise confident intervals, it is quite clear that the burden of HIV/syphilis in MSMW is almost as high as that in MSM-only. Inconsistent condom use with their female partners is very common in MSMW. Although information bias is likely to influence the results, we are confident that we can conclude that MSMW could facilitate an expansion of the HIV epidemic from MSM to the female population. Special efforts are needed to convince MSMW to refrain from HIV risk behaviors – and outreach education programs implemented by their peers may be a strategy. We also recommend culture-tailored education programs to educate the MSM community at large to consistently use condom with females, so as to prevent HIV transmission to the female population.

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Chapter 6

Determinants of recent HIV testing among male sex workers and other men who have sex with men in Shenzhen, China: A cross-sectional study

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Submitted for publication

Abstract

Objectives: To investigate determinants of recent (last year) HIV testing among male sex workers (also referred as 'money boys', MBs) and other men who have sex with men (MSM) in Shenzhen, China.

Design: Cross-sectional study using primary data on socio-demographics and behaviors for a group of MBs and other MSM in 2010.

Methods: We recruited 510 MBs and 533 other MSM by time-location sampling in Shenzhen, China. Two multivariate logistic regression models were constructed to identify determinants of recent HIV testing among MBs and other MSM.

Results: Overall, 43% of MBs and 48% of other MSM reported having been tested for HIV in the last year. Determinants of testing among MBs were: having multiple anal and having more commercial male partners; among other MSM: having homosexual orientation, having only male sex partners and having a history of sexually transmitted infection. Having unprotected anal intercourse was not and living in Shenzhen longer was positively associated with HIV testing among both MBs and other MSM.

Conclusions: For MBs, education programs are needed to increase their awareness of actual HIV risk. For other MSM, de-stigmatizing programs are needed to encourage those with female partners to go for testing. For both MSM groups, new comers to Shenzhen should be targeted most intensely.

6.1 Introduction

National surveillance data show that the HIV prevalence among men who have sex with men (MSM) has increased nationally from 1.5% in 2005 to 5.0% in 2009, while the prevalence among the general population stays stable below 0.1%.[1] Of the 48,000 reported new HIV cases in China in 2011, approximately 30% were attributable to MSM.[1] Due to traditional cultural values, a substantial proportion of Chinese MSM are married to females. It was reported that 50-70% of MSM have had sex with females.[2] Furthermore, inconsistent condom use with female partners is very common.[3] Given the above, there is much concern that MSM may act as a bridge in transmitting HIV to the general heterosexual population. Therefore, MSM have become a priority population for the prevention and control of the HIV epidemic in China.

HIV testing is crucial in epidemic prevention and control efforts. It allows for early detection of infection and timely referral to treatment and medical care, thereby reducing mortality and infectiousness.[4,5] HIV testing also helps to prevent transmission, as knowledge of HIV status may help MSM to change their high-risk behavior.[6] For these reasons, HIV testing has been widely implemented in industrialized and developing countries. The Chinese government is committed to this strategy, especially in priority populations such as MSM. The government has offered free HIV testing since 2003 and enacted a series of policies to increase the uptake of testing, such as the 'Plan for HIV/AIDS Prevention and Control among MSM, 2007-2010'.[7] However, the uptake of testing among MSM remains unacceptably low in China, with testing rates in the last year ranging from 15% to 56%.[8,9] Analysis of the profile of MSM who undertake HIV testing (and those previously untested) could help identify opportunities for education and prevention and raise the uptake of testing in China.

So far, there are only four published studies on determinants of HIV testing among MSM in China.[10-13] Three of these have treated MSM just as a homogeneous group, whereas in reality substantially different subgroups can be distinguished. In particular, male sex workers, also referred to as 'money boys' (MBs), are a distinct subgroup of MSM.[14-17] This is supported by a study in Shanghai[12] and our previous research on risk factors of HIV infection.[18] Both documented that the profile of socio-demographics and behavior significantly differs between MBs and other MSM. These subgroups may therefore also differ in patterns of HIV testing. Thus, it is necessary to separate MBs and other MSM to identify determinants of HIV testing. While the study in Shanghai focused on a lifetime testing history, it is better to investigate determinants of recent (last year) HIV testing in this study.

We used data from a cross-sectional study that separately recruited MBs and other MSM by a Time-Location Sampling (TLS) method in Shenzhen, China in 2010. The aim of this work is to understand the possible differences between MBs and other MSM in HIV testing rates and the determinants of recent testing, so that public health efforts promoting HIV testing can be directed effectively in these different subgroups of MSM.

6.2 Methods

Study setting and participants

The study was conducted in Shenzhen, a developed city in southern China, which shares a border with Hong Kong. The number of MSM is estimated at more than 100,000, including about 5000 MBs. As previously described,[18] there are more than 50 active MSM venues, where MBs can solicit their clients and other MSM (not providing commercial sex) can seek partners. These venues include bars, massage centers, saunas, parks, dorm-based venues (a kind of small home-based call boy brothels providing dormitories for MBs, advertised through Internet), and suburb recreational centers (a kind of multifunctional venues in industrial areas located in suburbs and offering video film, TV, karaoke, mahjong, sauna, and private bedrooms).

MBs and other MSM were recruited in parallel by Time-Location Sampling (TLS) from April 2010 to November 2010. TLS is a method to systematically sample potential participants at randomly selected venue-day-time periods (VDTs), through creation of a sampling frame that comprises the universe of venues, days and time periods where and when the population congregates.[19-21] Detailed information about how this sampling method was applied to recruit MSM in Shenzhen was described previously.[22,23] General eligibility criteria for MBs and other MSM were: male, at least 18 years old, Chinese national, and having engaged in oral or anal sex with a man in the last 6 months. Other eligibility criteria were: having (MBs) and having not (other MSM), been paid for male-male sex in the last 6 months. Participation was voluntary and anonymous. Each eligible participant was invited to complete a questionnaire and for blood testing for HIV. Verbal consent was obtained. Participants were given the option to only do the questionnaire if they did not want to take a blood test. We offered 50 RMB (6 Euros) to those who completed both the questionnaire and the HIV test. Participants testing negative were informed about results by internet and participants testing positive were informed by phone and referred to healthcare services for further consulting and treatment. Confidentiality and anonymity were strictly observed in this study. Of the 564 MBs and 851 eligible other MSM identified, 544 (96.5%) MBs and 550 (64.6%) other MSM participated in the study (both the questionnaire and blood testing). No participants refused blood testing for HIV. Refusal rates varied with VDTs, ranging from 0 to 27.3% in MBs and from 0 to 76.6% in other MSM. Mean refusal rate was the lowest in suburb recreational centers (0% in MBs and 8.4% in other MSM) and the highest in bars (6.4% in MBs and 61.4% in other MSM). The study was approved by the international review boards of the Chinese University of Hong Kong and Shenzhen Center for Disease Control and Prevention (Shenzhen CDC).

Data collection

A palmtop computer-assisted questionnaire was used to collect information on the outcomes of interest: recent HIV testing and possible determinants. The questionnaire used in this study was previously verified.[22, 23] At venues, peer recruiters trained by Shenzhen CDC explained the study, distributed the questionnaire and clarified the questions if necessary. It took each participant

about 30 minutes to finish the questionnaire. Recent HIV testing was defined as any self-reported HIV testing during the last year. Determinants of interest were socio-demographics, sexual behaviors in the last 6 months, sexually transmitted infection (STI) history, substance use history, access to HIV-related services in the last year, HIV-related knowledge and condom use knowledge. Information on barriers and incentives to HIV testing was not asked for, therefore the analyses that follow are focused on socio-demographic and behavioral determinants of HIV testing, not on why MSM did or did not seek HIV testing.

Socio-demographic information collected included venue of recruitment, age, education, *hukou* registration (provinces/cities where people were registered as permanent residence), hometown, duration of living in Shenzhen, income, and marital status. Following the 2008 National MSM surveillance,[24] 4 provinces/cities, i.e. Sichuan, Chongqing, Yunnan, and Guizhou, were defined as hometowns with high HIV prevalence (higher than 10%). The other 27 provinces/cities in China were defined as hometown with low HIV prevalence.

Behavioral information collected included sexual orientation, gender of first sex partner, age of first sex experience, type of sex partners (men only, or men and women), whether or not having multiple (≥ 2) anal sex partners, any male sex partners from Hong Kong, anal sex role (insertive, receptive, or both), any unprotected anal intercourse experience, any condom rupture experience, number of female sex partners (0, 1 or more than 1), any unprotected anal or vaginal intercourse in the last 6 months. MBs were asked three more questions: duration of providing sex for males (not longer than 1 year or longer than 1 year), number of male clients (l-4 or more than 4 clients), and ever sold sex to women in the last 6 months. All the other measures such as HIV-related knowledge, condom use knowledge were previously described.[23] Age, age of first sexual experience (intercourse), and duration of living in Shenzhen were used as continuous variables and the other variables were used as categorical variables in the univariate and multivariate logistic regression analysis.

Laboratory test for HIV

After completing the questionnaire, participants were asked to provide a blood sample for HIV testing. Testing was performed in accordance with standardized laboratory procedures provided by the National Center for Disease Control and Prevention of China. A rapid test (Determine HIV-1/2/O; Abbott Laboratories, Illinois, USA) and ELISA (Wantai Biotech Inc, Beijing) was used for screening; Western blot (Genlabs Diagnostics, Singapore) for confirmation. Inviting participants for HIV testing was not essential for this study, but we routinely did so for surveillance.

Data analysis

Eventually, 510 MBs and 533 other MSM were included in the data analysis. Questionnaires with missing values on venue attendance data (34 by MBs and 17 by other MSM) were excluded. We first performed descriptive analysis by chi-square test to compare other MSM and MBs regarding

socio-demographics, behaviors, STI history, access to HIV-related services and condom use and HIV-related knowledge. We then performed univariate and multivariate logistic regression analysis for MBs and other MSM, separately. Logistic regression was done by backward stepwise elimination. The variables attaining $p < 0.20$ significance in univariate analysis were included in the multivariate regression analysis, retaining only variables achieving $p < 0.10$ significance in the final model. The cut-off point for the final model was set at $p = 0.10$ instead of 0.05, because in this exploratory analysis we did not want to miss out the borderline significant factors. The correlates were expressed in terms of odds ratios, including 95% confidence interval (95% CI). All statistical analyses were performed using SPSS software (version 20.0).

6.3 Results

Comparison of HIV infection, socio-demographics and behaviors between MBs and other MSM

A total of 1043 MSM (510 MBs and 533 other MSM) were enrolled in our study. All the 1043 MSM agreed to be tested for HIV. Compared to other MSM, the MBs showed a significantly lower prevalence of HIV (3.3% vs. 9.4%, $p < 0.001$). The majority (94%) of MBs had been recruited from dorm-based venues or high-end venues (bars/massage centers/gyms), whereas the majority (76%) of other MSM had been recruited from low-end venues (parks, recreational centers or saunas). Compared to other MSM, the MBs were younger (mean age: 34 ± 4 vs 30 ± 8 years, $p < 0.001$), less educated, more mobile (3.3% of MBs vs. 6.9% of other MSM were holding Shenzhen *hukou* registration, $p < 0.001$), and living in Shenzhen shorter. Behavioral patterns also differed significantly between MBs and other MSM. In general, MBs were less likely to identify themselves as homosexuals (19.4% vs. 57.6%, $p < 0.001$), had multiple anal sex partners (80.2% of MBs vs. 70.4% of other MSM had more than one anal partner, $p = 0.001$), used condoms more consistently (30.6% of MBs vs. 43.8% of other MSM had unprotected anal intercourse, $p < 0.001$), and had more female sex partners (15.5% of MBs vs. 2.6% of other MSM had multiple female partners). Detailed comparison of socio-demographic and behavioral information between MBs and other MSM is shown in Table 6.1.

Table 6.1. Comparison of HIV infection, socio-demographics and behaviors between 510 'money boys' (MBs) and 533 other men who have sex with men (MSM) in Shenzhen, China: results from a cross-sectional study in 2010.

Characteristic	MBs (N = 510)		Other MSM (N = 533)		P-value
	n	n	%	n	%
HIV serostatus (based on current laboratory test)					
Positive	17	3.3	50	9.4	**<0.001**
Demographic information					
Venue type of recruitment					**<0.001**
Bar/massage center/gym	272	53.3	104	19.5	
Dorm-based venue	207	40.6	22	4.1	
Park	10	2.0	100	18.8	
Recreational center	13	2.5	127	23.8	
Sauna	8	1.6	180	33.8	
Education level					**<0.001**
Junior high school or lower	153	30.0	107	20.1	
Senior high school	287	56.3	189	35.5	
College or above	70	13.7	237	44.5	
Hukou registration					**<0.001**
Shenzhen	17	3.3	37	6.9	
Other cities in Guangdong province	39	7.6	85	15.9	
Other provinces	454	89.0	411	77.1	
Hometown with high HIV prevalence					0.17
No	432	84.7	467	87.6	
Yes*	78	15.3	66	12.4	
Duration of living in Shenzhen (years)					**<0.001**
< 1	276	54.1	120	22.5	
1-2	83	16.3	65	12.2	
> 2	147	28.8	318	59.7	
NA (short-time visitors)	4	0.8	30	5.6	
Monthly income (RMB)					**0.001**
≤ 3000	39	7.6	41	7.7	
3001-5000	101	19.8	95	17.8	
> 5000	31	6.1	44	8.3	
Marital status					**<0.001**
Unmarried	472	92.5	390	73.2	
Married	38	7.5	143	26.8	

Table 6.1. Comparison of HIV infection, socio-demographics and behaviors between 510 'money boys' (MBs) and 533 other men who have sex with men (MSM) in Shenzhen, China: results from a cross-sectional study in 2010 *(Continued)*.

Characteristic	MBs (N = 510)		Other MSM (N = 533)		P-value
	n	n	%	n	%
Sexual behavioral information					
Self-identified sexual orientation					**<0.001**
Homosexual/gay	99	19.4	307	57.6	
Bisexual	157	30.8	180	33.8	
Heterosexual or unsure	254	49.8	46	8.6	
Gender of first sex partner					**<0.001**
Male	128	25.1	318	59.7	
Female	382	74.9	215	40.3	
Type of sex partners in the last 6 months					**<0.001**
Men only	128	25.1	431	80.9	
Men and women	382	74.9	102	19.1	
Multiple anal sex partners in the last 6 months					**<0.001**
No	101	19.8	158	29.7	
Yes	409	80.2	375	70.4	
Hong Kong male sex partner in the last 6 months					<**0.001**
Yes	222	43.5	56	10.5	
No	266	52.2	466	87.4	
Unsure	22	4.3	11	2.1	
Anal sex role in the last 6 months^					0.073
Insertive	174	36.6	214	43.8	
Both	226	47.5	204	41.7	
Receptive	76	16.0	71	14.5	
Unprotected anal intercourse in the last 6 months					**<0.001**
Yes	156	30.6	247	46.3	
No	354	69.4	286	53.7	
Condom rupture during anal intercourse in lifetime					**<0.001**
Never	372	72.9	378	70.9	
Yes	47	9.2	73	13.7	
Unsure	86	16.9	60	11.3	
NA (no condom use)	5	1.0	22	4.1	
Unprotected sex with females in the last 6 months					**<0.001**
Yes	149	29.2	75	14.1	
No	361	70.8	458	85.9	

Table 6.1. Comparison of HIV infection, socio-demographics and behaviors between 510 'money boys' (MBs) and 533 other men who have sex with men (MSM) in Shenzhen, China: results from a cross-sectional study in 2010 *(Continued)*.

Characteristic	MBs (N = 510)		Other MSM (N = 533)		P-value
	n	n	%	n	%
Sexual behavioral information					
Number of female sex partners in the last 6 months					**<0.001**
0	195	38.2	408	76.5	
1	82	16.1	94	17.6	
> 1	233	35.7	31	5.8	
Duration of providing commercial sex for males					
≤ 1 year	346	67.8	NA		
> 1 year	164	32.2	NA		
Number of male clients in the last 6 months					
1-4	168	32.9	NA		
> 4	342	67.1	NA		
Sold sex to females in the last 6 months					
Yes	165	32.4	NA		
No	345	67.6	NA		
STI history, substance use, use of services, knowledge, perceived risk					
Diagnosed with STIs in the last year					**0.037**
No	475	93.1	477	89.5	
Yes	35	6.9	56	10.5	
Ever used substance					**<0.001**
No	462	90.6	520	97.6	
Yes	48	9.4	13	2.4	
Access to HIV-related services					**<0.001**
No	43	8.4	107	20.1	
Yes	467	91.6	426	79.9	
HIV-related knowledge					**0.001**
Low	89	17.5	56	10.5	
High	421	82.5	477	89.5	
Condom use knowledge					0.64
Low	62	12.2	70	13.1	
High	448	87.8	463	86.9	

Table 6.1. Comparison of HIV infection, socio-demographics and behaviors between 510 'money boys' (MBs) and 533 other men who have sex with men (MSM) in Shenzhen, China: results from a cross-sectional study in 2010 *(Continued)*.

Characteristic	MBs (N = 510)		Other MSM (N = 533)		P-value
	n	n	%	n	%
STI history, substance use, use of services, knowledge, perceived risk					
Self-perceived HIV risk					**0.019**
Very low	453	88.8	441	82.7	
Moderate	48	9.4	78	14.6	
Very high	9	1.8	14	2.6	
Recent HIV testing (any self-reported HIV testing during the last year)					
Tested	210	43.3	258	48.4	0.10

* Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
^ The total does not end up with 510 for MBs and 533 for other MSM, because 34 MBs and 44 other MSM reported not having anal sex in the last 6 months.

Determinants of recent HIV testing among MBs

Overall, 43.3% of MBs reported having been recently (during the last year) tested for HIV. In univariate analysis, recent HIV testing was more common in MBs recruited from high-end venues (bar/massage center/gym) than those recruited from dorm based venues (48.8% vs 38.2%, p = 0.021). Having multiple anal sex partners (more than 1 vs.1 or no anal sex male partners, OR = 2.33, p = 0.001), having male sex partners from Hong Kong (OR = 1.48, p = 0.034), having more than 4 male clients (OR = 1.79, p = 0.003) and having a self-reported STI history (OR = 2.00, p = 0.002) were significantly associated with having been tested for HIV. The difference in HIV testing between MBs with different duration of living in Shenzhen (p = 0.10) was below the cut-off level (p = 0.20) for inclusion in multivariate analysis (Table 6.2).

In multivariate analysis, having multiple anal sex partners (OR = 2.00, p = 0.006) was highly associated with HIV testing (Table 2). MBs who had more male clients (more than 4 vs. 4 or fewer) were more likely to have been recently tested (OR = 1.79, p = 0.053). Also, HIV testing rates increased with the duration of living in Shenzhen (in years, OR = 1.01, p = 0.078).

Table 6.2. Determinants of recent HIV testing among 510 'money boys' (MBs) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	95% CI	P-value
All	221	510	43.3						
Demographic information									
Venue type of recruitment						0.044			
Bar/massage center/gym	104	272	38.2	1.00					
Dorm-based venue	101	207	48.8	1.54	(1.07- 2.22)	0.021			
Other venues (park, recreational center, sauna)	16	31	51.6	1.72	(0.82- 3.63)	0.15			
Age (continuous, in years)				1.01	(0.97- 1.06)	0.57			
Education level						0.19			
Junior high school or lower	57	153	37.3	1.00					
Senior high school	133	287	46.3	1.46	(0.97- 2.17)	0.067			
College or above	31	70	44.3	1.34	(0.75- 2.38)	0.32			
Hukou registration						0.91			
Shenzhen	8	17	47.1	1.16	(0.44- 3.06)	0.77			
Other cities in Guangdong province	16	39	41.0	0.91	(0.47- 1.76)	0.78			
Other provinces	197	454	43.4	1.00					
Hometown with high HIV prevalence									
No	184	432	42.6	1.00					
Yes*	37	78	47.4	1.22	(0.75- 1.97)	0.43			
Duration of living in Shenzhen (categories, years)#									
< 1	114	280	40.7						
1-2	34	83	41.0						
> 2	73	147	49.7						

Table 6.2. Determinants of recent HIV testing among 510 'money boys' (MBs) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	95% CI	P-value
Demographic information									
Duration of living in Shenzhen (continuous, in year)				1.13	(0.98- 1.31)	0.10	1.14	(0.99-1.33)	0.078
Monthly income (categories, RMB)									
≤ 3000	92	226	40.7	1.00					
> 3000	129	284	45.4	1.21	(0.85- 1.73)	0.29			
Marital status									
Unmarried	208	472	44.1	1.00					
Married	13	38	34.2	0.66	(0.33- 1.32)	0.24			
Sexual behavior									
Self-identified sexual orientation						0.20			
Homosexual/gay	46	99	46.5	1.34	(0.84- 2.14)	0.23			
Bisexual	75	157	47.8	1.41	(0.94- 2.11)	0.095			
Heterosexual or unsure	100	254	39.4	1.00					
Gender of first sex partner									
Male	57	128	44.5	1.07	(0.71- 1.60)	0.75			
Female	164	382	42.9	1.00					
Age of first sex experience (continuous, in years)				0.95	(0.89- 1.03)	0.23			
Type of sex partners in the last 6 months									
Men only	87	201	43.3	1.00					
Men and women	134	309	43.4	1.00	(0.70- 1.44)	0.99			
Multiple anal sex partners in the last 6 months									
No	28	101	27.7	1.00			1.00		
Yes	193	409	47.2	2.33	(1.45- 3.75)	**0.001**	2.03	(1.23- 3.36)	**0.006**

Table 6.2. Determinants of recent HIV testing among 510 'money boys' (MBs) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	95% CI	P-value
Demographic information									
Hong Kong male sex partner in the last 6 months									
No	104	266	39.1	1.00					
Yes	108	222	48.6	1.48	(1.03- 2.12)	**0.034**			
Unknown	9	22	40.9						
Anal sex role in the last 6 months^						0.69			
Insertive	79	174	45.4	1.00					
Both	99	226	43.8	0.94	(0.63- 1.40)	0.75			
Receptive	30	76	39.5	0.78	(0.45- 1.36)	0.39			
Unprotected anal intercourse in the last 6 months									
No	149	354	42.1	1.00					
Yes	72	156	46.2	1.18	(0.81- 1.72)	0.39			
Condom rupture during anal intercourse						0.63			
Never	165	372	44.4	1.00					
Yes	22	47	46.8	1.10	(0.60- 2.03)	0.75			
Unsure	32	86	37.2	0.74	(0.46- 1.25)	0.23			
NA (no condom use)	2	5	40.0						
Number of female sex partners in the last 6 months						0.31			
0	120	295	40.7	1.00					
1	66	136	48.5	1.38	(0.91- 2.07)	0.13			
> 1	35	79	44.3	1.16	(0.70- 1.92)	0.56			

Table 6.2. Determinants of recent HIV testing among 510 'money boys' (MBs) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	95% CI	P-value
Demographic information									
Unprotected sex with females in the last 6 months									
No	157	361	43.5	1.00					
Yes	64	149	43.0	0.98	(0.67- 1.44)	0.91			
Duration of providing commercial sex for males									
≤ 1 year	141	346	40.8	1.00					
> 1 year	80	164	48.8	1.39	(0.95- 2.01)	0.088			
Number of male clients in the last 6 months									
1-4	57	168	33.9	1.00			1.00		
> 4	164	342	48.0	1.79	(1.22- 2.63)	**0.003**	1.49	(0.99- 2.25)	**0.053**
Sold sex to females in the last 6 months									
Yes	65	165	39.4	1.00					
No	156	345	45.2	1.27	(0.87- 1.85)	0.22			
STI history and substance use									
Diagnosed with STIs in the last year									
No	423	952	44.4	1.00					
Yes	56	91	61.5	2.00	(1.29- 3.11)	**0.002**			
Ever used substance									
No	202	462	43.7	1.00					
Yes	19	48	39.6	0.84	(0.46- 1.55)	0.58			

*Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
We used it as continuous variable in the logistic regression, the categories were only used to describe testing in different duration stratums.
^ The total does not end up with 510, because 34 MBs reported not having had anal sex in the last 6 months

Determinants of recent HIV testing among other MSM

Overall, 48.4% of other MSM reported having been recently (in the last year) tested for HIV. In univariate analysis, the HIV testing rate increases with duration of living in Shenzhen ($p < 0.001$). Compared to MSM with bisexual or heterosexual orientation, MSM with homosexual orientation reported a higher percentage of HIV testing (58.0% vs. 37.2%, $p < 0.001$ and 58.0% vs. 28.3%, $p < 0.001$). Having a higher income (above 3000 vs. 3000 RMB or less per month, OR = 1.42, $p = 0.043$), having only male sex partners (vs. having both male and female sex partners, OR = 2.38, $p < 0.001$), having multiple anal sex partners (OR = 1.70, $p = 0.006$), and having a self-reported STI history (OR = 2.26, $p = 0.006$) were significantly associated with HIV testing. Compared to MSM having no female sex partners, MSM having one female sex partner reported a significantly lower percentage of HIV testing (31.8% vs.51.6%, $p = 0.001$), whereas MSM having multiple (more than one) female sex partners reported a similar percentage of HIV testing (50.0% vs. 51.6%, $p = 0.91$). MSM having had unprotected sex with females reported a significantly lower percentage of HIV testing than did MSM not having had unprotected sex with females (33.3% vs. 50.9%, $p = 0.005$).

In multivariate analysis, living in Shenzhen longer (in years, OR = 1.34, $p < 0.001$), having only male sex partners (versus having both male and female sex partners, OR = 1.81, $p = 0.026$), and having a self-reported STI history (OR = 2.53, $p = 0.004$) were significantly associated with HIV testing (Table 6.3). Compared to MSM with homosexual orientation, MSM with bisexual or heterosexual orientation reported a lower percentage of HIV testing (OR = 0.53, $p = 0.003$ and OR = 0.42, $p = 0.018$).

Table 6.3. Determinants of recent HIV testing among 533 general men who have sex with men (MSM) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	(95% CI)	P-value
All	258	533	48.4						
Demographic information									
Venue type of recruitment						0.22			
Bar/massage center/gym	49	104	47.1	1.00					
Dorm-based venue	11	22	50.0	1.12	(0.45- 2.82)	0.81			
Park	55	100	55.0	1.37	(0.79- 2.38)	0.26			
Recreational center	51	127	40.2	0.75	(0.45- 1.27)	0.29			
Sauna	92	180	51.1	1.17	(0.72- 1.90)	0.52			
Age (continuous, in years)				1.01	(0.99- 1.03)	0.34			
Education level						0.46			
Junior high school or lower	46	107	43.0	1.00					
Senior high school	94	189	49.7	1.31	(0.81- 2.12)	0.27			
College or above	118	237	49.8	1.32	(0.83- 2.08)	0.24			
Hukou registration						0.57			
Shenzhen	21	37	56.8	1.44	(0.73- 2.84)	0.29			
Other cities in Guangdong province	41	85	48.2	1.02	(0.64- 1.63)	0.93			
Other provinces	196	411	47.7	1.00					
Hometown with high HIV prevalence									
No	230	467	49.3	1.00					
Yes*	28	66	42.4	0.76	(0.45- 1.28)	0.30			

Table 6.3. Determinants of recent HIV testing among 533 general men who have sex with men (MSM) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio. *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	(95% CI)	P-value
Demographic information									
Duration of living in Shenzhen (categories, years)#									
< 1	52	150	34.7						
1-2	29	65	44.6						
>2	177	318	55.7						
Duration of living in Shenzhen (continuous, in years)				1.39	(1.20- 1.60)	**<0.001**	1.34	(1.15- 1.55)	**<0.001**
Monthly income (RMB)									
≤ 3000	120	272	44.1	1.00					
> 3000	138	261	52.9	1.42	(1.01- 2.00)	**0.043**			
Marital status									
Unmarried	189	390	48.5	1.00					
Married	69	143	48.3	0.99	(0.68- 1.46)	0.97			
Sexual behavior									
Self-identified sexual orientation						**<0.001**			**0.003**
Homosexual/gay	178	307	58.0	1.00			1.00		
Bisexual	67	180	37.2	0.43	(0.30- 0.63)	<0.001	0.53	(0.35- 0.81)	0.003
Heterosexual or unsure	13	46	28.3	0.29	(0.15- 0.56)	<0.001	0.42	(0.20- 0.86)	0.018
Gender of first sex partner									
Male	162	318	50.9	1.00					
Female	96	215	44.7	0.78	(0.55- 1.10)	0.15			
Age of first sex experience (continuous, in years)				1.01	(0.97- 1.05)	0.59			

Table 6.3. Determinants of recent HIV testing among 533 general men who have sex with men (MSM) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio. *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	(95% CI)	P-value
Demographic information									
Type of sex partners in the last 6 months									
Men only	226	431	52.4	1.00			1.00		
Men and women	32	102	31.4	0.42	(0.26- 0.66)	**<0.001**	0.55	(0.33- 0.93)	**0.026**
Sexual behavior									
Multiple anal sex partners in the last 6 months									
No	62	158	39.2	1.00					
Yes	196	375	52.3	1.70	(1.16-2.48)	**0.006**			
Hong Kong male sex partner in the last 6 months									
No	225	466	48.3	1.00					
Yes	26	56	46.4	0.93	(0.53- 1.62)	0.79			
Unknown	7	11	63.6						
Anal sex role in the last 6 months^						0.95			
Insertive	105	214	49.1	1.00					
Both	99	204	48.5	0.98	(0.67- 1.44)	0.91			
Receptive	36	71	50.7	1.07	(0.62- 1.83)	0.81			
Unprotected anal intercourse in the last 6 months									
No	148	286	51.7	1.00					
Yes	110	247	44.5	0.75	(0.53- 1.05)	0.097			

Table 6.3. Determinants of recent HIV testing among 533 general men who have sex with men (MSM) in Shenzhen, China, derived from univariate and multivariate logistic regression. Recent HIV testing was defined as any self-reported HIV testing during the last year. AOR = adjusted odds ratio. *(Continued)*.

Characteristic	Recently tested for HIV			Univariate			Multivariate		
	Yes (n)	Total (N)	n/N (%)	OR	(95% CI)	P-value	AOR	(95% CI)	P-value
Demographic information									
Condom rupture during anal intercourse						0.43			
Never	188	378	49.7	1.00					
Yes	37	73	50.7	1.04	(0.63- 1.72)	0.88			
Unsure	25	60	41.7	0.72	(0.42- 1.25)	0.25			
NA (no condom use)	8	22	36.4						
Number of female sex partners in the last 6 months						0.004			
0	224	434	51.6	1.00					
1	27	85	31.8	0.44	(0.27- 0.72)	0.001			
>1	7	14	50.0	0.94	(0.32- 2.72)	0.91			
Unprotected sex with females in the last 6 months									
No	233	458	50.9	1.00					
Yes	25	75	33.3	0.48	(0.29- 0.81)	**0.005**			
STI history and substance use									
Diagnosed with STIs in the last year									
No	221	477	46.3	1.00					1.00
Yes	37	56	66.1	2.26	(1.26- 4.04)	**0.006**			2.53
Ever used substance									
No	252	520	48.5	1.00					
Yes	6	13	46.2	0.91	(0.30- 2.75)	0.87			

*Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
We used it as continuous variable in the logistic regression, the categories were only used to describe testing in different duration stratums.
^ The total does not end up with 510, because 34 MBs reported not having had anal sex in the last 6 months

6.4 Discussion

Our study confirmed that socio-demographics and behavioral patterns differed between MBs and other MSM. A slightly lower percentage of the former had undergone HIV testing in the past year (43% versus 48%, p = 0.10). MBs having multiple anal sex partners and having more male clients reported a higher percentage of HIV testing. For other MSM, having homosexual orientation, having only male sex partners, and having STI history reported a higher percentage of HIV testing history. Having lived in Shenzhen longer was associated with HIV testing for both MBs and other MSM.

With growing interest in HIV 'treatment as prevention',[25] encouraging MSM to test for HIV becomes one of the key strategies for HIV prevention. It is recommended that MSM should be tested for HIV at least once a year,[26, 27] and there is evidence that frequent testers have significantly lower chance of being newly HIV positive.[28] In our study, 46% of all the participants had been recently (during the last year) tested for HIV, i.e. more than the national average of 38% in the whole MSM population estimated from 2008 till 2011.[29] It seems that Shenzhen in this respect is doing better than many other cities in China. However, the rates are still disappointingly low compared with rates reported by MSM in some cities in developed countries. For instance, this rate was 76% among MSM in New York in 2011,[30] and 57% among MSM in UK in 2010.[31] Given the fact that HIV prevalence among MSM in Shenzhen (about 10%) is higher than that in these developed countries (8% in New York and 5% in UK),[30, 31] effective strategies to promote HIV testing among MSM in China are needed to catch up with the relatively high HIV testing rates in developed countries.

In our study, relatively fewer MBs than other MSM reported having undergone a HIV test in the last year. This phenomenon is just the opposite of that in other cities in China, such as Chongqing[13] and Shanghai[12] and other countries in Asia, such as Thailand.[32] This finding may be explained as follows: first, a higher proportion of MBs (compared to other MSM) were originally from cities other than Shenzhen, had lived in Shenzhen less than one year, were low educated and had a low level of HIV-related knowledge (Table 1). These circumstances may undermine the likelihood of knowing about the HIV testing service. Second, a higher proportion of MBs reported no unprotected anal intercourse and having perceived very low HIV risk (Table 1). These MBs may therefore have thought testing unnecessary, providing they have used condoms consistently.

Regarding determinants of HIV testing, 'duration of living in Shenzhen' was associated with recent HIV testing among both MBs (although not significant, p = 0.078) and other MSM ($p < 0.001$). This makes sense from an epidemiological point of view as those having lived in Shenzhen longer are more likely to be aware of the existence of the HIV testing provided by the Shenzhen health authorities. Moreover, our results indicate that the longer the duration of having lived in Shenzhen, the higher the proportion of MSM having had a test in the past

year. It seems that MSM adhere to regular checks once they have been tested, which suggests that efforts to promote HIV testing among MSM should target the new comers. However, it is also possible that our sampling procedure has biased the association between HIV testing and duration of living in Shenzhen. Although we gave participants the option to only complete the questionnaire if they did not want to take an HIV test, all subjects in our study chose to both do the questionnaire and the HIV testing. It is possible that they took the HIV testing because of the 50 RMB (6 Euros) incentives. However, as our incentives for the testing are not very much, it is not very likely to encourage those who do not want to be tested to take one. Moreover as participants completing only the questionnaire receive no incentives, those who do not want to be tested may simply refuse both the testing and the questionnaire. As a result, perhaps a certain proportion of those who are more willing to be tested frequently could have retained for our study.

Surprisingly, we did not identify any association between unprotected anal intercourse and HIV testing among both MBs and other MSM. This suggests probably they did not acknowledge that this practice carries themselves increased susceptibility of getting HIV and also may be unaware of the benefit of being tested. Given the relatively low rates of HIV testing in general, efforts should be made to increase the awareness of HIV susceptibility when engaging in risky sexual behavior (e.g. unprotected anal intercourse) and to educate the MSM community at large about the importance and advantages of getting HIV tested. These efforts will be beneficial not only for MBs and other MSM, but also for females. As almost half of MBs and one fifth of other MSM had at least one female sex partner, efforts to make them aware of their HIV serostatus may prevent many females from getting HIV.

Among MBs, those with multiple anal sexual partners or a large number of male clients in the last 6 months were most likely to have been recently tested for HIV. Although there is hardly any research focusing on MBs, the result from our study echoes with findings from previous studies about other MSM, which showed the increased likelihood of HIV testing with increasing number of male sexual partner.[10,33] It seems that MBs in our study with many male partners were aware of their HIV risk. However, as shown above, MBs engaging in unprotected anal intercourse tended to be less aware of this susceptibility. We recommend that education campaigns to promote HIV testing among MBs should first increase awareness of actual HIV risk and correct any misunderstanding of sexual risk behaviors.

Among other MSM, homosexual self-identified sexual orientation and having a STI history were associated with having been tested for HIV in the last year (Table 3). Those MSM with homosexual orientation were more likely to have been tested, perhaps due to their higher self-perceived HIV risk. On the other hand, previous research has showed that MSM with bisexual and heterosexual orientation tend not to identify socially with the MSM community[34] and feel reluctant to turn to professional health services, such as HIV testing. Discrimination towards MSM needs to be reduced to encourage MSM to identify and accept their own sexual orientation, so that they

would get support from peers and seek professional health services. We also identified that other MSM with a history of STIs were more likely to have been tested than those without a STI history. This may reflect that local public health services have successfully integrated HIV testing into STI clinics. We recommend that health service providers at STI clinics should continue to offer HIV testing, where appropriate, when MSM approach them for STIs/HIV advice.

There are some limitations to the study presented here. First, we used the time-location sampling method, which is based on venues. Men who do not go to venues, such as those who seek partners through internet, were therefore not included. Thus, the findings may not be representative of the MSM population at large. Second, all our participants are willing to be tested in the current study. Those who refused to participate in our study may have refused because they just have been tested recently and thought it is not necessary to repeat one, or because they were afraid of a positive result and did not want to be informed about their serostatus, or because they did not have any unsafe sexual practices and believed testing is not needed. These refusals could bias our results in either direction, especially considering the overall refusal rate is high (35%) among other MSM in our study. For MBs, the overall refusal rate is very low (4%), which may be because that we implemented the study during working hours of MBs, but outside working hours of other MSM. Third, some data were self-reported, and it may well be that engaging in some behaviors, such as substance use, was under-reported, thereby introducing information bias. Fourth, this study was cross-sectional, so causal inferences cannot be made. Sexual risk behaviors such as having multiple anal sex partners were measured within a time frame of the last 6 months, whereas HIV testing was reported within a time frame of the last year. It is possible that those who had fewer anal sex partners may have been lectured on safe sex in their prior testing and consequently reduced the number of anal sex partners. Finally, our questionnaire included only socio-demographic and behavioral determinants of HIV testing. Socio-psychological factors (e.g. fear of being discriminated) and structural factors (e.g. accessibility and quality of staff) that may be associated with HIV testing were not considered. We recommend future studies to take these potential factors into account.

In conclusion, the recent HIV testing rate is still low in both MBs and other MSM population of Shenzhen. Effective intervention programs are needed to promote HIV testing among the MSM population. For MBs, education campaigns are needed to equip them with knowledge of safe sexual practices and to highlight the importance of HIV testing. For other MSM, besides education campaigns, we recommend setting up programs to reduce discrimination and to encourage them to accept their own sexual orientation and therefore link them with professional health services, such as HIV testing. We also recommend that health service providers at STI clinics continue to offer HIV testing, where appropriate, when MSM approach them for STIs/HIV advice.

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Chapter 7

A comparison between respondent-driven sampling and time-location sampling among men who have sex with men in Shenzhen, China

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Abstract

Background: Men who have sex with men (MSM) are a key population for HIV control and prevention in China. It is difficult to acquire representative samples of this hidden population. Respondent-driven sampling (RDS), based on peer referral, and time-location sampling (TLS) based on random selection of venue-day-time periods, are among the most commonly used sampling methods. However, differences in HIV-related characteristics of MSM recruited by these two methods have not been fully evaluated.

Methods: We compared socio-demographics, risk behaviors, utilization of HIV-related intervention services and HIV/syphilis infection rates between samples of 621 RDS MSM and 533 TLS MSM in Shenzhen, China in 2010.

Results: The HIV prevalence was comparable in RDS and TLS MSM (8.4% vs. 9.3%, $p = 0.65$). TLS recruited larger proportions of marginalized subgroups than RDS: MSM recruited by TLS were older, less educated and more likely to be migrants (without Shenzhen *hukou* registration), to be non-gay identified and to engage in risky sexual behaviors. On the other hand, MSM recruited by TLS were more likely to have been covered by HIV-related intervention services (80% vs. 69%, $p = 0.001$).

Conclusion: In Shenzhen, where population movement is common, TLS is more effective to tap into the marginalized segments of MSM. But because TLS can only reach MSM who physically attend venues and HIV-related intervention services are already commonly available at gay venues in Shenzhen, RDS is more informative for allocating prevention efforts than TLS. Furthermore, researchers and public health authorities should take into account different the sample composition of RDS and TLS and apply sampling methods consistently when evaluating trends over time.

7.1 Introduction

According to the national surveillance report, men who have sex with men (MSM) comprised approximately 30% of the new HIV cases in China and the prevalence of HIV among them has increased from about 1% in 2005 to 5% in 2011.[1] Due to the traditional cultures and values, bisexual behavior is very common among Chinese MSM. It was estimated that 50-70% of MSM have had sex with females in their lifetime.[2] There is much concern that MSM will act as a key driver and act as bridge of the HIV epidemic to the general heterosexual population. To track the epidemic and to plan effective control measures, the Chinese government has called for detailed studies of the profiles of socio-demographic, behavioral and risk factors of HIV infection among MSM. However, such studies have many challenges, one of which is acquiring representative population samples.

The gold standard for acquiring representative data is probability-based or population-based sampling. Such a sampling method, however, is not appropriate to sample MSM, because MSM constitute a small proportion (reported to be 2-4% in China[3]) of the total population. Therefore, population-based surveys need to be very large to include enough MSM for precise estimates. Also, due to stigmatization and discrimination, MSM will be under-recognized in population-based surveys.[4] In the absence of a feasible probability-based sampling method, convenience sampling methods, such as internet-based sampling and venue-based sampling, have for many years been used to access MSM. These methods are efficient to recruit participants but lack validity in representation.

In recent years, quasi-probability sampling methods, i.e. respondent-driven sampling (RDS) and time-location sampling (TLS) have been developed to improve representativeness of studied samples. RDS is a long-chain peer referral recruitment method, which allows making population-based inferences through statistical adjustments.[5] It starts with identification of potential 'seeds', individuals who are then asked to recruit their peers in the study, who in turn further refer their peers, and so on. Each participant is limited to referring two to four peers to avoid bias. For these features, RDS presents to be an effective sampling method with statistical rigor.[4,6] However, it is still an experimental methodology being used for surveillance of high risk groups of HIV/AIDS and debate about the underlying assumptions remains.[7] Through creation of a sampling frame that comprises the universe of venues, days and time periods where and when the population congregates, TLS systematically samples potential participants at randomly selected venue-day-time periods.[4,6,8,9] However, a notable limitation of TLS is that it only includes MSM who attend physical venues frequently.

With their own advantages and disadvantages, RDS and TLS stay as two irreplaceable and key sampling methods. In theory, RDS is capable of reaching the marginalized segments of MSM (e.g. MSM who seek partners only via personal social network or internet and who often have disadvantaged socio-economic status), whereas TLS can only reach the visible segments of MSM

(i.e. MSM who attend physical venues frequently). To date, differences in characteristics of MSM recruited by these two methods have not been fully evaluated in practice. There are only three studies comparing socio-demographic and behavioral characteristics of MSM recruited by RDS and TLS.[4,6,10] However, these studies were limited by a small sample size,[6] comparing data from different years,[4] and lack of biological markers.[4,10] In our study we take advantage of a unique opportunity in which RDS and TLS were used simultaneously to sample MSM with relatively large sample sizes (n = 621 by RDS and n = 533 by TLS) in Shenzhen, China. We hypothesized that the different sampling methodologies of TLS and RDS tap into different segments of MSM, and result in different HIV epidemic estimates. In this paper, we present the empirical evidence of these differences with focus on general MSM, i.e. those who reported not having sold sex to another man in the last 6 months.

7.2 Methods

Setting

Shenzhen is the first special economic zone in Guangdong province, South China. It is a well-developed city, neighboring Hong Kong. Driven by the flourishing economy and openness, numerous people have moved from other places to Shenzhen, from both inner rural areas of China and developed cities like Hong Kong. This 'floating population' constitutes the majority of the over 10 million Shenzhen inhabitants,[11] and many MSM are part of this floating population group. It is estimated that there are more than 100,000 MSM and more than 50 MSM venues.[12] Sentinel surveillance data revealed that prevalence of HIV infection among MSM increased from 0.2% in 2002 to over 10% in 2012 in Shenzhen.[13] Currently it is one of the cities in China hit hardest by the HIV epidemic among MSM.

RDS and participants

Between May and December 2010, RDS was used to recruit MSM through their social and sexual networks. To begin recruitment chains, we selected 10 initial seed participants that were diversified by age, marital status and education level. The seed participants were all general MSM, who reported not having sold sex to another man in the last 6 months. The seeds were selected based on a group discussion with MSM peers from a local non-government organization (NGO), who has collaborated with Shenzhen Center for Disease Control and Prevention (Shenzhen CDC) for nearly 10 years. We gave each seed participant three coded coupons to recruit peers. After informed consent, we then enrolled participants who presented the coupons and who were deemed eligible. In turn, each newly enrolled participant was given three coded coupons to extend the recruitment chain.

Eligibility criteria were: male, at least 18 years old, Chinese national, and having engaged in oral or anal sex with a man in the last 6 months. Male sex workers (also referred to as 'money boy' (MB) who had sold sex to another man in the last 6 months) were excluded from our

recruitment, because our previous research has shown that MBs are a significantly different subgroup of MSM[14] and need to be recruited and analyzed separately.

All eligible participants were invited to complete an anonymous computer-assisted questionnaire and come for a confidential HIV and syphilis testing at our interview site. We selected one community clinic run by Shenzhen CDC in cooperation with the local NGO as our interview site. The address, phone number, and office hours of the site were printed on the coupons. In order to avoid duplication of participation, we used a fingerprint system. Upon enrolment, new potential participants were asked to have their fingerprints scanned, which were then checked against our list of previous participants to ensure that they were new to this study. However, the RDS and TLS projects were independent of each other and each MSM could have participated in both RDS and TLS.

TLS and participants

During the same recruiting period (from May to December, 2010) of RDS, we also recruited MSM by TLS. Details about how TLS was applied to sample MSM in Shenzhen was described previously.[14] In brief, a random sample of venue-day-time periods (VDTs) was drawn from all possible VDT periods. At the randomly selected VDTs, eligible subjects at venues were invited to participate. At venues where participants were recruited, participants were invited to complete an anonymous computer-assisted questionnaire and a confidential HIV and syphilis testing. Eligibility criteria were the same as with the RDS method. In TLS, we separately recruited MBs and general MSM, and only data on general MSM were used for this study.

For both the RDS and TLS surveys, participants were given the option of only completing the questionnaire if they did not want to be tested, but an incentive was offered only to those who completed the blood testing. In RDS sampling, each individual received 50 RMB (about 6 Euro) for his own participation and a further 10 RMB (about 1.2 Euro) for each participant whom he recruited. In TLS sampling, each individual received 30 RMB (about 4 Euro) for his participation. In both RDS and TLS surveys, there is no participant who completed the questionnaire but refused testing. Verbal consent was obtained. Participants with negative testing results were informed by internet and participants with positive results were informed by phone and referred to healthcare services for further consultation and treatment. Confidentiality and anonymity was strictly observed. The study was approved by the review board of Shenzhen CDC.

Socio-demographic and behavioral measures

For both the RDS and the TLS projects, palmtop computer-assisted questionnaires were used to collect socio-demographic and behavioral information. Questionnaires used in this study were previously verified.[14] Trained peer recruiters by Shenzhen CDC explained the study, distributed the questionnaires and assisted with clarifying questions at the interview site (RDS) or at venues (TLS). It took each participant about 30 minutes to finish the questionnaire.

Socio-demographic information collected were venues of recruitment, age, education, *hukou* registration (a province/city where a person was registered as a permanent resident), hometown, duration of living in Shenzhen, income, marital status and sexual orientation. According to 2008 National MSM surveillance,[15] we defined 4 provinces/cities, i.e. Sichuan, Chongqing, Yunnan, and Guizhou as hometown with high HIV prevalence, because HIV prevalence was above 10%. The other 27 provinces/cities in China were defined as hometown with low HIV prevalence.

Behavioral information collected were gender of first sex partner, age of first sex experience (not older than 20 years old, or older than 20 years old), type of sex partners (men only, or men and women), number of anal sex partners (no, one, or more than one), any male sex partners from Hong Kong, usual anal sex role (insertive, receptive, or both), any unprotected anal intercourse experience, any condom rupture experience, number of female sex partners (no, one, or more than one), any unprotected anal or vaginal intercourse in the last 6 months. All other background information, such as HIV-related knowledge and condom use knowledge, was described previously.[14] All variables were categorical, except for age.

Laboratory test for HIV and syphilis

After each questionnaire interview, a blood sample was collected for HIV and syphilis testing. We performed the testing in accordance with standardized laboratory procedures provided by the National Center for Disease Control and Prevention of China. HIV was tested using a rapid test (Determine HIV-1/2/O; Abbott Laboratories, Illinois, USA) and ELISA (Wantai Biotech Inc, Beijing) for screening and Western blot (Genlabs Diagnostics, Singapore) for confirmation. Syphilis was tested using rapid plasma regain method (Rongsheng Biotech Inc, Shanghai, China) for qualitative screening and *Treponema pallidum* particle agglutination assay (Fujirebio Inc, Japan) for confirmation.

Data management

For data collected by RDS, weighting has to be used to adjust for respondents' social network size (i.e. the larger a social network, the greater the likelihood that someone might be recruited by other participants in his social network) and recruitment patterns. We measured the size of the social network of a MSM as the number of other MSM they knew by name, by nickname, or by face, and who were 18 years or older, lived in Shenzhen and whom they could reach during one month. Individualized weights of HIV (outcome variable) was calculated by RDS Analysis Tool (RDSAT, version 7.1) and then exported to SPSS (version 20.0).

For data collected by TLS, it is necessary to use weights based on the probability that a person is sampled to obtain estimates that refer to the population in the sampling frame.[9] We calculated participants' weights according to the following formula: $w = (n_1/N_1)/ (n_2/N_2)$, where w is the weight of participants sampled in a venue, n_1 is the total number of eligible subjects at the venue, N_1 is the total number of eligible subjects at all venues in the sampling frame, n_2 is the number of eligible subjects that participated in our survey at the venue, and N_2 is the total number of

eligible subjects that participated in our survey at all venues in the sampling frame. Information of weights was also imported into SPSS.

Data analysis

We analyzed the data in three steps. In the first step, we calculated population adjusted point estimates and 95% confidence intervals (CI) of the frequency of all the variables on socio-demographics and behavior of RDS MSM in RDSAT and TLS MSM in SPSS. In the second step, we compared the adjusted socio-demographic and behavioral information of the RDS MSM and the TLS MSM by proxy-z test. In the final step, we separately conducted weighted logistic regression of HIV risk factors for RDS and TLS data. For both RDS and TLS data, we first performed univariate logistic regression analysis of HIV infection and possible risk factors. The variables attaining $p < 0.20$ significance in univariate analysis were included in the multivariate regression analysis. Only variables achieving $p < 0.05$ significance were retained in the final model using backward stepwise elimination. Age was used as a continuous variable in the univariate and multivariate logistic regression. Categories of age were only used to illustrate trend in prevalence of HIV in different age stratums. Impact of risk factors was expressed as odds ratios (OR) with 95% confidence interval (CI).

7.3 Results

Over an 8-month period, the initial seeds led to recruitment of 611 participants (coupon return rate: 611/1841 = 33%) who completed both the questionnaire and the serological survey, resulting in a total sample of 621 participants (including the 10 seeds) by RDS. Of the initial 10 seeds, 7 produced at least one wave of recruitment, with the longest chain reaching 22 waves and recruiting 256 participants, the shortest chain recruited only one participant (Table S7.1). The composition of key socio-demographics (education, marital status and age) stabilized after wave 3 (Table S7.2).

During the same sampling period, 851 eligible MSM were identified by TLS and 550 (64.6%) of them participated in the study. Refusal rates varied with VDTs, ranging from 0 to 76.6%. Mean refusal rate was lowest in suburb recreational centers (8.4%) and highest in bars (61.4%). We excluded 17 questionnaires with missing values on venue attendance data. In total 533 TLS MSM were included in the final data analysis.

Table 7.1 compares socio-demographics between RDS and TLS samples. Compared with RDS, TLS MSM were older (mean age: 30 ± 8 vs. 28 ± 7 years, $p < 0.001$), marginally less educated (18.5% vs. 12.6% finished junior high school or lower education, $p = 0.056$), and less likely to hold a Shenzhen hukou (6.6% vs. 13.9%, $p < 0.001$). There were no significant differences between RDS and TLS samples regarding hometown, income and marital status. Compared with RDS MSM, TLS MSM were less likely to self-identify as homosexual (57.9% vs. 70.8%,

Table 7.1. Comparison of HIV/syphilis infection, socio-demographics, behaviors and use of HIV-related services between 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) and 533 MSM by time-location sampling (TLS) in Shenzhen, China in 2010.

Characteristic	RDS Crude (N=621)		RDS Adjusted		TLS Crude (N=533)		TLS Adjusted		P-value
	n	n/N (%)	n/N (%)	(95% CI)	n	n/N (%)	n/N (%)	(95% CI)	
HIV infection (from laboratory test)									0.65
No	562	90.5	91.6	(88.3- 94.1)	483	90.6	90.7	(88.3- 93.2)	
Yes	59	9.5	8.4	(5.9- 11.7)	50	9.4	9.3	(6.8- 11.7)	
Syphilis infection (from laboratory test)									0.055
No	499	80.4	79.7	(74.0- 84.6)	458	85.9	85.6	(82.3- 88.8)	
Yes	122	19.6	20.3	(15.4- 26.0)	75	14.1	14.4	(11.2- 17.7)	
Demographics									
Venue of recruitment									
Low-end venues	NA				407	76.4	74.8	(70.6- 78.5)	
Dorm-based venues	NA				22	4.1	3.7	(2.1- 5.5)	
High-end venues	NA				104	19.5	21.6	(18.0- 25.3)	
Age (mean ± sd, continuous, in years)	(28 ± 7)		(28 ± 7)		(30 ± 8)		(30 ± 8)		**<0.001**
Education level									
Junior high school or lower	97	15.6	12.6	(8.0- 16.3)	107	20.1	18.5	(15.1- 22.1)	0.056
Senior high school	260	41.9	37.4	(32.4- 43.4)	189	35.5	35.2	(30.9- 39.5)	0.54
College or above	264	42.5	50.0	(43.0- 55.8)	237	44.5	46.4	(41.7- 51.0)	0.37
Hukou registration									
Shenzhen	80	12.9	13.9	(9.4- 17.6)	37	6.9	6.6	(4.6- 8.7)	<0.001
Other cities in Guangdong provinces	112	18.0	22.6	(17.2- 28.0)	85	15.9	15.5	(12.6- 18.6)	0.010
Other provinces	429	69.1	63.5	(58.3- 69.6)	411	77.1	77.9	(74.5- 81.5)	**<0.001**
Hometown with high HIV prevalence									0.93
No	554	89.2	88.2	(83.8- 91.7)	467	87.6	88.4	(85.7- 91.1)	
Yes*	67	10.8	11.8	(8.3- 16.2)	66	12.4	11.6	(8.9- 14.3)	

Table 7.1. Comparison of HIV/syphilis infection, socio-demographics, behaviors and use of HIV-related services between 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) and 533 MSM by time-location sampling (TLS) in Shenzhen, China in 2010 *(Continued)*.

Characteristic	RDS Crude (N=621)		RDS Adjusted		TLS Crude (N=533)		TLS Adjusted		P-value
	n	n/N (%)	n/N (%)	(95% CI)	n	n/N (%)	n/N (%)	(95% CI)	
Demographics									
Duration of staying in Shenzhen (years)									
< 1	195	31.4	34.5	(28.1- 39.8)	150	28.1	29.1	(25.3- 33.2)	0.13
1-2	79	12.7	10.4	(7.4- 14.0)	65	12.2	11.5	(8.7- 14.3)	0.63
> 2	347	55.9	55.1	(49.7- 61.3)	318	59.7	59.4	(55.0- 63.6)	0.24
Monthly income (RMB)									
≤ 3000	361	58.1	54.2	(47.8- 60.1)	272	51.0	50.1	(45.4- 54.8)	0.30
3001-5000	158	25.4	26.4	(21.0- 31.5)	153	28.7	28.9	(25.0- 32.9)	0.46
> 5000	102	16.4	19.4	(14.9- 24.7)	108	20.3	21.0	(17.5- 24.6)	0.61
Marital status									0.075
Unmarried	512	82.4	79.6	(74.2- 84.5)	390	73.2	73.4	(69.1- 77.2)	
Married	109	17.6	20.4	(15.5- 25.8)	143	26.8	26.6	(22.8- 30.9)	
Sexual behavior									
Self-identified sexual orientation									
Homosexual/gay	441	71.0	70.8	(65.4- 76.3)	307	57.6	57.9	(53.5- 62.3)	<0.001
Bisexual	139	22.4	21.6	(17.1- 26.3)	180	33.8	33.7	(29.5- 38.1)	<0.001
Heterosexual or unsure	41	6.6	7.6	(4.8- 10.7)	46	8.6	8.4	(5.8- 11.0)	0.70
Gender of first sex partner									0.014
Male	429	69.1	68.7	(63.1- 74.0)	318	59.7	59.8	(55.4- 64.3)	
Female	192	30.9	31.3	(26.0- 36.9)	215	40.3	40.2	(35.7- 44.6)	

Table 7.1. Comparison of HIV/syphilis infection, socio-demographics, behaviors and use of HIV-related services between 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) and 533 MSM by time-location sampling (TLS) in Shenzhen, China in 2010 *(Continued)*.

Characteristic	RDS Crude (N=621)		RDS Adjusted		TLS Crude (N=533)		TLS Adjusted		P-value
	n	n/N (%)	n/N (%)	(95% CI)	n	n/N (%)	n/N (%)	(95% CI)	
Sexual behavior									
Age of first sex experience									0.79
≤ 20	355	57.2	50.9	(45.2- 56.8)	266	49.9	50.4	(46.1- 54.9)	
> 20	266	42.8	49.1	(43.2- 54.8)	267	50.1	49.6	(45.1- 53.9)	
Type of sex partners in the last 6 months									0.002
Men only	552	88.9	89.0	(85.3- 92.3)	431	80.9	80.8	(77.4- 84.0)	
Men and women	69	11.1	11.0	(7.7- 14.7)	102	19.1	19.2	(16.0- 22.6)	
Number of anal sex partners in the last 6 months									
0	35	5.6	7.6	(4.8- 11.6)	44	8.3	8.6	(6.1- 11.5)	0.66
1	169	27.2	39.5	(33.8- 46.0)	114	21.4	21.5	(11.9- 25.1)	<0.001
> 1	417	67.1	52.9	(46.1- 58.3)	375	70.4	70.0	(65.7- 74.2)	**<0.001**
Hong Kong male sex partner in the last 6 months									0.23
Yes	89	14.3	9.7	(6.8- 12.4)	56	10.5	11.7	(8.7- 10.1)	
No	532	85.7	90.3	(87.6- 93.2)	477	89.5	88.3	(89.9- 91.3)	
Anal sex role in the last 6 months^									
Insertive	253	43.2	45.0	(38.8- 50.7)	214	43.8	43.2	(38.7- 47.9)	0.63
Both	167	28.5	30.3	(24.9- 36.4)	204	41.7	42.3	(37.5- 47.2)	0.002
Receptive	166	28.3	24.7	(19.9- 30.4)	71	14.5	14.5	(11.4- 18.3)	**<0.001**
Unprotected anal intercourse in the last 6 months									0.077
Yes	316	50.9	52.1	(46.0- 58.1)	247	46.3	45.4	(41.1- 49.6)	
No	305	49.1	47.9	(41.9- 54.0)	286	53.7	54.6	(50.4- 58.9)	

Table 7.1. Comparison of HIV/syphilis infection, socio-demographics, behaviors and use of HIV-related services between 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) and 533 MSM by time-location sampling (TLS) in Shenzhen, China in 2010 *(Continued)*.

Characteristic	RDS Crude (N=621)		RDS Adjusted		TLS Crude (N=533)		TLS Adjusted		P-value
	n	n/N (%)	n/N (%)	(95% CI)	n	n/N (%)	n/N (%)	(95% CI)	
Sexual behavior									
Condom rupture during anal intercourse									
Never	418	67.3	66.3	(61.0- 72.4)	378	70.9	71.2	(67.4- 75.0)	0.16
Yes	76	12.2	10.4	(6.8- 14.1)	73	13.7	13.2	(10.3- 16.0)	0.27
Unsure	103	16.6	16.5	(12.5- 20.6)	60	11.3	11.4	(8.9- 14.0)	0.032
NA (no condom use)	24	3.9	6.8	(3.5- 10.3)	22	4.1	4.2	(2.5- 6.2)	0.18
Number of female sex partners in the last 6 months									
0	522	84.1	84.4	(80.6- 88.6)	434	81.4	82.0	(78.6- 85.2)	0.38
1	73	11.8	13.5	(9.3- 17.4)	85	15.9	15.5	(12.2- 18.9)	0.48
> 1	26	4.2	2.1	(1.1- 3.2)	14	2.6	2.5	(1.3- 4.0)	0.66
Unprotected sex with females in the last 6 months									0.10
Yes	63	10.1	9.8	(6.7- 13.2)	75	14.1	13.7	(10.8- 16.7)	
No	558	89.9	90.2	(86.8- 93.3)	458	85.9	86.3	(83.3- 89.2)	
STI history, drug use, HIV knowledge, use of services									
Diagnosed with STIs in the last year									0.93
No	533	85.8	89.2	(85.8- 92.1)	477	89.5	89.0	(86.1- 91.6)	
Yes	88	14.2	10.8	(7.9- 14.2)	56	10.5	11.0	(8.4- 13.9)	
Used illicit drugs in the last 6 months									0.80
No	597	96.1	97.6	(95.7- 98.9)	520	97.6	97.3	(95.7- 98.7)	
Yes	24	3.9	2.4	(1.1- 4.3)	13	2.4	2.6	(1.3- 4.3)	
HIV-related knowledge									0.71
Low	53	8.5	9.1	(5.7- 13.3)	56	10.5	10.0	(7.5- 12.6)	
High	568	91.5	90.9	(86.7- 94.3)	477	89.5	90.0	(87.4- 92.5)	

Table 7.1. Comparison of HIV/syphilis infection, socio-demographics, behaviors and use of HIV-related services between 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) and 533 MSM by time-location sampling (TLS) in Shenzhen, China in 2010 *(Continued)*.

Characteristic	RDS Crude (N=621)		RDS Adjusted		TLS Crude (N=533)		TLS Adjusted		P-value
	n	n/N (%)	n/N (%)	(95% CI)	n	n/N (%)	n/N (%)	(95% CI)	
STI history, drug use, HIV knowledge, use of services									
Condom use knowledge									0.16
Low	91	14.7	10.5	(7.8- 14.2)	70	13.1	13.7	(10.8- 16.8)	
High	530	85.3	89.5	(85.8- 92.2)	463	86.9	86.3	(83.2- 89.2)	
Self-perceived HIV risk									
Very low	481	77.5	80.8	(75.2- 84.2)	441	82.7	82.1	(78.6- 85.4)	0.64
Moderate	121	19.5	17.1	(13.8- 22.4)	78	14.6	15.2	(12.0- 18.6)	0.48
Very high	19	3.1	2.0	(0.9- 3.6)	14	2.6	2.7	(1.3- 4.2)	0.52
Access to HIV-related services in the last year									0.001
No	166	26.7	31.1	(25.3- 36.9)	107	20.1	20.0	(16.3- 23.6)	
Yes	455	73.3	68.9	(63.1- 74.7)	426	79.9	80.0	(76.4- 83.7)	
Tested for HIV in the last year									0.008
No	359	57.8	61.1	(55.0- 66.5)	275	51.6	51.1	(46.6- 55.5)	
Yes	262	42.2	38.9	(33.5- 45.0)	258	48.4	48.9	(44.5- 53.4)	

* Provinces where HIV prevalence is higher than 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
^ 35 MSM by RDS and 44 MSM by TLS had no anal sex in the last 6 months.

$p < 0.001$), and more likely to have both male and female partners (19.2% vs. 11.0%, $p = 0.002$), to report both receptive and insertive sex role (42.3% vs. 30.3%, $p = 0.002$) and to have more than one anal sex partner (70.0% vs. 52.9%, $p < 0.001$), as shown in Table 7.1. On the other hand, TLS MSM were more likely to have used HIV-related intervention services (80.0% vs. 68.9%, $p = 0.001$) and been tested for HIV (48.9% vs. 38.9%, $p = 0.008$) in the last year (Table 7.1). Syphilis infection rate was lower in TLS MSM (14.4% vs. 20.3%, $p = 0.055$), but HIV infection rate was slightly higher in TLS MSM, although not significantly so (9.3% vs. 8.4%, $p = 0.65$), than that in RDS MSM (Table 7.1).

Table 7.2 compares risk factors of HIV infection between RDS and TLS samples. In multivariate logistic regression, HIV infection was associated with from a hometown with high HIV prevalence (adjusted odds ratio, AOR = 2.44, $p = 0.034$), having multiple anal sex partners (AOR = 2.21, $p = 0.027$), having STIs history (AOR = 3.85, $p < 0.001$), not using any HIV-related services (AOR = 3.66, $p < 0.001$) and self-perceiving moderate (AOR = 2.41, $p = 0.017$) or high HIV risk (AOR = 4.61, $p = 0.045$) in RDS MSM. For TLS MSM, HIV infection rate was significantly lower in MSM having a monthly income higher than 3000 RMB than those having a monthly income of 3000 RMB or less (AOR = 0.46, $p = 0.012$). Moreover, HIV infection rate was significantly lower in MSM having both male and female partners than those having male partners only (AOR = 0.35, $p = 0.043$). Frequency data and results of univariate logistic regression analyses of HIV risk factors in RDS and TLS MSM are shown in Table S7.3 and Table S7.4.

Table 7.2. Comparison of risk factors of HIV infection between 621 RDS MSM and 533 TLS MSM. AOR = adjusted odds ratio.

Characteristic	RDS (N= 621)			TLS (N = 533)		
	AOR	(95% CI)	P	(AOR	(95% CI)	P
Demographic						
Hometown with high HIV prevalence						
No	1.00					
Yes *	2.44	(1.07- 5.55)	**0.034**			
Monthly income (RMB)						
≤ 3000				1.00		
> 3000				0.46	(0.25- 0.84)	**0.012**
Sexual behavior						
Type of sex partners in the last 6 months						
Men only				1.00		
Men and women				0.35	(0.13- 0.97)	**0.043**
Condom rupture during anal intercourse			0.049			
Never	1.00					
Yes	0.84	(0.30- 2.36)	0.74			
Unsure	0.20	(0.05- 0.77)	0.019			
NA (no condom use)	1.97	(0.70- 5.55)	0.20			
Multiple anal sex partners in the last 6 months						
No	1.00					
Yes	2.21	(1.09- 4.48)	**0.027**			
STI history, drug use, HIV knowledge, use of services						
Diagnosed with STIs in the last year						
No	1.00					
Yes	3.85	(1.84- 8.04)	**<0.001**			
Access to HIV-related services in the last year						
Yes	1.00					
No	3.66	(1.93- 6.93)	**<0.001**			
Self-perceived HIV risk			0.017			
Very low	1.00					
Moderate	2.41	(1.17- 4.96)	0.017			
Very high	4.61	(1.03- 20.59)	0.045			

* Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.

7.4 Discussion

Our study shows that both RDS and TLS resulted in sizable and diverse samples of MSM in Shenzhen, China. The estimates of HIV prevalence in participants recruited by TLS and RDS were comparable. We found that TLS recruited larger proportions of hidden subgroups than RDS: MSM recruited by TLS were older, less educated and more likely to be migrants (without Shenzhen *hukou* registration), to be non-gay identified and to engage in risky sexual behaviors. On the other hand, MSM recruited by TLS were more likely to be covered by HIV-related intervention services. Our study, for the first time, shows that TLS is more effective to reach core high-risk MSM than RDS.

During the same survey period, RDS reached a larger number of MSM, and of the 49 participants attending both the RDS and TLS surveys, the majority (82%, 40/49) attended the RDS survey first. This indicates that RDS is more effective to reach general MSM than TLS. However, contrary to the RDS theory and previous evidence that RDS can reach more marginalized segments of MSM,[4,6,10] TLS tended to recruit a larger proportion of marginalized subgroups in our study. MSM recruited by TLS tended less likely to have Shenzhen *hukou* registration, less educated and more likely to be non-gay identified. We explain these results as follows: first, as homosexuality is not largely accepted by the society, MSM in China usually hide their same sex activities from their peers, friends and relatives while living in their hometown.[16] Compared with the MSM who migrated from other places, native Shenzhen MSM residents may feel more reluctant to seek partners at venues. The higher proportion of migrant MSM may have consequently resulted in a higher proportion of less educated subjects in the TLS survey than that in the RDS survey. Compared to native residents, migrants tend to have limited education and relatively low social status,[17] which may be the same for migrant MSM in Shenzhen. Second, there is evidence that MSM who search partners over the internet are younger and more educated than venue-based MSM.[18,19] As TLS can only sample MSM who physically attend venues, it is thus understandable that MSM recruited by TLS were older and less educated than those recruited by RDS. Third, in Shenzhen, public health authorities through the local CDC have collaborated with a NGO for nearly 10 years. With efforts from the local CDC and MSM peers of the NGO, venues including small parks, recreational centers and saunas that are often invisible were very well mapped. This provides us a good opportunity to tap into the more marginalized MSM by TLS. In our TLS survey, the majority of MSM were recruited from low-end venues (parks, recreational centers or saunas) where quick and unsafe sex often occurs. Previous studies of Chinese MSM have revealed that MSM who attend these low-end venues are often more marginalized, e.g. who tend to be older, less educated and more likely to be married and identify themselves as non-gay.[14] Finally, different from TLS, RDS uses social networking in the recruitment process. In societies where stigma is attached to MSM, those MSM who identify themselves as non-gay tend to be less likely to connect with the MSM community than those MSM who identify themselves as gay.[20,21] Thus, RDS may not be as effective as TLS to reach these 'marginalized' MSM. In our RDS survey, we selected 3 non-gay identified MSM as seeds, although they were able to prolong

the recruitment chains, we found that the recruitment was often stopped when a new non-gay identified MSM was enrolled.

In our study, TLS MSM were more likely to report risky sexual behavior, in terms of having both male and female partners, engaging in both receptive and insertive sex role and having multiple anal sex partners. On the other hand, TLS MSM were also more likely to have used HIV-related intervention services, i.e. condom promotion, peer education and HIV counseling. Inconsistent with our study, a study in Guatemala found that the utilization of HIV-related services was more common among RDS MSM than that among TLS MSM, because outreach activities in gay venues were usually not allowed by gatekeepers of gay venues there.[10] While in Shenzhen, public health authorities through the local CDC have collaborated with a NGO for nearly 10 years. MSM peers from the NGO were trained by the public health authorities and have been delivering HIV-related intervention services to MSM in gay venues in a friendly way for both gatekeepers and MSM.[22] The common access to HIV-related intervention services among TLS MSM may have decreased their risks of getting HIV or syphilis. Therefore, the HIV infection rate was comparable and the syphilis infection rate was even lower in TLS MSM than that in RDS MSM in our study.

Although the RDS and TLS surveys showed comparable HIV prevalence, the risk factors of HIV identified by these two surveys were completely different. Many of the risk factors identified in the RDS survey are also commonly reported worldwide by previous studies.[23-26] While in the TLS survey, only having a low income and having male sex partners only (vs. having both male and female partners) were associated with HIV infection. In our surveys, sexual behaviors were measured either within a time frame of the last 6 months, whereas HIV-related services utilization was reported within a time frame of the last year. It is thus very likely that a certain proportion of the TLS participants engaging in high risk behavior, such as having multiple anal sex partners, have received information on reducing HIV risks and subsequently adjusted their risk behaviors. As the majority of the TLS MSM have used HIV-related intervention services in the year prior to the survey, it is possible that this common access to HIV-related services has counteracted the risk of getting HIV infected in the key subgroups engaging in high risk behaviors. Over the past decade, most of the intervention control efforts in Shenzhen were targeted to MSM attending gay venues and these efforts turned out to be acceptable and effective.[22] However, internet-based MSM tend to be neglected by such intervention efforts. As there is evidence that internet is commonly used nowadays by MSM to seek quick sex,[27,28] we recommend public health authorities to pay more attention to these internet-based MSM. Risk factors identified in the RDS survey may be informative for designing HIV prevention and control programs and internet may be an important channel to disseminate such prevention programs.

There are several limitations to our study. Firstly, both the RDS and the TLS surveys are susceptible to recall bias and social desirability bias, as the majority of variables are self-reported. However, given that questionnaires were the same in the RDS and TLS surveys, we expect that these sources of biases would affect both samples in a similar way. Secondly, all our participants were willing to be tested in the current study. Those who refused to participate in our study may have refused because they just have been tested recently, or because they were afraid of a positive result, or because they did not have any unsafe sexual practices and believed that testing is not needed. These refusals could cause response bias, especially considering that the overall refusal rate was high: 35% among TLS MSM. The refusal rate among RDS MSM was not retained but can be reflected by the low coupon return rate (33%). Furthermore, both the RDS and TLS surveys are cross-sectional, thus casual inferences cannot be made.

In conclusion, the findings of the comparison between RDS and TLS in this study highlight that RDS is not necessarily a more effective method to reach the more marginalized subgroups of hidden populations. Under certain socio-demographic and geographic circumstances, such as in Shenzhen where population movement is common, TLS is more effective to reach the marginalized segments of MSM. On the other hand, as TLS can only reach MSM who physically attend venues and HIV-related intervention services are already commonly available at gay venues in Shenzhen, RDS is more informative for allocating prevention efforts than TLS. Researchers and public health authorities should take into account the different sample composition of RDS and TLS and be consistent in applying sampling methods when evaluating trends over time.

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Table S7.1. Seeds and their recruits, number of recruitment waves, and total number of recruits by recruitment chain in the respondent-driven sampling (RDS) survey of men who have sex with men in Shenzhen, China in 2010.

Seed ID	Number of recruits	Number of waves linked	Total number of recruits linked
A	3	22	184
B	2	22	256
C	1	2	4
D	0	0	0
E	3	3	8
F	0	0	0
G	2	4	10
H	3	19	148
I	0	0	0
J	1	1	1

Table S7.2. Changes in RDS sample size and composition over recruitment wave.

Wave	n	Change in recruits	Education, n (%)			Marital status, n (%)		Age group, n (%)			
			Junior high school or lower	Senior high school	College or above	Unmarried	Married	<20	20-25	26-30	>30
0	10	NA	1 (10.0)	7 (70.0)	2 (20.0)	7 (70.0)	3 (30.0)	0 (0.0)	2 (20.0)	4 (40.0)	4 (40.0)
1	15	15	3 (20.0)	7 (46.7)	5 (33.3)	14 (93.3)	1 (6.7)	3 (20.0)	8 (53.3)	3 (20.0)	1 (6.7)
1-2	37	22	6 (16.2)	14 (37.8)	17 (45.9)	33 (89.2)	4 (10.8)	3 (8.1)	15 (40.5)	13 (35.1)	6 (16.2)
1-3	62	25	9 (14.5)	22 (35.5)	31 (50.0)	50 (80.6)	12 (19.4)	6 (9.7)	20 (32.3)	21 (33.9)	15 (24.2)
1-4	93	31	17 (18.3)	36 (38.7)	40 (43.0)	74 (79.6)	19 (20.4)	10 (10.8)	31 (33.3)	31 (33.3)	21 (22.6)
1-5	124	31	20 (16.1)	50 (40.3)	54 (43.5)	100 (80.2)	24 (19.4)	14 (11.3)	48 (38.7)	37 (29.8)	25 (20.2)
…											
1-21	603	11	96 (15.9)	248 (41.1)	259 (43.0)	497 (82.4)	106 (17.6)	52 (8.6)	231 (36.7)	190 (30.2)	151 (24.5)
1-22	611	8	96 (15.7)	253 (41.4)	262 (42.9)	505 (82.7)	106 (17.3)	55 (9.0)	226 (37.0)	182 (29.8)	148 (24.2)
Total	621	611	97 (15.6)	260 (41.9)	264 (42.5)	512 (82.4)	109 (17.6)	55 (8.9)	228 (36.7)	186 (30.0)	152 (24.5)

Table S7.3. Risk factors of HIV infection in 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
All	52	621	8.4			
Demographic						
Age (categories, in years)						
18-20 years	6	55	10.7			
21-25 years	20	204	9.8			
26-30 years	18	190	9.5			
> 30 years	8	172	4.6			
Age (continuous, in years)				0.97	(0.92- 1.01)	0.14
Education level						0.090
Junior high school or lower	12	79	15.2	2.33	(1.08- 5.00)	0.031
Senior high school	19	236	8.1	1.19	(0.63- 2.26)	0.60
College or above	21	306	6.9	1.00		
Hukou registration						0.24
Shenzhen	3	84	3.5	0.39	(0.12- 1.29)	0.12
Other cities in Guangdong province	14	136	10.1	1.17	(0.61- 2.26)	0.64
Other Provinces	32	401	8.1	1.00		
Hometown with high HIV prevalence						
No	42	547	7.7	1.00		
Yes *	10	74	13.2	1.79	(0.85- 3.79)	0.13
Duration of staying in Shenzhen (categories)						
< 1 year	22	215	10.2			
1-2 years	6	64	9.2			
> 2 years	24	342	7.0			
Duration of staying in Shenzhen (continuous, in years)				0.86	(0.68- 1.08)	0.20
Monthly income (RMB)						
≤ 3000	34	340	10.0	1.00		
> 3000	18	281	6.4	0.64	(0.36- 1.16)	0.15
Marital status						
Unmarried	46	494	9.3	1.00		
Married	6	127	4.6	0.52	(0.22- 1.23)	0.14
Sexual behavior						
Self-identified sexual orientation						0.25
Homosexual/gay	42	440	9.5	1.00		
Bisexual	10	135	7.3	0.79	(0.39- 1.61)	0.52
Heterosexual or unsure	0	46	0.0	0.08	(0.00- 1.91)	0.12

Table S7.3. Risk factors of HIV infection in 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression *(Continued)*.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
Sexual behavior						
Gender of first sex partner						
Male	36	428	8.4	1.00		
Female	16	193	8.1	0.96	(0.52- 1.78)	0.90
Age of first sex experience						
≤ 20	30	321	9.3	1.00		
> 20	22	300	7.3	0.79	(0.45- 1.41)	0.43
Type of sex partners in the last 6 months						
Men only	49	552	8.9	1.00		
Men and women	3	69	4.3	0.40	(0.11- 1.44)	0.16
Multiple anal sex partners in the last 6 months						
No	14	283	5.1	1.00		
Yes	38	338	11.2	2.37	(1.26- 4.45)	**0.007**
Hong Kong male sex partner in the last 6 months						
Yes	5	62	7.9	0.96	(0.36- 2.58)	0.94
No or unknown	47	559	8.4	1.00		
Anal sex role in the last 6 months^						
Insertive	21	261	8.0	1.00		
Both	18	169	10.7	1.35	(0.70- 2.62)	0.36
Receptive	11	146	7.5	0.89	(0.41- 1.91)	0.76
Unprotected anal intercourse in the last 6 months						
No	21	324	6.4	1.00		
Yes	31	297	10.4	1.66	(0.93- 2.95)	0.086
Condom rupture during anal intercourse						0.093
Never	38	414	9.2	1.00		
Yes	5	64	7.5	0.79	(0.29- 2.11)	0.64
Unsure	3	103	2.8	0.26	(0.07- 0.91)	0.035
NA (no condom use)	6	40	14.4	1.65	(0.64- 4.22)	0.30
Unprotected sex with females in the last 6 months						
No	48	561	8.6	1.00		
Yes	4	60	6.5	0.76	(0.27- 2.19)	0.61

Table S7.3. Risk factors of HIV infection in 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression *(Continued)*.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
STI history, drug use, HIV knowledge, use of services						
Diagnosed with STIs in the last year						
No	32	532	6.0	1.00		
Yes	15	66	22.4	4.45	(2.28- 8.80)	**<0.001**
Used illicit drugs in the last 6 months						
No	50	605	8.3	1.00		
Yes	2	16	12.3	1.32	(0.26- 6.63)	0.73
HIV-related knowledge						
High	48	564	8.5	1.00		
Low	4	57	7.0	0.85	(0.30- 2.41)	0.76
Condom use knowledge						
High	42	547	7.7	1.00		
Low	10	74	13.5	1.82	(0.86- 3.83)	0.12
Self-perceived HIV risk						0.006
Very low	33	497	6.6	1.00		
Moderate	16	111	14.4	2.36	(1.25- 4.47)	0.008
Very high	3	13	22.6	4.42	(1.19- 16.45)	0.027
Access to HIV-related services in the last year						
Yes	26	434	6.0	1.00		
No	26	187	13.9	2.57	(1.45- 4.56)	**0.001**
Tested for HIV in the last year						
No	28	374	7.5	1.00		
Yes	23	246	9.3	1.28	(0.72- 2.27)	0.40
Used illicit drugs in the last 6 months						
No	50	605	8.3	1.00		
Yes	2	16	12.3	1.32	(0.26- 6.63)	0.73
HIV-related knowledge						
High	48	564	8.5	1.00		
Low	4	57	7.0	0.85	(0.30- 2.41)	0.76
Condom use knowledge						
High	42	547	7.7	1.00		
Low	10	74	13.5	1.82	(0.86- 3.83)	0.12

Table S7.3. Risk factors of HIV infection in 621 men who have sex with men (MSM) by respondent-driven sampling (RDS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression *(Continued)*.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
STI history, drug use, HIV knowledge, use of services						
Self-perceived HIV risk						0.006
Very low	33	497	6.6	1.00		
Moderate	16	111	14.4	2.36	(1.25- 4.47)	0.008
Very high	3	13	22.6	4.42	(1.19- 16.45)	0.027
Access to HIV-related services in the last year						
Yes	26	434	6.0	1.00		
No	26	187	13.9	2.57	(1.45- 4.56)	0.001
Tested for HIV in the last year						
No	28	374	7.5	1.00		
Yes	23	246	9.3	1.28	(0.72- 2.27)	0.40

* Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
^ 35 MSM by RDS had no anal sex in the last 6 months

Table S7.4. Risk factors of HIV infection in 533 men who have sex with men (MSM) by time-location sampling (TLS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
All	49	533	9.2			
Demographic						
Age (categories)						
18-20	3	36	7.8			
21-25	17	156	10.9			
26-30	13	141	9.3			
> 30	16	200	8.0			
Age (continuous, in years)				0.99	(0.96- 1.03)	0.73
Venue of recruitment						0.72
Low-end venues	49	399	12.3	1.00		
Dorm-based venues	2	20	10.0	0.73	(0.34- 1.57)	0.42
High-end venues	8	114	7.0	0.87	(0.18- 4.32)	0.87
Education level						0.13
Junior high school or lower	14	99	14.3	1.00		
Senior high school	17	188	9.0	0.61	(0.29- 1.27)	0.19
College or above	18	246	7.3	0.48	(0.23- 0.99)	0.046
Hukou registration						0.50
Shenzhen	4	35	10.7	1.25	(0.44- 3.56)	0.68
Other cities in Guangdong province	5	83	5.7	0.61	(0.24- 1.54)	0.29
Other provinces	40	415	9.5	1.00		
Hometown with high HIV prevalence						
No	41	471	8.8	1.00		
Yes *	8	62	12.2	1.55	(0.71- 3.41)	0.27
Duration of staying in Shenzhen (categories)						
< 1 year	14	155	9.1	1.02	(0.53- 1.95)	0.96
1-2 years	7	61	10.9	1.23	(0.52- 2.94)	0.64
> 2 years	28	317	8.9	1.00		
Monthly income (RMB)						
≤ 3000	33	267	12.3	1.00		
> 3000	16	266	6.0	0.46	(0.25- 0.85)	**0.012**
Marital status						
Unmarried	35	391	8.9	1.00		
Married	14	142	9.9	1.09	(0.58- 2.06)	0.78

Table S7.4. Risk factors of HIV infection in 533 men who have sex with men (MSM) by time-location sampling (TLS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression *(Continued)*.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
Sexual behavior						
Self-identified sexual orientation						0.91
Homosexual/gay	29	309	9.5	1.00		
Bisexual	15	179	8.4	0.91	(0.49- 1.70)	0.77
Heterosexual or unsure	5	45	10.6	1.14	(0.42- 3.09)	0.79
Gender of first sex partner						
Male	26	319	8.1	1.00		
Female	23	214	10.8	1.37	(0.78- 2.43)	0.28
Age of first sex experience						
≤ 20	27	268	10.2	1.00		
> 20	22	265	8.2	0.77	(0.43- 1.37)	0.37
Type of sex partners in the last 6 months						
Men only	45	432	10.5	1.00		
Men and women	4	101	3.7	0.36	(0.13- 0.97)	**0.044**
Multiple anal sex partners in the last 6 months						
No	15	160	9.4	1.00		
Yes	34	373	9.1	0.96	(0.52- 1.78)	0.90
Hong Kong male sex partner in the last 6 months						
Yes	8	62	12.2	1.00		
No or unknown	41	471	8.8	0.68	(0.31- 1.50)	0.34
Anal sex role in the last 6 months^						
Insertive	16	211	7.6	1.00		
Both	19	207	9.2	1.28	(0.65- 2.52)	0.47
Receptive	9	71	12.6	1.87	(0.81- 4.31)	0.14
Unprotected anal intercourse in the last 6 months						
Yes	26	291	9.1	1.00		
No	23	242	9.4	1.05	(0.59- 1.86)	0.87
Condom rupture during anal intercourse						
Never	31	378	8.3	1.00		
Yes	10	71	14.3	1.83	(0.87- 3.81)	0.11
Unsure	6	61	9.2	1.12	(0.45- 2.78)	0.81
NA (no condom use)	2	23	8.1	0.76	(0.14- 4.03)	0.75
Unprotected sex with females in the last 6 months						
No	45	460	9.8	1.00		
Yes	4	73	5.2	0.56	(0.21- 1.53)	0.56

Table S7.4. Risk factors of HIV infection in 533 men who have sex with men (MSM) by time-location sampling (TLS) in Shenzhen, China in 2010, derived from weighted univariate logistic regression *(Continued)*.

Characteristic	HIV infection			Univariate		
	n	N	n/N (%)	OR	(95% CI)	P
STI history, drug use, HIV knowledge, use of services						
Diagnosed with STIs in the last year						
No	47	474	9.9	1.00		
Yes	2	59	3.2	0.27	(0.06- 1.22)	0.089
Used illicit drugs in the last 6 months						
No	49	518	9.5	1.00		
Yes	0	15	0.0	∞	(0.32- ∞)	0.62
HIV-related knowledge						
High	44	480	9.2	1.00		
Low	5	53	8.9	0.94	(0.35- 2.47)	0.89
Condom use knowledge						
High	39	460	8.4	1.00		
Low	10	73	14.2	1.74	(0.85- 3.57)	0.13
Self-perceived HIV risk						
Very low	41	437	9.3	1.00		
Moderate	7	81	9.1	0.96	(0.43- 2.15)	0.93
Very high	1	15	6.1	0.51	(0.05- 5.14)	0.57
Access to HIV-related services in the last year						
Yes	40	426	9.3	1.00		
No	9	107	8.6	0.89	(0.43- 1.86)	0.76
Tested for HIV in the last year						
No	20	272	7.3	1.00		
Yes	29	261	11.2	1.56	(0.87- 2.78)	0.13

* Provinces where HIV prevalence has exceeded 10% in mainland China, i.e. Sichuan, Chongqing, Yunnan and Guizhou.
^ 44 MSM by TLS had no anal sex in the last 6 months.

Chapter 8

Joint marketing as a framework for targeting men who have sex with men in China: A pilot intervention study

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Abstract

Objective: To apply the joint marketing principle as an new intervention approach for targeting men who have sex with men (MSM) who are often difficult to reach in societies with discrimination towards homosexuality and HIV/AIDS.

Methods: A pilot intervention according to the principles joint marketing was carried out by the CDC in Shenzhen, China, in MSM social venues. A self-designed questionnaire of HIV knowledge, condom use and access to HIV related services was used before and after the pilot intervention to evaluate its effectiveness.

Results: The CDC supported gatekeepers of MSM social venues in running their business and thereby increasing their respectability and income. In return, the gatekeepers cooperated with the CDC in reaching the MSM at the venues with health promotion messages and materials. Thus a win-win situation was created, bringing together two non-competitive parties in reaching out to a shared 'customer', the MSM. The pilot intervention succeeded in demonstrating acceptability and feasibility of the joint marketing approach targeting MSM. HIV knowledge, the rate of condom use and access to HIV related services of participants in the pilot intervention increased significantly.

Discussion: The joint marketing intervention is an innovative way to create synergies between the gatekeepers of MSM social venues and public health officials for reaching and potentially changing HIV high-risk behaviors among MSM.

8.1 Introduction

The HIV epidemic in China continues to expand and by the end of 2011 the cumulative number of HIV/AIDS cases was estimated at 780,000.[1] Historically, injection drug users (IDUs) and former plasma donors (FPDs) were the two major groups affected by China's HIV epidemic.[2] However, HIV prevalence has lately increased rapidly among men who have sex with men (MSM). Nationally, the prevalence of HIV among MSM increased from 1.5% in 2005 to 5.0% in 2009.[1] Accounting for only 2-4% of the Chinese adult male population,[3] MSM comprised approximately 30% of the new HIV cases in 2011.[1] Also, due to the traditional culture and values, a substantial proportion of Chinese MSM are married to females. It was estimated that 50-70% of MSM have had sex with females in their lifetime.[4] The common bisexual behavior among Chinese MSM may further bridge the HIV epidemic to the female population. Therefore, MSM have become a priority population for prevention and control of the HIV epidemic in China.

Several factors are associated with the ongoing HIV transmission among MSM in China, such as lack of HIV knowledge; high prevalence of sexually transmitted diseases and unprotected anal intercourse; illicit substances use; and unrecognized infections due to lack of HIV testing.[5-8] To curb the spread of HIV through MSM, several interventions have been implemented to reduce high-risk behaviors and to increase HIV testing in China. These interventions have consisted largely of distributing condoms and educational materials through MSM volunteers and often in MSM social venues such as gay bars.[9-11] These peer-driven behavioral interventions through MSM volunteers usually create a friendlier and culturally sensitive environment for MSM to seek information about HIV. The extent however, to which these volunteer-based interventions reach MSM depends on the social network of the volunteers and may thus have insufficient reach among the whole target population. Also, without a systematic structured framework for cooperation between public health officials and MSM volunteers, educational materials produced may not appeal to the target population. Finally, it is often difficult for MSM volunteers to provide professional consultation and education. All these factors may undermine the effectiveness of peer-driven behavioral interventions.

In this article, we present a pilot intervention study targeting MSM in Shenzhen, China. The intervention is innovative in that it applies the principal of 'joint marketing'. Similar to social marketing,[12,13] the joint marketing approach is also based on commercial marketing techniques. In joint marketing, companies offering non-competitive services work together to gain more customer exposure. The strength of a joint marketing intervention is that it can motive 'gatekeepers' (e.g. club owners) of MSM social venues to become involved and cooperate with public health officials. We hypothesized that the joint marketing approach can achieve a win-win situation for gatekeepers of MSM social venues and public health officials responsible for the control of HIV, to the benefit of MSM.

8.2 Methods

The guiding theory

Joint marketing can be used naturally and effectively when products share a 'buyer persona' [14]. A buyer persona is a detailed profile of an example buyer that represents the real audience – an archetype of the target buyer. Marketers can use buyer personas to clarify the goals, concerns, preferences and decision process that are most relevant to their prospective customers. A joint marketing approach includes the following steps: determine target audience and geographic area; formulate key messages and forms of delivery; agendas, timelines and event logistics; establish staffing and expert resource requirements; secure costs and funding alternatives and follow-up processes.[15] As both the gatekeepers of MSM social venues and the public health officials endeavor to attract and reach MSM, we assumed that the joint marketing approach can be applied to motivate the gatekeepers to be involved in an intervention targeting MSM. Following the components of the joint marketing approach, we designed and implemented this pilot intervention project.

Study location and intervention design

The study was conducted from May, 2009 to May, 2010 in Shenzhen, China. As the first special economic zone in China, Shenzhen has substantial exposure to Western culture. There are between 50,000 to 100,000 MSM in Shenzhen.[16] The prevalence of HIV infection among MSM increased from 0.2% in 2002 to about 10% in 2010.[17] Through continuous outreach efforts to MSM over the years, the local staff of the Center for Disease Control (CDC) gained insight into the local MSM networks and venues, providing a sound foundation for interventions.

The first step of a joint marketing strategy is to determine the target audience and geographic area. For the pilot intervention we targeted eight MSM social venues, including three gay bars, two saunas, and three gymnasiums in Shenzhen. Due to the strong stigma in the society, MSM venues often face difficulties in making profits due to frequent closure, suspension and consolidation of the business ordered by various government agencies. To motive the MSM venues to become involved in our intervention study, the CDC helped to generate a supportive social environment for these venues through active dialogue between the CDC and other government agencies, including administrations for public security, culture, and industry and commerce. Through this strategy, all the available venues (48 venues) agreed to participate, but we only selected eight of these entertainment venues to implement this pilot intervention, due to the limited financial and human resources. The selection criteria were that the floor space of the venues should be larger than 200 m^2, and the average number of daily customers should be more than 150. Also, the gatekeepers of the venues should fully understand the importance of providing HIV prevention and control measures to MSM, and had experience in carrying out prevention activities. To guarantee the quality of the intervention, a governmental agreement was signed between Shenzhen CDC and the eight selected venues. The target audience included all MSM in the venues. To assess this pilot intervention, we also selected six entertainment venues as a

control group, including two gay bars, two saunas, and two gymnasiums having a similar floor space and number of customers.

The key elements of our intervention were educational materials, together with the provision of condoms and lubricants, distributed by trained peer educators, CDC staff and also the gatekeepers themselves at the venues. The educational materials included handbooks, flyers and posters, which were developed with the active collaboration of MSM volunteers from a non-governmental organization. The CDC has collaborated with this non-government organization for nearly ten years in conducting interventions targeting MSM. The handbooks and flyers were used throughout these interventions and showed to appeal to the MSM. For this pilot intervention, we continuously used these handbooks and flyers and we also specially developed new posters and brochures on HIV and STD testing and counseling. These specially developed posters and brochures were displayed at the venues by the gatekeepers as part of educational materials to raise the awareness of being tested. We also arranged monthly performances and lectures to educate MSM. To attract MSM to the intervention venues, the CDC helped the venues establish a positive social reputation by publicizing them on the official CDC website and granting them the status of demonstration units for health education by the government. With more clients visiting and profits increasing, the gatekeepers were more willing to follow the CDC's instructions and cooperate with the CDC in the interventions. The timelines for the intervention was relatively flexible; the CDC staff distributed the educational materials and condoms regularly (at least once per month) and also on the request by these venues. At the control venues, the educational materials, including the specially developed new posters and brochures were offered, but often not used, because the gatekeepers were not motivated in the same way as at the intervention venues to participate. We also distributed the condoms and lubricants, but gatekeepers were not or only minimally involved. It was difficult to arrange performances and lectures at the control venues because of lack of support by the gatekeepers. Instead of motivating the gatekeepers to join together with the public health officials to the benefit of MSM, the inventions at the control venues were done mainly by the public health officials.

With regard to the staffing requirements, the CDC staff had experience with implementing interventions targeting MSM, and they trained MSM volunteers and gatekeepers how to participate in this pilot intervention project. The main costs of the intervention included the educational materials, condoms and lubricants, and the time and financial incentives for training the MSM peers to better equip them with knowledge and skills to cooperate with the CDC for implementing the intervention. In using joint marketing as a framework, the consumers' cost should also be taken into account. Here the consumers referred to are MSM and the cost included are the social, psychological and physical cost associated with the propagated health-changing behaviors. By conducting the intervention in a for MSM friendly platform, we minimized the costs of our consumers.

Evaluation of the intervention and statistical analysis

To assess the effectiveness of this pilot intervention, we compared the results of our questionnaire-based interviews before and after the one-year intervention, and between the intervention venues and the control venues. The questionnaire included age, marital status, education, HIV-related knowledge, ever having sex with female or male partners in the past six months, condom use with female or male partners in the past six months and during the last sexual intercourse, and access to HIV services. There were eight core questions to evaluate HIV-related knowledge.[18] A high knowledge level was defined as having answered correctly six or more out of the eight core questions. Access to HIV services was defined as receiving any services including condom promotion, peer education, and HIV consulting and testing services in the past year. The CDC staff and the trained MSM volunteers explained the aims, significance, benefits, and other aspects of the study to all eligible MSM and obtained verbal informed consent. Confidentiality was strictly observed in this study. Eligibility criteria were age 18 years and above and self admitted ever having had sex with another man. Each participant completed the questionnaires with one CDC staff or trained MSM volunteer anonymously. Due to the limited timeframe and resources, we could not assess large samples of MSM. We therefore used a two-stage sampling method for recruiting participants. In the first stage we randomly selected four and three venues from the eight intervention and the six control venues, respectively. In the second stage we used a convenience sampling method to select MSM and restricted the number of participants to 30 at each of the intervention venues and 40 at each of the control venues. We implemented the survey consistently at baseline and after completing the 1-year study (cross-sectional study design).

EpiData 3.1 software was used as database and SPSS 13.0 was used to analyze the data. Chi-square tests were used to compare pre- and post-intervention indicators.

8.3 Results

Sociodemographic characteristics

At baseline we included for analysis 111 and 105 valid questionnaires out of the total of 120 questionnaires taken at the intervention and control venues, respectively. Questionnaires were considered invalid if there were one or more missing answers. Of the participants at the intervention venues, the mean age was 28.0 years (SD: 5.7), the majority never married (67.6%), and 55.0% had completed at least college education. Of the participants at the control venues, the mean age was 26.8 years (SD: 8.4), the majority never married (64.8%), and 52.4% had completed at least college education. At the post-intervention survey we included for analysis 120 and 98 valid questionnaires at the intervention and control venues, respectively. Of the participants at the intervention venues, the mean age was 28.8 years (SD: 5.9), the percentage never married was 69.2%, and 57.6% had completed at least college education. Of the participants at the control venues, the mean age was 27.3 years (SD: 7.9), the majority never married (66.3%), and 56.1% had completed at least college education. With regard to age, marital status and education,

there were no statistically significant differences between intervention and control venues and between baseline and post-intervention surveys.

HIV-related knowledge

At the baseline survey there was no statistically significant difference in HIV-related knowledge between intervention and control venues. There were significant increases at the intervention venues in the proportion of participants giving correct answers to most HIV knowledge related questions, with the exception of two questions: "Can HIV transmit through sharing needles?" and "Can HIV transmit to children through breast feeding?" (Table 8.1). For both questions there was already a high percentage with a correct answer in the baseline survey. There was also a statistically significant increase at the intervention venues in the proportion of participants holding a high knowledge level. No increase of HIV-related knowledge was identified at the control venues.

Table 8.1. Percentage of correct answers on knowledge questions on HIV and percentage of participants with a high knowledge level at baseline and after completion of the pilot intervention.

Questions	Intervention venues (%)		Control venues (%)	
	Pre	Post	Pre	Post
Is it possible to identify HIV positives from appearance?	64.9	93.3*	64.8	59.2
Can HIV transmit through mosquito biting?	54.1	80.8*	51.4	56.1
Can HIV transmit through sharing meals?	78.4	89.2*	70.5	73.5
Can HIV transmit through blood transfusion and using blood products?	92.8	99.2*	88.6	89.8
Can HIV transmit through sharing needles?	93.7	99.2	91.4	91.8
Can HIV transmit to children through breast feeding?	94.6	99.2	90.5	90.8
Can condom use reduce the HIV transmission?	84.7	98.3*	84.8	86.7
Can the HIV transmission probability be reduced by being constant in a certain sexual partner?	78.4	89.2*	73.3	75.5
With a high knowledge level	73.0	91.7*	66.7	68.4

* Difference in percentages at baseline (pre) and after completion of the pilot intervention (post): p value < 0.05

Condom use

At the baseline survey there was no statistically significant difference between intervention and control venues. Of the participants at the intervention venues, 91.9% (102/111) and 93.3% (112/120) reported having male sex partners, and 30.6% (34/111) and 34.2% (41/120) reported having female sex partners in the past six months at the baseline and post-intervention survey, respectively ($p > 0.05$). The proportion of participants indicating consistent condom use in the past six months and condom use during the last intercourse increased significantly with male partners (Table 2). However, no increase of consistent condom use in the past six months and condom use during the last intercourse was indicated with female partners (Table 3). Of the

participants at the control venues, 92.4% (97/105) and 90.8% (89/98) reported having male sex partners, and 33.3% (35/105) and 33.7% (33/98) reported having female sex partners in the past six months at baseline and post-intervention survey, respectively ($p > 0.05$). No increase of the proportion of participants indicating consistent condom use in the past six months and condom use during the last intercourse was identified with male partners or female partners (Table 8.2 & Table 8.3).

Table 8.2. Percentage of participants using a condom during anal intercourse with a male partner among those who reported having male sex partners in the past six months and during the last intercourse at baseline and after completion of the pilot intervention.

Condom use	Intervention venues (%)*		Control venues (%)+	
In the past six months	Pre n/N	Post n/N	Pre n/N	Post n/N
Never	11/102 (10.8)	2/112(1.7)	17/97(17.1)	12/89(13.3)
Sometimes	51/102 (50.0)	41/112(36.7)	48/97(49.5)	45/89(51.0)
Consistent	40/102 (39.2)	69/112(61.6)	32/97(33.3)	32/89(35.7)
During the last intercourse	81/111 (73.0)	102/120(85.0)	67/105(63.8)	64/98(65.3)

* For all percentages at baseline (pre) and after completion of the pilot intervention (post): p value < 0.05.
+ For all percentages at baseline (pre) and after completion of the pilot intervention (post): p value > 0.05

Table 8.3. Percentage of participants using a condom during intercourse with a female partner among those who reported having female sex partners in the past six months and during the last intercourse at baseline and after completion of the pilot intervention.

Condom use	Intervention venues (%) +		Control venues (%)+	
In the past six months	Pre n/N	Post n/N	Pre n/N	Post n/N
Never	12/34(35.3)	14/41(34.1)	11/35(31.4)	12/33(36.4)
Sometimes	8/34(23.5)	10/41(24.4)	9/35(25.7)	10/33(30.3)
Consistent	14/34(41.2)	17/41(41.5)	15/35(42.9)	11/33(33.3)
During the last intercourse	62/111(55.9)	70/120(58.3)	54/105(51.4)	53/98(54.1)

+ For all percentages at baseline (pre) and after completion of the pilot intervention (post): p value > 0.05

Access to HIV-related services

The percentage of participants reporting having ever received condom promotion, peer education, and HIV consulting and testing services in the past year was higher at the intervention venues than at the control venues. The access to condom promotion, peer education, and HIV consulting and testing services increased significantly at the intervention venues but not at the control venues (Table 8.4).

Table 8.4. Percentage of participants receiving any HIV services in the past year at baseline and after completion of the pilot intervention.

HIV services	Intervention venues (%)		Control venues (%)	
	Pre	Post	Pre	Post
Condom promotion	70.3	85.0*	60.0	64.3
Peer education	10.8	24.2*	4.8	5.1
HIV consulting and testing	69.4	90.8*	52.4	56.1

* Difference in percentages at baseline (pre) and after completion of the pilot intervention (post): p value < 0.05

8.4 Discussion

Our joint marketing pilot intervention for reducing high-risk sexual behavior and increasing HIV related knowledge and access to health services among MSM appears feasible and effective as a HIV prevention strategy, demonstrating that this joint marketing intervention is an innovative way to create synergies between the gatekeepers of MSM social venues and public health officials to reach MSM.

In this joint marketing intervention, the CDC basically supported gatekeepers of MSM social venues in running their business with active dialogue towards other government agencies and thereby increasing their respectability and income. In return, they were asked to cooperate with the CDC public health staff in reaching the MSM at the venue with health promotion messages and materials. In this way a win-win situation was created, bringing together two non-competitive parties in reaching out to a shared customer (*buyer persona*), the MSM. This approach is certainly appropriate in societies with strong stigma towards homosexuality and HIV/AIDS. Although homosexual activities became legal in China since 1997, Chinese MSM still experience social discrimination from family members, peers and colleagues.[19] Such environments lead many MSM to hide their sexual orientation and express their sexual behavior secretly where they cannot be reached by public health or other government officials.[20] MSM will tend to gather quietly and owners of bars and clubs for these men will distrust authorities and resist government interference. Breaking down these barriers with gatekeepers is an important step in reaching out to MSM for HIV prevention.

This pilot study succeeded in demonstrating acceptability and feasibility of the joint marketing approach targeting MSM. The evaluation of its effectiveness however, is limited by its design and sample size and the findings must therefore be interpreted with caution. The contribution of the individual components of the intervention (e.g. agreement with gatekeepers, educational materials and condom distribution, and lectures and performances) cannot be established in this study. The results can only be attributed to the entire package of the joint marketing approach. Also, our selection criterion of the intervention venues that gatekeepers should have

experience in carrying out prevention activities may have introduced positive selection bias. The better access to HIV-related services among MSM at the intervention venues than MSM at the control venues at baseline most likely resulted from this bias. We had to select "experienced" gatekeepers to guarantee the process of the pilot intervention, due to the limited timeframe and resources. Furthermore, self-reported behavior is a less reliable outcome indicator than for instance counting new cases of HIV or other sexually transmitted diseases. Future studies with more rigorous design are needed to confirm the effectiveness of the joint marketing intervention targeting MSM.

At the baseline survey, MSM were already highly aware that HIV can be transmitted through needle sharing and breast feeding, but a significant increase in other HIV related knowledge was shown at the post-intervention survey. It is also encouraging that our intervention appears to have increased condom use during penile-anal intercourse. As unprotected penile-anal intercourse is associated with a high rate of HIV transmission, reduction of unprotected penile-anal intercourse is crucial for the control of the HIV epidemic among MSM.[21] From this point of view, our intervention may have positive implications for future HIV prevention efforts among MSM in China. At the post-intervention survey, however, there was no apparent increase in condom use with female partners. Traditional cultural and family values may play a role here, and highlights the need for effective interventions to halt HIV spreading through MSM to the female population.

Although HIV consulting and testing services are offered free in China, the HIV testing rates remain very low among Chinese MSM, only 30% of MSM report being ever tested.[5,22,23] This intervention showed its potential to increase access to HIV consulting, testing and other related services. By placing posters advertising HIV consulting and testing services provided by CDC in the venues visited by MSM, their awareness for the need of being tested can be increased. Because the local CDC also posted advertisements of the participating venues on its website, the gatekeepers of these venues were motivated and willing to cooperate with CDC. With their cooperation it was much easier to distribute condoms, educational materials and even offer face-to-face education. Moreover, with posting of advertisements for the venues on the CDC website and communicating with MSM in their social venues, the local CDC set an example to the public in respecting MSM.

Our joint marketing approach followed both the principals of customer-centeredness of commercial marketing and of equality and human care of public health. We consider both essential in targeting the often marginalized MSM and recommend that future intervention efforts apply these principles and target MSM in a discreet manner and respecting their privacy.

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Chapter 9

General discussion

9.1 Answering the research questions

1. What are the trends in engaging in sexual risk behaviors among general heterosexual population groups in China?

Our systematic review focused on five indicators of recent sexual risk behavior: 1) premarital sex, 2) commercial sex, 3) multiple sex partners 4) condom use, and 5) STI prevalence. We included 174 observational studies on population groups that do not belong to the classical high risk groups (i.e. floating population, college students and other groups including out-of-school youth, rural residents and subjects from gynecological or obstetric clinics and premarital check-up centers). We show that there are no increased tendencies to engage in sexual risk behaviors among these groups over the past decades in China (Chapter 2).

This observation might be explained by the continuous efforts of the Chinese government and various non-government organizations to educate people about HIV/STIs through mass media and condom promotion campaigns. Also, there have been changes in the demographics of the sampled populations over the past years, in particular for the floating population. In the early period, this group comprised mainly of single males, who may have sought sexual services, whereas the later floating populations included migrating families and 'temporary couples', who are single migrants who meet each other in the same working area and form a temporary fixed sexual partnership. Thus, the proportion that engaged in high-risk sexual behaviors might have decreased, which could have compensated for an increase in risk among the rest of this group.

The floating population, in particular those who migrated from rural to urban areas in search of job opportunities, arouse much attention from public health authorities in China. It is estimated that there are over 200 million members of this floating population.[1] They are more often engaged in high-risk sexual behaviors, including unprotected sex and multiple sex partners,[2-5] and showed a higher HIV prevalence,[6] in comparison to permanent residents. There is concern that the floating population will serve as a driver of the HIV epidemic. Over the past decade, the Chinese government has allocated a large budget for HIV prevention among the floating population. The proportion of spending on HIV prevention among floating population accounts for about 10% of the total US $217 million in 2012, which is 1.5 times more than for MSM, who are the predominant route of HIV transmission.[7]

Our systematic review shows that the tendency to engage in sexual risk behaviors within the floating population may not have increased over the past decades (Chapter 2). Besides the floating population, college students and other population groups that do not belong to the classical high risk population groups all revealed no increasing trend of engaging in sexual risk behaviors in our review. The results are consistent with the Chinese Comprehensive HIV Sentinel Surveillance Data on college students and pregnant women.[8] It indicates that the HIV

epidemic among the general population is apparently under control and the general population may be unlikely to serve as key driver for a rapidly increasing HIV epidemic.

In conclusion, we recommend that China prioritizes the well-known high-risk groups, and avoids diluting the effect of available resources for prevention by spreading these thinly over the whole population, because the epidemic is unlikely to spread rapidly among the general population. On the other hand, these potential risk groups should not be neglected altogether. The current comprehensive surveillance should be continued to detect any changes in time. Even with a stable trend of engaging in sexual risk behaviors, STIs/HIV can continue to spread if all prevention and treatment activities are stopped.

2. What are the patterns of HIV risk and prevention behavior among FSWs in Shenzhen, China?

In our assessment, we used syphilis infection as the indicator of HIV risk behavior, and uptake of HIV-related services as the indicator of HIV prevention behavior. Our studies focused on 1) quantifying the burden of syphilis infection and its trend, 2) evaluating determinants of syphilis infection, 3) evaluating determinants of no uptake of HIV-related services.

We show that the syphilis prevalence is about 5% among FSWs in Shenzhen, Guangdong province from 2009 to 2012. The prevalence has slightly declined compared to the earlier years. Syphilis was particularly common among FSWs who use condoms inconsistently, who have a history of illicit drug use and are in the oldest age groups (Chapter 3). In Chapter 4, we describe a positive association between consistent condom use and uptake of HIV-related intervention services. Therefore, we assume that the declined syphilis prevalence among FSWs in Shenzhen is likely be due to comprehensive intervention services including condom promotion and peer education that have been initiated since 2004.[9] The positive association between consistent condom use and uptake of services was also found in other studies.[10-12] Thus, increasing uptake of these HIV intervention services may help to further reduce the burden of syphilis. However, we found that the uptake of HIV-related intervention services by FSWs is rather low. The overall uptake rate of condom promotion, peer education, and HIV testing by FSWs was 48%, 28% and 22%, respectively, in Shenzhen (Chapter 4). Previous studies on determinants of uptake of HIV-related services were predominantly on HIV testing.[13-16] Condom promotion and peer education that are key components of HIV-related services, to some extent have been neglected. Our study is one of the first that explored common determinants of no uptake of all the three services. We found no uptake of all services was common among FSWs in younger age groups and the new comers to Shenzhen.

There seems to be a paradox of results in Chapter 3 and 4 in that older FSWs tend to use HIV-related intervention services more often, but still were more likely to be infected by syphilis.

This is because the syphilis testing method used in our study cannot differentiate between recent and old persistent infection. It is very likely that syphilis infection among young FSWs was only identified when these FSWs grew older. At a relatively old age, those infected FSWs were referred to healthcare workers, which may have facilitated their uptake of HIV intervention services. If they have used the HIV-related services earlier, they may have reduced their HIV risk behavior and may have counteracted syphilis. This highlights the importance of incorporating STI screening and treatment into the HIV-related services.

Although HIV-related services for FSWs have been rolled out since 2004 and probably lead to a slight decline of syphilis prevalence in Shenzhen, indicators of HIV risk and prevention behavior are far from satisfactory. HIV-related services need to promoted at large among FSWs to reduce the burden of syphilis, also to the benefit of other STIs, in particular HIV. Previous research in India found that the perceived repercussions of being seen accessing HIV-related services was the key barrier to uptake of services.[17] In China, FSWs experience a high level of condemnation across the society,[18] the perceived fear of being seen accessing services may also be the key barrier. It is clear that programs to reduce stigma are needed. Also, there is evidence that peers and gatekeepers of venues have positive influence on promoting HIV prevention behavior among FSWs.[19,20] Providing professional training to peers of FSWs and gatekeepers may be an entry point to reach FSWs and an important strategy to increase acceptability of HIV-related services.

In conclusion, we recommend point-of-care outreach screening programs for early syphilis diagnosis and link such programs with timely treatment. Also, comprehensive intervention services (e.g. condom promotion and peer education) should be continued to increase the overall condom use and reduce illicit drug use among FSWs. These services should be particularly intensified and advocated among young and recently started FSWs. Training peers of such young and recently started FSWs and initiating peer outreach programs may be an important strategy to reach the population.

3. What are the patterns of HIV risk and prevention behavior among MSM in Shenzhen, China?

For HIV risk behavior, we investigated the following indicators: 1) commercial sex, 2) group sex, 3) multiple sex partners, 4) receptive or both receptive and insertive anal sex role, 5) inconsistent condom use, 6) substance use, 7) HIV and syphilis infection. For HIV prevention behavior, we used uptake of HIV-related services, and in particular HIV testing, as the indicator. Our studies focused on 1) comparing HIV risk and prevention behavior among MSMW with MSM-only, 2) quantifying the HIV testing rate and evaluating determinants of recent HIV testing. We found that, compared to MSM-only, MSMW reported comparable HIV prevention behavior but more HIV risk behavior (Chapter 5). HIV testing rate was disappointingly low in both male

sex workers (also referred as money boys, MBs) and other MSM; only 43% of MBs and 48% of other MSM reported having been tested for HIV in the last year (Chapter 6). Determinants of testing among MBs were: having multiple anal and having more commercial male partners; among other MSM: having homosexual orientation, having only male sex partners and having a history of STI. Having unprotected anal intercourse was not, and living in Shenzhen longer was positively associated with HIV testing (Chapter 6).

There have been debates on whether MSMW may serve as a bridge population to transmit the HIV epidemic from MSM to the heterosexual population. Some researchers have argued that this is unlikely because there is evidence that the HIV prevalence among MSMW appears to be substantially lower than among MSM-only,[21,22] and they assumed that MSMW entertain low sexual activity profiles with their female partners.[23] However, results from our study show that HIV prevalence was as high among MSMW as among MSM-only and sexual intercourses with regular female partners were as common as with their male partners (Chapter 5). Given that inconsistent condom use with their female partners was common (Chapter 5), MSMW may very well transmit HIV to their female partners. Therefore, MSM in Shenzhen are not only a driver of the HIV epidemic for the homosexual population, but likely also for the general heterosexual population.

With growing interest in HIV 'treatment as prevention',[24] encouraging MSM to test for HIV becomes one of the key strategies for HIV prevention. It is recommended that MSM should be tested for HIV at least once a year.[25,26] We show that the HIV testing rate was disappointingly low in Shenzhen, as compared to Western countries, where the HIV prevalence among MSM is not as high as in Shenzhen.[27,28] Previous studies on determinants of HIV testing in China tend to treat MSM as a homogeneous group.[29-31] We, for the first time, separately evaluated determinants of recent HIV testing in MBs and other MSM. Among MBs, we found that having a large number of partners was, whereas having unprotected anal sex was not, significantly associated with having been tested in the last year. It highlights that education campaigns to promote HIV testing among MBs should first increase awareness of actual HIV risk and correct any misunderstanding about sexual risk behaviors. Among other MSM, we confirmed that having homosexual orientation, and having a history of STI were associated with HIV testing which was previously found in Australia and China.[32,33]

So far, there are hardly any specifically designed HIV prevention programs that address the characteristics and behavioral patterns of MSM. The available HIV prevention services for MSM such as condom promotion and peer education are only parts of broader HIV prevention programs for classical high-risk population groups.[34] We recommend public health authorities to take into account specific characteristics of MSM for future HIV prevention and control efforts. For instance, to curb HIV transmission from MSM to the general heterosexual population, it may be more effective to target MSMW to reduce their HIV risk behaviors through their peers than through general MSM who do not have sex with women. Moreover, to advocate

frequent HIV testing, differences between MBs and other MSM need to be considered. For MBs, education programs are needed to increase their awareness of actual HIV risk. For other MSM, de-stigmatizing programs are needed to encourage those with female partners to go for testing. In all, innovative prevention services that fit the culture of the MSM community are needed in China.

4. How are MSM best reached for HIV surveillance and interventions?

Both respondent-driven sampling (RDS) and time-location sampling (TLS) can be used to reach MSM for HIV surveillance. Joint marketing, which brings companies offering non-competitive services work together to gain more customer exposure, is an innovative way for implementing HIV interventions targeting MSM. It can motivate gatekeepers of gay venues and proved to be acceptable and feasible.

We show that both respondent-driven sampling (RDS) and time-location sampling (TLS) can result in sizable and diverse samples of MSM in Shenzhen, China. However, the two sampling methods have reached different segments of MSM: TLS MSM were more marginalized in terms of being less educated, more likely to be migrants, non-gay identified and to report risky sexual behaviors. Nevertheless, TLS MSM also reported more use of HIV-related intervention services (Chapter 7). The different sample composition of RDS and TLS was also identified in other studies.[35,36,37] Interestingly, all previous studies have shown that MSM reached by RDS were more marginalized, which is just the opposite of our results. The different results between previous studies and our study may be due to the unique socio-demographic characteristics of our study location. In Shenzhen, over 80% of the inhabitants, including MSM, are internal migrants, who migrate from other places to Shenzhen for better job opportunities or for the more relaxed atmosphere.[38] While living in their hometown, MSM usually hide their same sex activities from their peers, friends and relatives.[39] Compared with MSM migrated from other places, the native Shenzhen MSM residents may feel more reluctant to seek partners at venues. Consequently, TLS in our study resulted in higher proportion of migrant MSM, who are often less educated and engage in higher risk behaviors.[2,5,6] Researchers and public health authorities should take into account the different sample composition of RDS and TLS and apply sampling methods consistently when evaluating trends over time for surveillance.

The common uptake of HIV-related intervention services among TLS MSM indicates that readily-in-use intervention services provided at venues are preferable to MSM. Rolling out such venue-based intervention services may help to reduce HIV risk behavior among MSM who physically attend venues. An important barrier for these venue-based intervention services is that gatekeepers of gay venues are often very reluctant to cooperate with public health authorities to implement intervention services in China.[40] It is thus crucial to motivate gatekeepers to be involved in these HIV prevention programs. We show that joint marketing can create synergies

between gatekeepers of gay venues and public health authorities for reaching and potentially changing HIV high-risk behaviors among MSM (Chapter 8). Nevertheless, to optimize the use of these already available HIV-related intervention services provided by local public health authorities at community-level sites, it is important to reach MSM who seldom attend gay venues. Since RDS recruits participants by peer referral chain, it can be a potential tool to reach those 'HIV-related services naïve' MSM.

In conclusion, RDS and TLS both are important sampling methods for surveillance of socio-demographics and behaviors of MSM. The different sample composition of RDS and TLS needs to be taken into account when evaluating trends over time. Joint marketing proves to be a feasible way to motivate gatekeepers of gay venues for rolling out venue-based HIV-related intervention services. RDS can be a potential tool to reach 'HIV-related services naïve' MSM, so that to optimize community-based HIV-related intervention services.

9.2 Challenges of implementing methadone maintenance treatment (MMT) for opiate users in China

In this thesis, we have focused mainly on sexual transmission of HIV, because this is the predominant mode of HIV transmission in China nowadays.[41] HIV epidemics among drug users are clearly decreasing in most regions of China since 2005.[34] This under-control HIV epidemic among drug users is probably due to the large roll-out of successful harm-reduction programs countrywide since 2003.[42] However, challenges of implementing harm-reduction programs (e.g. MMT) still exist in China. Here, we discuss some challenges of implementing MMT as encountered over the past decades.

Drug users in China are mainly opiate users

The history of opiate use in China can be traced back to the time of the Opium Wars with the British Empire in the 19th century, when China was forced to legalize opiate importation. By 1949, there were over 20 million opiate users in China (5% of the population).[43] To curb the epidemic, the new government after the 2nd World War launched a strict nationwide anti-drug campaign, and the elimination of opiate use was announced in 1952.[44] This success was linked to the government policy of separating China from the West. However, in the context of governmental reform and the open-door policies in the 1980s, opiate use re-emerged, particularly in Yunnan and Guangxi, the provinces bordering Myanmar and Vietnam.[45] Opiates are produced and smuggled from these areas, referred to as the Golden Triangle, into China. Along the drug traffic routes, more and more youth and young adults have become opiate users. Subsequently, opiate use has spread quickly from these border areas into the inner regions of the country. Drug users were registered when intercepted by China's Public Security Bureaus (PSB). The number of registered drug users increased from 0.15 million in 1991 to 1.3 million in 2009 (Figure 9.1). Among the 1.3 million registered drug users, over 70% are addicted to opiates.[46]

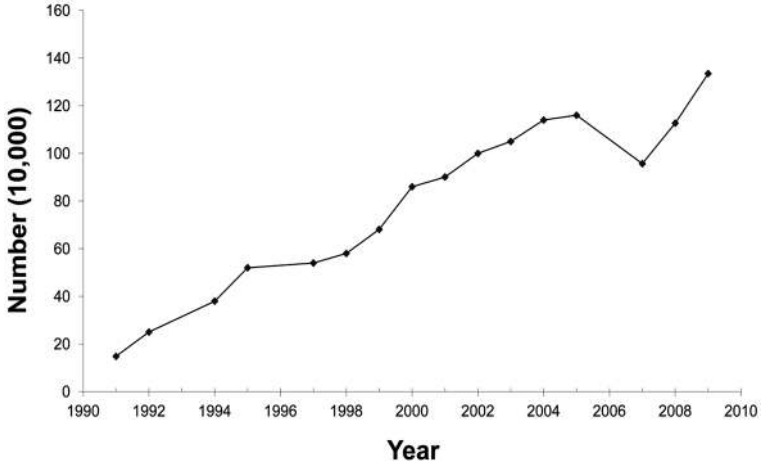

Figure 9.1. The number of registered drug users between 1991 and 2009 shows an increasing trend of drug use in China. Source: Annual Reports on Drug Control, Beijing, China National Narcotics Control Commission.[46] In the years of 1993, 1996 and 2006, the number of registered drug users was missing, and in the year of 2007 the registration method was changed by the government.

Sharing of needles and equipment is common among Chinese drug users, ranging from around 50% to over 70% of the drug users,[47] and thereby rendering drug users the primary transmission source of HIV in China for decades. To finance their habit, approximately 10% of the drug users also engage in commercial sex[48-50] and may serve as a bridge to transmit the HIV epidemic to the heterosexual population.

MMT in China

MMT is a harm reduction service using methadone, a long-acting synthetic narcotic analgesic, to stabilize opiate users and help them avoid returning to previous patterns of opiate use.[51] In China, methadone-based withdrawal regimens first became available for opiate users in 1993. At that time, the application of methadone was very limited; only well-organized hospitals could provide this kind of substitution treatment for patients. The average treatment duration and dosage was strictly kept within 7-21 days and 40-50 mg/day. Once discharged, patients were forbidden to further use methadone.[52,53] This situation lasted for a decade. The contentious issue for the government was whether it is sensible to expend public budgets to support opiate users with another addictive substance for a prolonged period.

It was not until 2004 that improvement in social well-being of opiate users was demonstrated through the first eight pilot MMT clinics. The Chinese Government subsequently decided to expand the MMT programs throughout the entire nation with the enactment of the Five-Year Action Plan to Control HIV/AIDS (2006-2010).[54] By the end of 2009, a total of 668 MMT clinics

had been established nationwide in 27 provinces, cumulatively serving about 236,000 clients.[41] These programs have reduced injection drug use and criminal behavior, and also improved social behavior.[42,55,56]

As clearly proven by research, length of retention is strongly associated with the effectiveness of the methadone maintenance treatment.[57] However, large challenges still exist in reducing the high dropout rate in Chinese MMT programs, which is estimated at 30%-40%.[58] Chinese studies have found that this can be attributed to the relatively low dosage of methadone,[52] relatively high cost and poor availability of methadone, and lack of psychosocial support.[59-63] The Chinese government heavily subsidizes MMT programs, and methadone now costs about ten Yuan (about one Euro) per day – much less than opiates – but it is still unaffordable to many opiate users in China.[64] In terms of cost-effectiveness, it is not effective to establish a substitution treatment program in areas where there are less than 500 opiate users.[42] For those living in areas without MMT services, MMT is hard to access because methadone can only be taken at specially licensed clinics. With regard to psychosocial support, the training of medical staff in MMT programs is not sufficient. The personnel structure often cannot keep pace with the rapid expansion of the MMT programs; nurses and consultants are urgently needed.

Furthermore, misunderstandings about the principals of MMT are still common among the medical staff and the provision of counseling; behavioral interventions and psychosocial support is difficult for them.[65] Consequently, some misconceptions toward MMT are also common among the MMT clients. For example, there is common belief that methadone is as addictive as heroin, or even worse.[64,66] Another issue that needs to be addressed regarding the effectiveness of MMT in China is the entry criteria. To enter MMT, opiate users have to show registration with Public Security and local resident registration, or three months residency for migrants.[67] Labeled as criminals, many opiate users believe (justly or not) that they will be arrested by the police if they try to get access to MMT. Instead of seeking help from professional health care providers, they opt to hide themselves and remain untreated.

In conclusion, there is a clear need to strengthen the current MMT programs, even after the successful roll-out. Further research is needed to identify strategies to overcome challenges of satisfying increase need and reducing drop out of MMT programs.

9.3 Conclusions and recommendations

Conclusions

- Over the past decades there is no evidence of increased sexual risk behavior among population groups in China that do not belong to the classical high risk groups.
- Syphilis prevalence has declined slightly among female sex workers in Shenzhen (China).

- Syphilis is common particularly among female sex workers in Shenzhen (China), who use condoms inconsistently, who have a history of illicit drug use, and who are in the age group of older than 30 years.
- No uptake of HIV-related services by female sex workers in Shenzhen (China) is found particularly among those aged younger than 30 years and among the new-comers to the city.
- In Shenzhen (China) men who have sex with men and women report similar HIV prevention behavior as men who have sex with men only, but more HIV risk behavior.
- HIV testing rates are equally low in money boys and other men who have sex with men in Shenzhen (China).
- Having multiple anal sex partners (money boys) and having homosexual orientation (other men who have sex with men) are the most important determinants of recent HIV testing in Shenzhen (China).
- Time-location sampling and respondent-driven tap into reach different segments of men who have sex with men in Shenzhen (China).
- Joint marketing is an innovative way to bring gatekeepers of gay venues and public health authorities together in reaching out effectively to men who have sex with men.

Recommendations

- China should prioritize the well-known high-risk groups for HIV and avoid diluting the effect of available resources for prevention of HIV by spreading these thinly over the whole population.
- China should initiate point-of-care outreach screening programs for early syphilis diagnosis among female sex workers, and such programs should be linked with timely treatment.
- Uptake of HIV-related intervention services in China should be advocated most intensively among female sex workers who are in the age of under 30 years and among those who are new-comers to Shenzhen (China).
- In China, HIV risk behavior among men who have sex with men and women needs to be reduced to prevent HIV transmission from men who have sex with men to the general heterosexual population.
- HIV testing promotion programs should convince money boys in China about their actual HIV risk and educate them about the importance of testing.
- Strong campaigns to reduce stigma about homosexuality are needed in China to encourage men who have sex with men to go for testing, especially those who have female partners.
- Time-location sampling and respondent-driven sampling should be used consistently when evaluating trends of HIV prevalence for surveillance.
- Public health authorities in China should motivate gatekeepers of gay venues for rolling out venue-based HIV-related intervention services.

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Summary

The aim of this thesis is to identify promising new avenues to control sexual transmission of HIV in different population groups (i.e. general population, CSWs and MSM) in China. This Thesis consists of nine chapters, with seven scientific papers (Chapters 2-8), a general introduction (Chapter 1) and a discussion (Chapter 9).

Chapter 1 gives a general introduction to HIV epidemiology. We also introduce the HIV epidemic, classical high-risk population groups and key HIV health services in China. At the end of 2011, 780 000 people were living with HIV/AIDS in China. National surveillance data show that the proportion of new HIV infections attributable to sexual (both heterosexual and homosexual) transmission had increased steadily from 57% in 2007 to 82% in 2011. Notably, this increase is seen particularly for homosexual transmission, which corresponds with an increase from 12% to 29% from 2007 to 2011. In this thesis, we investigate HIV risk and prevention behaviors in different sexually active groups (i.e. general population, CSWs and MSM). The field studies were conducted in Shenzhen, South China. We addressed the following research questions:

1. What are the trends in engaging in sexual risk behaviors among general heterosexual population groups in China?
2. What are the patterns of HIV risk and prevention behavior among FSWs in Shenzhen, China?
3. What are the patterns of HIV risk and prevention behavior among MSM in Shenzhen, China?
4. How are MSM best reached for HIV surveillance and interventions?

Chapter 2 describes a systematic review on trends of engaging in sexual risk behaviors among general heterosexual population groups in China. We focused on five indicators of recent sexual risk behavior, namely: 1) premarital sex, 2) commercial sex, 3) multiple sex partners 4) condom use, 5) STIs. We included 174 observational studies (published from 1980-2012) on population groups that do not belong to the classical high risk groups (i.e. internal migrants, college students and other groups including out-of-school youth, rural residents and subjects from gynecological or obstetric clinics and premarital check-up centers). Using generalized linear mixed model, we show that, there are no increased tendencies to engage in sexual risk behaviors among certain general population groups over the past decades in China (Chapter 2).

Chapter 3 and **4** discuss the patterns of HIV risk and prevention behavior among FSWs. We use syphilis infection as the indicator of HIV risk behavior and uptake of HIV-related services as the indicator of HIV prevention behavior. Using comprehensive surveillance data on FSWs between 2009 and 2012 in Shenzhen, China, we investigate risk factors of syphilis in Chapter 3. We performed questionnaire-based interviews for socio-demographics, sexual risk behavior, illicit drug use and syphilis testing results from 1653 FSWs recruited by venue-based sampling. We found that the overall syphilis prevalence was approximately 5%, showing a slightly decreasing trend. Factors significantly associated with syphilis infection were inconsistent condom use,

illicit drug use, and older age. Venues where FSWs were recruited and duration of commercial sex work were not significantly associated with syphilis infection.

Chapter 4 explores determinants of the low uptake of HIV-related intervention services by FSWs in Shenzhen, China. We interviewed 1656 FSWs, recruited by venue-based sampling, about socio-demographics, behaviors and uptake of HIV-related intervention services and identified determinants of no uptake of HIV testing; condom promotion; and peer education. We found that the overall uptake of HIV testing, condom promotion, and peer education by FSWs was only 21%, 48% and 28%, respectively. Younger age and shorter duration of working in Shenzhen were statistically significantly associated with no uptake of all three services. We also found that uptake of these services was positively associated with consistent condom use and good HIV-related knowledge.

Chapter 5 discusses the patterns of HIV risk and prevention behavior among MSMW. From a respondent-driven sampling survey in Shenzhen, China, we quantified the burden of HIV/syphilis and studied patterns of HIV risk and prevention behaviors in 107 MSMW, and compared these with those of 542 men who have sex with men only (MSM-only). For HIV risk behavior, we investigated indicators as follows: 1) commercial sex, 2) group sex, 3) multiple sex partners, 4) receptive or both receptive and insertive anal sex role, 5) illicit drug use. For HIV prevention behavior, we used uptake of HIV-related services and in particular, HIV testing as the indicator. Information regarding socio-demographics, condom use with different types of sexual partners and HIV risk and prevention behaviors were collected by a structured questionnaire. Information regarding HIV and syphilis infection was from laboratory test. We found that HIV prevention behaviors and consistent condom use with male partners did not differ between the two groups. However, HIV risk behaviors were more common among MSMW than MSM-only. Moreover, among MSMW, the HIV prevalence was as high as 6% and consistent condom use was extremely low with female partners in MSMW. Results from this study suggest that there is risk of HIV transmission from MSMW to the general heterosexual population.

Chapter 6 discusses the patterns of HIV prevention behavior among MBs and other MSM. We explored and compared determinants of recent HIV testing among MBs and other MSM in Shenzhen, China. We recruited 510 MBs and 533 other MSM by time-location sampling. We defined recent HIV testing as self reporting having been tested for HIV in the last year. We found that recent HIV testing was relatively uncommon in both MBs and other MSM, that 43% of MBs and 48% of other MSM reported having been tested for HIV in the last year. Determinants of testing among MBs were: having multiple anal and having more commercial male partners; among other MSM: having homosexual orientation, having only male sex partners and having a history of sexually transmitted infection. Having unprotected anal intercourse was not and living in Shenzhen longer was positively associated with HIV testing in both MBs and other MSM.

Chapter 7 discusses differences between two best methods to reach MSM for HIV surveillance. RDS, based on peer referral, and TLS based on random selection of venue-day-time periods, are recently developed and among the most commonly used sampling methods. They are appraised as the best methods to reach hidden populations such as MSM, because samples acquired by them are representative. We compared socio-demographics, HIV risk and prevention behaviors and HIV/syphilis infection rates between samples of 598 RDS MSM and 493 TLS MSM in Shenzhen, China in 2010. We found that the HIV prevalence was comparable in RDS and TLS MSM. However, TLS recruited larger proportions of key subgroups than RDS: MSM recruited by TLS were older, less educated and more likely to be migrants (without Shenzhen hukou registration), to be non-gay identified and to engage in risky sexual behaviors. On the other hand, MSM recruited by TLS were more likely to have been covered by HIV-related intervention services. Results from this study show that both RDS and TLS can result in sizable and diverse samples of MSM and thus both can be used for HIV surveillance. However, as composition of samples differs between these two methods, researchers and public health authorities need to be consistent with a certain sampling method when evaluating trends.

Chapter 8 describes how an innovative intervention strategy by using joint marketing as the framework for targeting MSM was piloted in Shenzhen, China. A self-designed questionnaire of HIV knowledge, condom use and access to HIV related services was used before and after the pilot intervention to evaluate its effectiveness. During the one-year intervention period, the Shenzhen CDC supported gatekeepers of MSM social venues in running their business and thereby increasing their respectability and income. In return, the gatekeepers cooperated with the CDC in reaching the MSM at the venues with health promotion messages and materials. Thus a win-win situation was created, bringing together two non-competitive parties in reaching out to a shared 'customer', the MSM. We found that the pilot intervention succeeded in demonstrating acceptability and feasibility of the joint marketing approach targeting MSM. HIV knowledge, the rate of condom use and access to HIV related services of participants in the pilot intervention increased significantly.

In **Chapter 9**, we provide and discuss answers to the research questions. We also included some discussion about challenges in implementing MMT in China. At the end of the chapter, we arrive at the following conclusions and recommendations:

Conclusions

- Over the past decades there is no evidence of increased sexual risk behavior among population groups in China that do not belong to the classical high risk groups.
- Syphilis prevalence has declined slightly among female sex workers in Shenzhen (China).
- Syphilis is common particularly among female sex workers in Shenzhen (China), who use condoms inconsistently, who have a history of illicit drug use, and who are in the age group of older than 30 years.
- No uptake of HIV-related services by female sex workers in Shenzhen (China) is found particularly among those aged younger than 30 years and among the new-comers to the city.
- In Shenzhen (China) men who have sex with men and women report similar HIV prevention behavior as men who have sex with men only, but more HIV risk behavior.
- HIV testing rates are equally low in money boys and other men who have sex with men in Shenzhen (China).
- Having multiple anal sex partners (money boys) and having homosexual orientation (other men who have sex with men) are the most important determinants of recent HIV testing in Shenzhen (China).
- Time-location sampling and respondent-driven sampling reach different segments of men who have sex with men in Shenzhen (China).
- Joint marketing is an innovative way to bring gatekeepers of gay venues and public health authorities together in reaching out effectively to men who have sex with men.

Recommendations

- China should prioritize the well-known high-risk groups for HIV and avoid diluting the effect of available resources for prevention of HIV by spreading these thinly over the whole population.
- China should initiate point-of-care outreach screening programs for early syphilis diagnosis among female sex workers, and such programs should be linked with timely treatment.
- Uptake of HIV-related intervention services in China should be advocated most intensively among female sex workers who are in the age of under 30 years and among those who are new-comers to Shenzhen (China).
- In China, HIV risk behavior among men who have sex with men and women needs to be reduced to prevent HIV transmission from men who have sex with men to the general heterosexual population.
- HIV testing promotion programs should convince money boys in China about their actual HIV risk and educate them about the importance of testing.
- Strong campaigns to reduce stigma about homosexuality are needed in China to encourage men who have sex with men to go for testing, especially those who have female partners.
- Time-location sampling and respondent-driven sampling should be used consistently when evaluating trends of HIV prevalence for surveillance.
- Public health authorities in China should motivate gatekeepers of gay venues for rolling out venue-based HIV-related intervention services.

Samenvatting

Het doel van dit proefschrift is om veelbelovende nieuwe wegen te identificeren om de seksuele overdracht van HIV in verschillende bevolkingsgroepen in China te beteugelen, d.w.z. de algemene bevolking, vrouwelijke sekswerkers en mannen die seks hebben met mannen (MSM). Dit proefschrift telt negen hoofdstukken, met zeven wetenschappelijke artikelen (Hoofdstukken 2-8), een algemene inleiding (Hoofdstuk 1) een een discussie (Hoofdstuk 9).

Hoofdstuk 1 geeft een algemene inleiding over de epidemiologie van HIV. Ook introduceren we de bevolkingsgroepen die epidemiologisch gezien een hoog risico lopen op HIV-besmetting en de belangrijkste gezondheidsdiensten in China die zich richten op HIV-infectie. Aan het eind van 2011 waren er 780.000 mensen met HIV/AIDS bekend in China. Nationale surveillance data laten zien dat het percentage nieuwe HIV-infecties dat toe te schrijven was aan seksuele overdracht (zowel heteroseksueel als homoseksueel) gestaag was toegenomen van 57% in 2007 tot 82% in 2011. Deze toename wordt vooral gezien voor homoseksuele overdracht, met een toename van 12% tot 29% over deze jaren. In dit proefschrift onderzoeken we riskant gedrag en preventiegedrag met betrekking tot HIV onder verschillende seksueel actieve groepen, te weten de algemene bevolking, vrouwelijke sekswerkers en mannen die seks hebben met mannen (MSM). Het veldonderzoek werd gedaan in in Shenzhen, Zuid-China. De volgende onderzoeksvragen werden geformuleerd:

1. Wat zijn de trends in riskant seksueel risicogedrag onder algemene heteroseksuele bevolkingsgroepen in China?
2. Wat zijn de patronen in riskant gedrag en preventiegedrag met betrekking tot HIV onder onder vrouwelijke sekswerkers in Shenzhen, China?
3. Wat zijn de patronen in riskant gedrag en preventiegedrag met betrekking tot HIV onder MSM in Shenzhen, China?
4. Hoe kunnen MSM het beste worden bereikt voor HIV-surveillance en interventies?

Hoofdstuk 2 beschrijft een systematisch literatuuronderzoek naar trends in riskant seksueel gedrag onder algemene heteroseksuele bevolkingsgroepen in China. De nadruk lag op vijf indicatoren van recent riskant seksueel gedrag, namelijk: 1) voorhuwelijkse seks, 2) commerciële seks, 3) meerdere sekspartners 4) condoomgebruik, 5) seksueel overdraagbare infecties. Dit onderzoek betrof 174 observationele studies (gepubliceerd in 1980-2012) naar bevolkingsgroepen die niet behoren tot de klassieke groepen met een hoog risico (d.w.z. migranten, universiteitsstudenten en overige groepen inclusief schoolverlaters, de plattelandsbevolking, en bezoekers van van gynecologische en verloskundige klinieken en voorhuwelijkse adviescentra). Met behulp van een generalized linear mixed model tonen we aan dat er in de afgelopen decennia geen stijgende trends zijn in het vertonen van riskant seksueel gedrag onder bepaalde algemene bevolkingsgroepen in China (Hoofdstuk 2).

De **hoofdstukken 3** and **4** gaan in op patronen in riskant gedrag en preventiegedrag met betrekking tot HIV onder vrouwelijke sekswerkers. Een syfilis-infectie diende als indicator van

riskant gedrag; het gebruikmaken van HIV-gerelateerde gezondheidsdiensten als indicator van preventiegedrag. Met gebruikmaking van uitgebreide surveillance data betreffende vrouwelijke sekswerkers tussen 2009 en 2012 in Shenzhen, China, onderzoeken we risicofactoren voor syfilis in Hoofdstuk 3. In interviews op basis van vragenlijsten werden de volgende gegevens verzameld van 1653 vrouwelijke sekswerkers die waren geworven via venue-based sampling: sociaal-demografische kenmerken, riskant seksueel gedrag, illegaal drugsgebruik en de uitslag van testen op syfilis. We vonden een algehele prevalentie van syfilis-infectie van ongeveer 5%, met een licht dalende trend. De volgende factoren bleken significant geassocieerd te zijn met syfilis-infectie: inconsistent condoomgebruik, illegaal drugsgebruik, en hogere leeftijd. De locatie waar de vrouwelijke sekswerkers waren geworven en de duur van de periode waarin ze commercieel sekswerk verrichtten waren niet significant geassocieerd met syfilis-infectie.

Hoofdstuk 4 gaat in op determinanten van het lage gebruik van HIV-gerelateerde gezondheidsdiensten door vrouwelijke sekswerkers in Shenzhen, China. We hielden interviews met 1656 vrouwelijke sekswerkers die waren geworven via venue-based sampling, en informeerden naar socio-demographics, gedrag en gebruik van HIV-gerelateerde gezondheidsdiensten en identificeerden determinanten van het niet gebruikmaken van testen op HIV, promotie van condoomgebruik, en voorlichting door lotgenoten. Het algehele gebruik van van testen op HIV, promotie van condoomgebruik, en voorlichting door lotgenoten door deze vrouwelijke sekswerkers bleeks respectievelijk slechts 21%, 48%, en 28% te zijn. Lagere leeftijd en kortere duur van het werken in Shenzhen waren statistisch significant geassocieerd met het niet gebruikmaken van alle drie aangeboden diensten. Het wel gebruikmaken van deze diensten was positief geassocieerd met consistent condoomgebruik en goede HIV-gerelateerde kennis.

Hoofdstuk 5 gaat in op patronen in riskant gedrag en preventiegedrag met betrekking tot HIV onder mannen die seks hebben met mannen en vrouwen (MSMW). Uit een respondent-driven sampling survey onder 107 MSMW in Shenzhen, China, hebben we het vóórkomen van HIV/syfilis gekwantificeerd en de patronen in riskant gedrag en preventiegedrag met betrekking tot HIV vastgesteld. Vervolgens zijn de uitkomsten vergeleken met die van 542 mannen die alleen sexuele omgang hebben met mannen (MSM-only). De volgende indicatoren voor riskant gedrag zijn onderzocht: 1) commerciële seks, 2) groepsseks, 3) meerdere sekspartners, 4) passieve of zowel passsieve als actieve rol bij anale seks, 5) illegaal drugsgebruik. Als indicator van HIV-preventiegedrag diende het gebruikmaken van HIV-gerelateerde gezondheidsdienstenservices en in het bijzonder het zich laten testen op HIV. Informatie over sociaal-demografische kenmerken, condoomgebruik met verschillende typen seksuele partners en riskant gedrag en preventiegedrag met betrekking tot HIV werden verzameld met behulp van een gestructureerde vragenlijst. Informatie betreffende HIV- en syfilis-infectie werd gehaald uit laboratoriumuitslagen. Wat betreft de indicatoren HIV-preventiegedrag en consistent condoomgebruik met mannelijke partners was er geen verschil tussen de twee groepen. Echter, riskant gedrag kwam meer voor onder MSMW dan onder MSM-only. Bovendien was de prevalentie van HIV onder MSMW niet minder dan 6% en was onder MSMW consistent condoomgebruik met vrouwelijke partners

bijzonder laag. De resultaten van dit onderzoek suggereren dat er een risico is op overdracht van HIV van MSMW naar de algemene heteroseksuele bevolking.

Hoofdstuk 6 gaat in op patronen in preventiegedrag met betrekking tot HIV onder zogenaamde money-boys (MBs) en andere MSM. Determinanten van het zich recent hebben laten testen op HIV zijn onderzocht en vergeleken onder 510 MBs en 533 andere MSM die waren geworven via time-location sampling in Shenzhen, China. Het zich recent hebben laten testen op HIV werd gedefinieerd als het zich hebben laten testen op HIV, volgens eigen opgave van deze mannen, in het afgelopen jaar. Bij beide groepen was dit betrekkelijk weinig het geval, namelijk 43% van de MBs en 48% van de andere MSM meldden dat ze waren getest op HIV in het afgelopen jaar. Determinanten onder MBs van wel zijn getest waren: meerdere anale en meer commerciële mannelijke partners; onder MSM: homoseksueel geaard, alleen mannelijke sekspartners en een eerder opgelopen seksueel overdraagbare infectie. Het hebben van onbeschermd anaal geslachtsverkeer was niet, en langer woonachtig zijn in Shenzhen was wel positief geassocieerd met zijn getest voor HIV, zowel onder MBs als andere MSM.

Hoofdstuk 7 gaat in op verschillen tussen twee methoden om MSM onder HIV surveillance te krijgen, te weten respondent-driven sampling (RDS), waarmee deelnemers worden verworven door eerdere deelnemers, en time-location sampling (TLS), gebaseerd op random selectie van venue-day-time periods. Omdat deze methoden representatieve steekproeven opleveren worden ze beschouwd als de beste methoden om 'verborgen' groepen zoals MSM te bereiken. In deze studie zijn de sociaaldemografische kenmerken, riskant gedrag en preventiegedrag met betrekking tot HIV, en de prevalentie van HIV-/syfilis-infectie vergeleken tussen 598 MSM verworven via RDS en 493 MSM verworven via TLS in Shenzhen, China in 2010. De prevalentie van HIV was vergelijkbaar tussen beide groepen. De TLS-methode leverde echter grotere proporties van cruciale subgroepen op dan de RDS-methode: MSM verworven via TLS waren ouder, lager geschoold en waren vaker migranten (zonder Shenzhen hukou registratie), niet-homoseksueel georienteerd en bezig met riskant seksueel gedrag. Overigen stonden deze MSM die waren verworven via TLS vaker onder toezicht van HIV-gerelateerde gezondheidsdiensten. Uit dit onderzoek blijkt dat beide sampling-methoden kunnen resulteren in deelname van omvangrijke en gediversifieerde groepen MSM en dat daarom beide geschikt zijn voor HIV-surveillance. Echter, aangezien de samenstelling van de samples verschilt tussen deze twee methoden, dienen onderzoekers en volksgezondheidsinstanties bij het evalueren van trends steeds dezelfde method toe te passen.

Hoofdstuk 8 beschrijft hoe in Shenzhen, China, een innovatieve interventiestrategie met gebruikmaking van 'joint marketing' werd uitgetest met MSM als doelgroep. De effectiviteit van deze strategie werd geëvalueerd door middel van het afnemen van een zelf-ontworpen vragenlijst betreffende HIV-kennis, condoomgebruik en toegang tot HIV-gerelateerde gezondheidsdiensten vóór en na de implementatie. Gedurende de één jaar durende interventieperiode steunde het Center for Disease Control and Prevention (CDC) in Shenzhen

de mensen in sleutelposities van de openbare gelegenheden die bezocht werden door MSM, waardoor deze 'gatekeepers' meer aanzien en inkomen verwierven. Als tegenprestatie werkten de gatekeepers samen met het CDC om de MSM gezondheidsvoorlichting te geven in de vorm van mededelingen en promotiemateriaal. Op deze manier werd door het samengaan van twee elkaar niet beconcurrerende partijen bij de pogingen een gezamenlijke 'cliënt' te bereiken, d.w.z. de MSM, een win-win situatie gecreëerd. De conclusie was dat met deze pilot-interventie de aanvaardbaarheid en uitvoerbaarheid was aangetoond van deze 'joint marketing' strategie. De HIV-gerelateerde kennis, het perecentage condoomgebruik en toegang tot HIVgerelateerde gezondheidsdiensten namen significant toe onder de deelnemers aan de pilot-interventie.

In **Hoofdstuk 9** presenteren en bespreken we de antwoorden op de onderzoeksvragen. We besteden ook aandacht aan de uitdagingen bij het implementeren van methadonbehandeling voor drugsverslaafden in China. Ten slotte presenteren we de volgende conclusies en aanbevelingen:

Conclusies

- Er is geen bewijs voor een toename van riskant seksueel gedrag in de afgelopen decennia onder bevolkingsgroepen in China die niet behoren de de klassieke groepen met een hoog risico.
- De prevalentie van syfilis onder vrouwelijke sexwerkers in Shenzhen (China) is licht afgenomen.
- Syfilis onder de vrouwelijke sekswerkers in Shenzhen (China) komt voornamelijk voor bij diegenen die niet consistent condoomgebruik van hun cliënten eisen, die een geschiedenis hebben van illegaal drugsgebruik, en die ouder zijn dan 30 jaar.
- De vrouwelijke sekswerkers in Shenzhen (China) die geen gebruik maken van HIV-gerelateerde gezondheidsdiensten zijn vooral zij die jonger zijn dan 30 jaar en recent naar de stad zijn gekomen.
- In Shenzhen (China) rapporteren mannen die seks hebben met mannen en vrouwen een soortgelijk preventiegedrag met betrekking tot HIV als mannen die seks hebben alleen met mannen, maar rapporteren echter meer riskant gedrag.
- De percentages 'money boys' en andere mannen die seks hebben met mannen die zich hebben laten testen op HIV in Shenzhen (China) zijn even laag.
- Anaal geslachtsverkeer met meerdere partners ('money boys') en een homoseksuele geaardheid (andere mannen die seks hebben met mannen) zijn de voornaamste determinanten van het zich recent hebben laten testen op HIV in Shenzhen (China).
- Time-location sampling en respondent-driven sampling leiden tot het bereiken van verschillende segmenten van de mannen die seks hebben met mannen in Shenzhen (China).
- Joint marketing is een innovatieve strategie waarbij de 'gatekeepers' van gay clubs en de gezondheidsdiensten gezamenlijk met succes de mannen die seks hebben met mannen kunnen bereiken.

Aanbevelingen

- In China zou men prioriteit moeten geven aan de welbekende groepen van de bevolking met een hoog risico op HIV, en niet door het verdelen van de beschikbare middelen voor de preventie van HIV over de gehele bevolking het effect daarvan te reduceren.
- In China zou men 'point-of-care' outreach screening-programma's moeten instellen voor een vroege diagnosis van syfilis onder vrouwelijke sekswerkers, en daaraan zou tijdige behandeling verbonden moeten zijn.
- De noodzaak om gebruik te maken van HIV-gerelateerde gezondheidsdiensten in China zou het intensiefst moeten worden gepropageerd onder vrouwelijke sekswerkers onder de leeftijd van 30 jaar en zij die zich zich recent hebben gevestigd in Shenzhen (China).
- In China zouden mannen die seks hebben met mannen en vrouwen minder riskant gedrag met betrekking tot HIV-infectie moeten vertonen teneinde de overdracht van HIV van mannen die seks hebben met mannen naar de algemene heteroseksuele bevolking te voorkomen.
- Programma's gericht op het propageren van het zich laten testen op HIV zouden 'money boys' in China moeten overtuigen van het werkelijke risico op HIV dat ze lopen en hen bijbrengen hoe belangrijk het testen is.
- Sterk aansprekende campagnes om de stigmatisering van homoseksualiteit te verminderen zijn nodig in China zodat mannen die seks hebben met mannen worden aangespoord zich te laten testen, vooral degenen die vrouwelijke partners hebben.
- Hetzij de time-location sampling methode hetzij de respondent-driven sampling method dient consistent gebruikt te worden bij het evalueren van trends in de prevalentie van HIV.
- De gezondheidheidsdiensten in China zouden er goed aan doen de 'gatekeepers' van gay clubs te motiveren in hun locaties HIV-gerelateerde interventies aan te bieden.

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Curriculum Vitae

Rui Cai was born on February 2nd, 1986 in Jilin, China. She obtained her Bachelor of Science in Medicine from Peking University Health Science Center, China in 2010. With support from the China Scholarship Council, she joined the Department of Public Health at the Erasmus MC, University Medical Center Rotterdam for a PhD program from 2010-2014. Here she conducted the research described in this thesis. She travelled regularly to Shenzhen, China, to design the studies together with the Chinese co-researchers, to assist in training the research staff, and to present the study findings in workshops. During her PhD period, she also obtained a Master of Science in Public Health at the Netherlands Institute of Health Sciences (NIHES) in Rotterdam in the academic year 2010-2012.

List of publications

Cai R, Richardus JH, Looman CWN, de Vlas SJ. Trends in high-risk sexual behaviors among general population groups in China. A systematic review. PLoS ONE 2013; 8: e79320.

Cai R, Tan JG, Chen L, Richardus JH, de Vlas SJ. Prevalence and risk factors of syphilis infection among female sex workers in Shenzhen, China: an observational study (2009-2012). Trop Med Int Health 2013; 18: 1531-8.

Cai R, Tan JG, Chen L, Looman CWN, Richardus JH, de Vlas SJ. Determinants of the low uptake of HIV-related services by female sex workers in Shenzhen, China: an observational study (2009-2012). (submitted)

Cai R, Zhao J, Cai WD, Chen L, Richardus JH, de Vlas SJ. HIV risk and prevention behaviors in men who have sex with men and women: a respondent-driven sampling study in Shenzhen, China. AIDS Behav 2014. (in press)

Cai R, Cai WD, Zhao J, Chen L, Richardus JH, de Vlas SJ. Determinants of recent HIV testing among male sex workers and other men who have sex with men in Shenzhen, China: a cross-sectional study. (submitted)

Zhao J, **Cai R**, Chen L, Cai WD, Yang ZR, Richardus JH, de Vlas SJ. A comparison between respondent-driven sampling and time-location sampling among men who have sex with men in Shenzhen, China. Arch Sex Behav; 2014 (in press)

Tan JG, **Cai R**, Lu ZX, Cheng JQ, de Vlas SJ, Richardus JH. Joint marketing as a framework for targeting men who have sex with men in China: a pilot intervention study. AIDS Educ Prev 2013; 25: 102-11.

PhD portfolio

Summary of PhD training

Name PhD student:	Rui Cai
Erasmus MC department:	Public Health
PhD period:	2010 – 2014
Promoter:	Prof.dr.J.H.Richardus
Supervisor:	Dr.S.J.de Vlas

	Period	Workload
Master of Public Health, Netherlands Institutes for Health Sciences (NIHES), Rotterdam, The Netherlands 2010-2012		
Erasmus Summer Program		
Principles of Research in Medicine	2011	20 hrs
Clinical Decision Analysis	2012	20 hrs
Methods of Clinical Research	2012	20 hrs
Methods of Public Health Research	2011	20 hrs
Topics in Meta-analysis	2012	20 hrs
Introduction to Public Health	2011	20 hrs
Methods of Health Service Research	2011	20 hrs
Primary and Secondary Prevention Research	2011	20 hrs
Social Epidemiology	2011	20 hrs
Logistic Regression	2012	40 hrs
Core Curriculum		
Study Design	2010	120 hrs
Classical Methods for Data-analysis	2010	160 hrs
Modern Statistical Methods	2010	120 hrs
Public Health Research Methods	2011	160 hrs
Public Health Research: Analysis of Population Health	2011	40 hrs
Public Health Research: Analysis of Determinants	2011	40 hrs
Public Health Research: Intervention Development and Evaluation	2011	40 hrs
International Comparison of Health Care Systems	2011	40 hrs
Site Visit to Municipal Health Service Rotterdam	2011	4 hrs
Integration module	2012	4 hrs
Advanced Short Courses		
Epidemiology of Infectious Diseases	2011	40 hrs
Courses for the Quantitative Researcher	2010	40 hrs
Planning and Evaluation of Screening	2011	40 hrs
Health Services: Research and Practice	2011	25 hrs
From Problem to Solution in Public Health	2011	30 hrs

	Period	Workload
Presentations		
Oral poster: Determinants of the low uptake of HIV-related services by female sex workers in Shenzhen, China: an observational study (2009-2012). 7th International AIDS Society Conference on HIV pathogenesis, treatment and prevention, Kuala Lumpur, Malaysia	2013	25 hrs
Poster: Determinants of recent HIV testing among male sex workers and other men who have sex with men in China. The 11th International Congress on AIDS in Asia and the Pacific. Bangkok, Thailand	2013	10 hrs
(Inter-)national conferences		
NTVG symposium, Utrecht, The Netherlands	2010	8 hrs
7th International AIDS Society Conference on HIV pathogenesis, treatment and prevention, Kuala Lumpur, Malaysia	2013	40 hrs
The 11th International Congress on AIDS in Asia and the Pacific. Bangkok, Thailand	2013	48 hrs
Teaching activities		
Involved in a three-day workshop of introduction of mathematical modeling in Shenzhen	2012	24 hrs
Involved in a one-week workshop of introduction of research methods of public health and infectious disease	2013	40 hrs
Involved in one-day course of the use of STDSIM for modeling HIV and ART	2014	8 hrs
Supervision of MSc student for six months	2014	52 hrs