HIV Risk among Men Who Have Sex with Men in a Large Chinese City

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In memory of my dearest mother, Bi Qing

and

to my beloved father, Zhang Jianqi,

for their endless love, unwavering support and encouragement!

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACASI   Audio computer-assisted self-interviewing
AIDS   Acquired immunodeficiency syndrome
AOR   Adjusted odds ratio
ART   Antiretroviral treatment
CASI   Computer-Assisted Self-administered Interview
CBO   Community-based organizations
CDC   Center for Disease Control and Prevention
CI   Confidence interval
CFA   Confirmatory factor analysis
eHealth   Electronic health
ELISA   Enzyme-linked immunosorbent assay
FSW   Female sex workers
HIV   Human immunodeficiency virus
HPV   Human papillomavirus
HSV   Herpes simplex virus
IDU   Injection drug users
IQR   Interquartile range
IRB   Institutional review board
ITT   Intent-to-treat
MARP   Most at-risk population
MSM   Men who have sex with men
NGO   Non-government organizations
PrEP   Pre-exposure prophylaxis
PLWH   People living with HIV
PWID   People who inject drugs
RCT   Randomized controlled trial
RDS   Respondent driven sampling
RDSAT   Respondent-driven sampling analysis tool
RPR   Rapid plasma reagin
STD   Sexually transmitted disease
STI   Sexually transmitted infection
TPPA   *Treponema pallidum* particle assay
UAI   Unprotected anal intercourse
UOI   Unprotected oral intercourse
URAI   Unprotected receptive anal intercourse
VCT   Voluntary counseling and testing

Introduction

Thirty years after the first discovery of AIDS among MSM in the United States, the global number of people infected with HIV in 2012 has reached 35.3 million (estimated range: 32.2 million-38.8 million) (Centers for Disease Control and Prevention (CDC), 1981; UNAIDS, 2013). HIV is a human retrovirus in the lentivirus family that attacks and destroys the human immune system and eventually causes AIDS, the last stage of HIV infection, characterized by a seriously weakened immune system with destruction of CD4+ T-lymphocytes and a high risk for opportunistic infection and malignancy (Peterman, Drotman, & Curran, 1985). MSM represent one of the key populations that have been disproportionately affected by HIV infection for nearly three decades (Centers for Disease Control and Prevention (CDC), 1981; UNAIDS, 2012). The global HIV prevalence among MSM ranged from 3.0% to 25% in surveys as of 2011, far higher than the general adult population across all countries surveyed (Beyrer et al., 2012).

MSM are males who engage in sexual activities with other males regardless of their gender identity (male, female, transgender, queer) and self-identified sexual orientation (homosexual, gay, bisexual or heterosexual) (UNAIDS, 2006, 2009). This term "MSM" is widely used in the public health and research field to address the behaviors in terms of disease risk rather than social identification since one's sexual orientation or gender identity may not reflect true behaviors (Centers for Disease Control and Prevention (CDC), 2012). The probability of HIV acquisition risk per homosexual contact (1.4%) is estimated to be 18-fold higher compared to the risk per heterosexual contact (0.08%) without any treatments (Beyrer, et al., 2012; Boily et al., 2009).

The global HIV epidemic among MSM has been expanding from continent to continent. In recent years, the epidemic continues at high levels and sometimes is even increasing in the

1

proportion of the total cases in high-income countries (such as USA, Australia, UK, Netherland and Canada) and in South America (such as Peru and Brazil), where MSM already represented the preponderant key population affected by HIV (Beyrer et al., 2010; Morris & Little, 2011; Sullivan et al., 2009). MSM emerging epidemics have been identified in Asia (van Griensven & de Lind van Wijngaarden, 2010), Africa (McIntyre, 2010) and Eastern Europe (Bridge, Lazarus, & Atun, 2010), where PWID or heterosexuals may predominantly drive local epidemics (Beyrer, et al., 2010). In addition, the rapidly rising co-infection rates with other STIs such as syphilis among MSM in many venues accelerated the HIV infection and transmission (Mayer et al., 2012; Tucker et al., 2010). Due to the hidden nature of this population, population sampling techniques become a universal methodological challenge in better understanding the HIV epidemic in MSM population (Beyrer, et al., 2012).

China has a long history of open and hidden homosexuality and the Chinese society has embraced various norms and attitudes towards it in different eras. Early sources suggested a tolerant coexistence of male homosexuality with traditional family ethics in ancient China, but this evolved subsequently to officially proscription of homosexuality, declaring it illegal in the eighteen century (1740) (Wah-Shan, 2001; Zhang, Li, Li, & Beck, 1999). By 1997, homosexuality was deemed legal again and after the mid-1980s has been more tolerated in the society despite continued stigmatization and discrimination (Choi et al., 2003; Kang, 2009; Kong, 2010; Lau, Choi, Tsui, & Su, 2007). Today MSM are still a marginalized population in China in contrast to the dominant monogamous heterosexual marriage norm in the country (Kong, 2010; Liu et al., 2006).

The HIV epidemic among Chinese MSM was not well appreciated until the early 21st century, and the incidence trends have increased markedly since 2005 (Choi, et al., 2003; State

Council AIDS Working Committee Office China, 2012; Zhang, Liu, Li, & Hu, 2000). In mainland China, the estimated number of MSM were 4.1 million (estimated range: 2.7-5.4 million) in 2009 (a total population of 1.33 billion in the same year) (The World Bank, 2013; www.aidsdatahub.org, 2013). By the end of 2011, MSM made up 17% of the estimated 780,000 PLWH, less than cases infected through heterosexual (47%) and injecting drug transmission (28%) (State Council AIDS Working Committee Office China, 2012). However, MSM accounted for 29.4% of the annual new infections of 48,000 persons, surpassing PWID (18.0%) (State Council AIDS Working Committee Office China, 2012). Furthermore, it is assumed that many heterosexual men are misclassified as such, due to social response bias in data collection; some heterosexuals were infected with illicit reinfusion of red blood cells after illegal harvesting of blood for the commercial market (State Council AIDS Working Committee Office UN Theme Group on AIDS in China, 2007). Most worrisome is that the national HIV prevalence in MSM (6.3% in 2011, 5.2% among youth MSM) exceeded that in PWID (4.0%) in 2011, who had long been the most affected key population since the onset of the Chinese HIV epidemic other than former plasma donors infected in limited time period over a decade ago (State Council AIDS Working Committee Office China, 2012; Sun, Nan, & Guo, 1994); the HIV prevalence also grew exponentially, nearly a 6-fold increase from 2001 (Chow, Wilson, Zhang, Jing, & Zhang, 2011). In addition, the average HIV incidence among MSM was estimated to be 3.5 per 100 person-years between 2005 to 2010 (Li et al., 2011). Geographically, HIV prevalence is generally higher and increasing more rapidly in the southwestern region, from 4.3% in 2004-2006 to 11.4% in 2007-2009, than in other parts of China where the prevalence was <5.0% (and even ≤1.0%) during the same time period (Chow, Wilson, Zhang, et al., 2011). Cities like Guiyang in Guizhou

Province, Kunming and Chengdu in Sichuan Province, and Chongqing City in this region usually had an HIV prevalence of >10% (Chow, Wilson, Zhang, et al., 2011; Wu et al., 2013).

The syphilis epidemic among Chinese MSM has also been increasing for the past 10 years (Chow, Wilson, Zhang, et al., 2011). The syphilis prevalence often positively correlated with HIV infection rates in most provinces except Chongqing Municipality and Yunnan Province where HIV prevalence is higher than syphilis (Luo et al., 2012; Wu, et al., 2013; Xiao et al., 2009). The national syphilis prevalence among Chinese MSM was 8.4% in 2011 (State Council AIDS Working Committee Office China, 2012). A 2009 natioanl survey in 61 cities showed that syphilis prevalence was higher in syphilis-positive MSM (12.5%), MSM aged 50–69 years (23.2%), and in North and northeast regions and some coastal cities in the east region (>15%) (Wu, et al., 2013). .

Our knowledge of accurate epidemiological characteristics of the Chinese MSM population is scant despite the rising HIV epidemic in Chinese MSM. Thus far, very few targeted interventions have been developed (Hong & Li, 2009; Liu, et al., 2006). Under this overarching theme of the rising HIV epidemic among Chinese MSM, I focused my research on the infections and risks among MSM in Chongqing City, a huge urban center with a high background HIV prevalence. I sought to address key gaps in knowledge relevant to the field of MSM-targeted HIV prevention in China.

Chongqing City, located in southwestern China, became the fourth municipality (cities directly-controlled by the central government; the other three are Beijing, Tianjin, and Shanghai) in 1997 (Chongqing Municipal Goverment, 2007b). It has now developed into a modernized economy center upon the upper Yangtze River and a hub connecting China's west and eastern coast with strong ties in commerce to the rest of the world (Chongqing Municipal Goverment,

2007b). The city is also a hotspot for the MSM community which is seriously affected by HIV (Wu, et al., 2013; Zhang, Chen, et al., 2012). HIV prevalence among local MSM increased rapidly from merely 0.5% in 2004 to an alarmingly 16.6% in 2009, although nearly 72% of the estimated MSM population had received simple interventions through the China Global Fund AIDS Program in the past six years or so (Feng et al., 2009; Wu, et al., 2013). The estimated annual incidence was 8.3 per 100 person-years between 2006 and 2008 while that of an aggregation of all other Chinese cities was 4.6 per 100 person-years between 2005 and 2010 (Li, et al., 2011). The syphilis prevalence among local MSM continued to rise from 8.9% in 2006 to 12.3% in 2009 as well (Zhang, Chen, et al., 2012).

From 2009 to 2011, three consecutive cross-sectional surveys were carried out among MSM population in Chongqing City aimed at evaluating changes of HIV prevalence and risk behaviors in the MSM population over time. Individuals were eligible if they were men 18 years or older, living and/or working in Chongqing at the time of survey, had self-reported oral/anal sex or mutual masturbation with another man during the past 12 months, and was willing to provide written informed consent. Study participants were recruited using a RDS approach (Heckathorn, 1997, 2002). RDS is considered as a rigorous recruitment approach for accessing members of hard-to-reach hidden populations characterized by persons having strong privacy concerns within a context of illegal and/or stigmatized activities (Johnston & Sabin, 2010; White et al., 2012). MSM are recognized as one of such populations with different levels of structure in their social networks in different communities (Abu-Raddad et al., 2010; Berg, 2009; Caceres, 2002; Malta et al., 2010; Smith, Tapsoba, Peshu, Sanders, & Jaffe, 2009; Wolitski & Fenton, 2011). Hidden populations do not enable an investigator to establish a true sampling frame which renders the traditional probability sample methods infeasible (Heckathorn, 1997, 2002;

Malekinejad et al., 2008). RDS is built upon a novel recruitment process based on two mathematical theories: first-order Markov chain theory and biased network theory (Heckathorn, 1997). It involves a chain referral sampling process beginning with a few purposefully selected "seeds"; the "seeds" are then given a fixed number of unique coupons (representing their "recruitment quota") to recruit their peers; the referred peers subsequently recruit another round of their peers in the same way until the anticipated sample size is reached (Heckathorn, 1997, 2002). "Seeds" and the respondents are usually given a limited set of coupons (3-4) for referral in order to encourage longer referral chains that allow more hidden individuals to be reached and thus to produce a more externally valid sample (Heckathorn, 2007; Magnani, Sabin, Saidel, & Heckathorn, 2005). Meanwhile, the relationship between recruiters and recruits is documented so that recruitment biases can be assessed and adjusted for in the analysis, making the final sample composition independent of the initial subjects (Heckathorn, 2002; Volz & Heckathorn, 2008). Information on the personal network size of each respondent is also collected to allow weighted analysis to compensate for the oversampling of respondents with larger social networks (Heckathorn, 1997, 2002). After a sufficient number of rounds of recruitment, the sample tends to reach "equilibrium" on selected key variables, i.e., the sample composition becomes stable on certain estimates independent of the initial seeds (Heckathorn, 1997, 2002). A positive feature of RDS is that there is a dual-incentive for both the eligible recruit and recruiter; there is no need to reveal participants' identifications to the investigators until the subject is actually recruited (Heckathorn, 1997). The ability to adjust for oversampling of subjects with large personal networks distinguishes RDS from snowball sampling which is believed to generate more biased convenience samples (Heckathorn, 1997, 2002).

Accurate application of the RDS method requires fulfillment of five assumptions: 1) the individuals in the social network are connected with each other through a pattern; 2) the individuals in the social network are randomly recruited; 3) sampling is done with replacement; 4) personal network sizes are accurately reported; 5) each respondent recruits a limited number of peers (Heckathorn, 2011). Promising results were reported from various hidden populations such as MSM, PWID, and FSW in over 29 countries such that RDS seemed produce unbiased sample of the hidden populations if all the assumptions were met and the procedures were correctly implemented (Goel & Salganik, 2010; Malekinejad, et al., 2008; McCreesh et al., 2012).

In our study, referred peers first filled out a short form for eligibility screening. If eligible and informed consent provided, participants completed a CASI in a private room on demographics, sexual behaviors, psychosocial behaviors, HIV testing history, alcohol and drug use, programmatic information, and sexual health. Venous blood samples were drawn for HIV-1 antibody and syphilis tests following standardized protocols for a screening test, confirmation of positives, and ongoing laboratory quality assurance (Jiang et al., 2010). Pre- and post-test HIV counseling were provided. HIV-negative individuals were referred to local health providers as needed. HIV-positive persons were evaluated by Chongqing CDC staff for eligibility of enrollment into sponsored ART programs. Syphilis-positive individuals were facilitated for referral to an STD clinic in Chongqing CDC or to a local hospital, if more convenient for the person. Each participant was compensated with 30 Chinese *Yuan* (≈US $4.50) for his participation in the study and an additional 20 Chinese *Yuan* (≈US $3.00) for referral of one eligible MSM who subsequently completed the study interview.

In this dissertation, I conducted secondary data analyses of the 2009 and 2010 surveys. The 2011 survey only had 78% of the planned 500 individuals recruited and was excluded due to

suboptimal representativeness.

In my first paper, I examined the current HIV testing situation among MSM in Chongqing City. Despite the fact that the proportion of MSM receiving HIV testing continuously increased from an estimated 19.1% in 2006 to 34.5% in 2009 in Chongqing City (Zhang, Chen, et al., 2012), testing rates are still low compared to some metropolitan cities in developed countries. For instance, 90% of MSM tested in 21 cities in the United States and 80.5% MSM tested in Australia (Finlayson et al., 2011; Lyons et al., 2012). In order to explore the reasons behind comparatively low testing rates among MSM in Chongqing, I analyzed risk factors for HIV testing using logistic regression model and described the barriers as well as the facilitators for taking HIV test.

In paper two, I identified the HIV and syphilis infection status and predictors for HIV infection for men in the 2009 and 2010 surveys. It was reported that only 35% of MSM in Chongqing City used condom consistently during anal sex with male partners from 2006 to 2009 (Zhang, Chen, et al., 2012). I was interested especially to see whether low condom use and selected partner characteristics predicted infection. To find out potential key factors for high HIV prevalence in Chongqing, I analyzed data from the two years' surveys with a logistic regression model, focused on these aforementioned aspects, as well as other risk factors likely to increase HIV risk.

College students composed a surprisingly large proportion of the MSM population in some metropolitan cities and little is known about this sub-group (Ouyang et al., 2009; Zhong et al., 2011). Hence, in my third paper, I studied the magnitude of HIV and syphilis prevalence in two subgroups: student and non-student MSM. I speculated that students might have lower risks of HIV infection than non-student MSM because students attained higher education and could be

more aware of taking HIV tests and engaging in safe sex. I used logistic regression model to compare the difference of the disease prevalence between these two groups and the correlated predictors. Upon completion of my analysis and publication of my paper, I realized that non-students could be college graduates or non-college graduates and should not be merged together So I conducted comparisons between students, non-college graduate non-students, and college graduate non-students and integrated the results here in my dissertation.

Finally in my fourth paper, I wished to explore a promising avenue of potential intervention for risk reduction about Chinese MSM, and I reviewed the efficacy of the Internet-based behavioral interventions to reduce HIV transmission. The use of the Internet represents a new strategy that may improve outreach to the marginalized population like MSM. The Internet has gradually become a popular and important vehicle to deliver health promotion in the digital era but its effectiveness is yet to be determined (Ybarra & Bull, 2007). A few behavioral interventions have been conducted in MSM via the Internet with various outcomes and inconsistent results (Bowen, Horvath, & Williams, 2007; Chiasson, Shaw, Humberstone, Hirshfield, & Hartel, 2009; Rhodes et al., 2011). Review of its effectiveness could provide scientific evidence for future development of interventions and public health programs among Chinese MSM, nearly half of whom log onto the Internet to seek sexual partners and became involved in other activities (Guo, Li, & Stanton, 2011). I systematically reviewed current randomized clinical trials and rigorously designed quasi-experimental studies of the Internet-based interventions for HIV prevention among MSM.

My dissertation is designed to better understand the risk factors for failing to test for HIV (paper 1) and for acquiring HIV (paper 2) among Chongqing MSM. I also probed issues of HIV risks among Chinese student MSM compared to college graduates, and non-students without

college degree (paper 3). Finally, I systematically reviewed Internet-based interventions that have sought to help reduce high risk behaviors among MSM (paper 4). The overall goal is to provide scientific evidence to reverse the rise of HIV among MSM in China.

Predictors of HIV Testing among Men Who Have Sex with Men in a Large Chinese City

Abstract

Background: HIV testing is the gateway for prevention and care. We explored factors associated with HIV testing among Chinese MSM.

Methods: In Chongqing City, we recruited 492 MSM in 2010 using respondent driven sampling in a cross-sectional study. Computer-assisted self-interviews were conducted to collect information on history of HIV testing.

Results: Only 58% of participants reported ever having taken an HIV test. MSM who had a college degree (aOR: 1.7; 95% CI: 1.2-2.6; *P*=0.008) were more likely to take a test; those who preferred a receptive role in anal sex were less likely to do so than those with insertive sex preference (aOR: 0.6; 95% CI: 0.35-0.94; *P*=0.03); those who used condoms with the recent male partner during the past 6 months were more likely to get tested (aOR: 2.87; 95%CI: 1.25-6.62; *P*=0.01). Principal perceived <u>barriers to testing</u> included: fear of knowing a positive result, fear of discrimination if tested positive, low perceived risk of HIV infection, and not knowing where to take a test. Factors reported to <u>facilitate testing</u> were sympathetic attitudes from health staff and guaranteed confidentiality. Prevalence was high: 11.7% HIV-positive and 4.7% syphilis positive.

Conclusion: The HIV testing rate among MSM in Chongqing is still low, though MSM prevalence is high compared to other Chinese cities. MSM preferring receptive anal sex are less likely to get testing and perceive having lower HIV risk. Along with expanded education and social marketing, a welcoming and non-judgmental environment for HIV testing is needed.

Introduction

HIV testing is an entry point both for HIV prevention and care (UNAIDS, 2010a). Early detection of HIV not only reduces the chance of transmitting the virus to uninfected individuals, but also enables timely treatment to reduce mortality and morbidity (Thompson et al., 2010). HIV testing is also the backbone of combination HIV prevention highlighting testing and linkage to care (Kurth, Celum, Baeten, Vermund, & Wasserheit, 2011). The UNAIDS strategy 2011-2015 proposed to reduce HIV sexual transmissions by half among MSM and to offer universal access to combination antiretroviral therapy (cART) for eligible people living with HIV by 2015 (UNAIDS, 2010a). These goals are achievable only if a high proportion of at-risk persons go for periodic HIV testing to know their status.

The Chinese government has implemented free HIV testing in HIV VCT clinics under the "Four Frees and One Care" policy since 2003 (Ministry of Health of the People's Republic of China, 2010). By the end of 2009, 7335 VCT clinics had been established with at least 1 or 2 per county, of which 43.4% were in local CDC venues, 26.1% in general hospitals (including Traditional Chinese Medicine Hospitals), 14.8% in township health centers, and 15.7% elsewhere (Ministry of Health of the People's Republic of China, 2010). Despite the efforts made by the government to facilitate universal access to HIV testing, 56% of an estimated 780,000 individuals living with HIV/AIDS in mainland China did not know their status at the end of 2011 (Ministry of Health of the People's Republic of China, 2012). National sentinel surveillance data

12

have suggested that MSM have now become one of the subgroups at highest risk for HIV in China, as is the case worldwide (Beyrer, et al., 2012; Beyrer et al., 2011). The national average prevalence of HIV infection among MSM in the sentinel sites surpassed that among intravenous drug users for the first time in 2010 (Ministry of Health of the People's Republic of China, 2012). Moreover, approximately 17% of MSM in China are currently married and 26% of MSM had female sexual partners in the last six months; unawareness of their HIV status could increase risk of MSM to both men and women (Chow, Wilson, & Zhang, 2011b).

Chongqing City, located in southwestern China, is among the world's largest cities. In Chongqing, HIV incidence rate among MSM was nearly twice that in other Chinese cities (8.3% vs. 4.6%) while the average testing rate in 2009 was only 34.5% (Li, et al., 2011; Zhang, Chen, et al., 2012). Our study aimed to assess the history of and the barriers to HIV testing among MSM in Chongqing City, with the goal of providing guidance for design of future interventions.

Materials and Methods

Study design and procedures

We conducted the study between September and December 2010 in Chongqing City, China. This was the second round of cross-sectional surveys following the first survey in 2009. The original aim of the serial cross-sectional surveys was to evaluate the change of HIV prevalence and risk behaviors in the MSM population over time. The study procedures and sampling strategies were described in detail elsewhere (Zhang, Ding, et al., 2012). In brief, participants were recruited using a RDS approach (Heckathorn, 1997). Six MSM were selected as initial seeds by several local gay-friendly CBO: three recruited from gay websites by *Lan Yu*,

Hua Yang Nian Hua Tong Xin and *Yang Guan Volunteer Groups*; two recruited from bars by *Cai Hong* and *Zhi Ai Volunteer Groups*; and one from brothel by *Lan Tian Volunteer Group*. They were chosen through focus group discussion, taking into consideration their demographic characteristics and sub-group memberships, active social networks, and motivation to recruit peers. Each seed and each of his referred peers was allowed to recruit up to 3 participants. All referred participants had to be a member of the recruiter's social network and meet the eligibility criteria for the study. Participants were compensated with 30 Chinese *Yuan* (≈US $4.5) for their participation in the study and an additional 20 Chinese *Yuan* (≈US $3.0) for those who successfully recruited eligible MSM who subsequently completed the study interview. Eligible participants (≥ 18 years old) completed a CASI on their history of receiving HIV testing, barriers and facilitators for taking a test, and, when applicable, reasons for not taking one. For the perceived barriers, all the participants were asked "In your opinion, what prevents a gay man from having an HIV test?"; to probe for reasons (barriers) for not taking a test, men who never took a test were asked "Why have you never tested for HIV?" Venous blood samples were collected to test for HIV and syphilis. All eligible persons expressing interest and providing written consent were enrolled in the study. The study protocol was reviewed and approved by the institutional review boards of the National Center for AIDS/STD Control and Prevention, China CDC, University of California, San Francisco, and Vanderbilt University.

Laboratory tests

Venous blood specimens were first screened for HIV-1 using a rapid test (Determine HIV-1/2™, Inverness Medical Japan Co., Ltd, Tokyo, Japan) at the study site and the result was given to the participant immediately after the interview, with counseling as to its meaning. All

samples were then sent to laboratories in Chongqing CDC for testing using ELISA (Vironostika HIV Uni-Form plus O™, bioMérieux Shanghai Company Ltd., Shanghai, China). Positive samples were confirmed by Western Blot for HIV-1 (HIV Blot 2.2 WBTM™, Genelabs Diagnostics, Singapore). Only the ELISA and Western blot positive tests were deemed seropositive. Syphilis antibody testing used the TPPA (InTec Products, Inc., Xiamen, China).

Statistical methods

We examined correlates of prior HIV testing among MSM who participated in the cross-sectional survey in 2010. The six seeds were excluded in all analyses as they were not recruited by peers (Volz & Heckathorn, 2008). Descriptive analyses of HIV and syphilis prevalence and characteristics of social demographics and sexual behaviors were conducted using RDSAT software (V 5.6.0™; www.respondentdrivensampling.org), which adjusted for personal social network size and patterns of recruitment (Heckathorn, 1997). Such adjustments compensate for potential bias arising from different personal social network sizes and respondents' homophily (recruitment of participants often occurs within certain groups) (Heckathorn, 1997). Univariate and multivariate logistic regression analyses were performed using RDSAT-generated individual weights for prior HIV testing (outcome variable). Variables significantly associated with prior HIV testing at the level of $P<0.1$ in the univariate analyses were included in the multivariate logistic regression model, calculating aOR and 95% CIs. Statistical analyses were carried out using STATA/SE V11.2™ (StataCorp LP, College Station, Texas, USA).

Results

Socio-demographic characteristics of study participants

Among the 492 respondents, 16 individuals (3.3%, 16/492) had enrolled in the 2009 survey. Of these 16, three individuals had been tested only once, all during the 2009 survey; the other 13 had been tested more than once. Since none of these 16 individuals tested HIV positive in the 2010 survey, we included them in the calculation of the HIV testing rate.

Of the 492 participants, 87% were never married and 98% were of Han ethnic origin. The median age was 24 years old (IQR: 21-28, range: 18-65); 78% were registered residents in Chongqing City. No income was reported by 29% and 45% were not enrolled in any health insurance plan. A quarter (25.2%) were students, of whom 88% were currently enrolled in college. The median age of having their first sex with a man was 20 years old (IQR: 18-23). More than one male sex partner in the past six months was reported by 56%, 18% of participants were currently living with a male sexual partner, and 40% had ever had sex with women. Two-thirds self-reported as preferring homosexual relations. Of 485 MSM (98.6%) who ever had anal sex, 33% preferred an insertive role, 30% preferred a receptive role, and 37% preferred both. Only half (51%) of participants perceived a high risk of getting HIV through homosexual contact. Among 477 MSM who had a recent male partner in the past six months, 94% of them (444/474) used condoms during anal sex, and 19% (89/474) always used condoms. (Table 1)

The adjusted HIV and syphilis prevalence rates were 11.7% (95% CI: 8.6%-11.6%) and 4.7% (95% CI: 2.6%-7.3%), respectively.

Table 1. Univariate and multivariate analysis of the association between selected characteristics and prior HIV testing behavior in 492 men who have sex with men in Chongqing City, China, 2010

Variables	Number of participants N=492	Never tested N=205 (%)	Ever tested N=287 (%)	Crude Odds Ratio (95%CI)	P-value	Adjusted Odds Ratio (95%CI)	P-value
Median age in years (IQR)	24 (21-28)	23 (20-28)	24 (22-28)	1.03 (0.99-1.06)	0.1		
Ethnicity					0.2		
Han majority	480	198 (41.2)	282 (58.8)	1.00			
Minorities	12	7 (58.3)	5 (41.7)	0.45 (0.14-1.48)			
Education					0.004		0.008
High school or below	168	85(50.6)	83 (49.4)	1.00		1.00	
College or above	324	120(37.0)	204 (63.0)	1.76 (1.19-2.59)		1.74 (1.16-2.62)	
Marital status					0.8		
Single	429	176 (41.0)	253 (59.0)	1.00			
Ever Married	63	29 (46.0)	34 (54.0)	1.07 (0.62-1.86)			
Having a cohabiting partner					0.03		0.06
male sexual partner	90	28 (31.1)	62 (68.9)	1.00		1.00	
female sexual partner or living alone	402	177 (44.0)	225 (56.0)	0.57 (0.35-0.94)		0.61 (0.36-1.01)	
Occupation					0.2		
Student	124	57 (46.0)	67 (54.0)	1.00			
Non-student	368	148 (40.2)	220 (59.8)	1.36 (0.90-2.05)			
Chongqing *Hu Kou* or registered residence					0.8		
No	107	47 (43.9)	60 (56.1)	1.00			
Yes	385	158 (41.0)	227 (59.0)	1.06 (0.68-1.65)			
Having a health insurance plan					0.8		
No	224	96 (42.9)	128 (57.1)	1.00			
Yes	268	109 (40.7)	159 (59.3)	1.05 (0.72-1.51)			
Ever having sex with a woman					0.6		
No	294	122 (41.5)	172 (58.5)	1.00			
Yes	198	83 (41.9)	115(58.1)	1.10 (0.76-1.60)			
Age at first sex with a man (median, IQR) (year)	20	20 (18-23)	20 (18-22)	0.98 (0.94-1.02)	0.2		
Self-reported sexual orientation					0.2		
Homosexual	331	130 (39.3)	201 (60.7)	1.00			
Bisexual	161	75 (46.6)	86 (53.4)	0.78 (0.53-1.15)			
Preferred role in anal sex[*]							
Insertive	162	55 (34.0)	107 (66.0)	1.00		1.00	
Almost equally	180	79 (43.9)	101 (56.1)	0.62 (0.40-0.97)	0.04	0.78 (0.49-1.26)	0.3
Receptive	143	67 (46.9)	76 (53.1)	0.55 (0.34-0.88)	0.01	0.58 (0.35-0.94)	0.03
Number of male partners in the past 6 months					0.1		
≤1	219	82 (37.4)	137(62.6)	1.00			
>1	273	123 (45.1)	150 (54.9)	0.74 (0.51-1.07)			
Ever exchanging sex for money with a male partner in the past 6 months					0.1		
No	479	197 (41.1)	282 (58.9)	1.00			
Yes	13	8 (61.5)	5 (38.5)	0.38 (0.12-1.23)			
Number of female partners in the past 6 months					0.8		
0	436	181 (41.3)	256 (58.7)	1.00			
≥1	56	25 (44.6)	31 (55.4)	0.94 (0.53-1.68)			
Condom use with the recent male partner during the past 6 months[§]							0.01
No	30	20 (66.7)	10 (33.3)	1.00		1.00	
Yes	444	176 (39.6)	268 (60.4)	3.05 (1.37-6.81)	0.007	2.87 (1.25-6.62)	
Self-perceived HIV risk via homosexual contacts					0.07		0.08
Moderate or none	243	92 (37.9)	151 (62.1)	1.00		1.00	
Great	248	112 (45.2)	136 (54.8)	0.71 (0.49-1.03)		0.71 (0.48-1.04)	

[*]7 men reported oral sex or masturbation only; [§]474 men reported having anal sex with the recent male partner during the past 6 months

Barriers and facilitators for HIV testing

Perceived barriers for taking an HIV test were assessed in 492 participants regardless of whether or not they had a history of HIV testing. The top four reasons for perceived barriers to HIV testing were psychological, including fear of knowing a positive result (78.7%), fear of discrimination with HIV positivity (76.7%), unwillingness of going to an HIV clinic (67.5%), and concern about meeting acquaintances at testing (67.1%). The response rates were similar between those who had and those who did not have a prior HIV testing for these four barriers. A structural barrier often mentioned was that persons did not know where to get tested; those who had not had prior testing (63%) were more likely to mention this reason than those who had (49%, P=0.001). (Figure 1)

Facilitating factors for HIV testing in the 492 MSM were a more sympathetic attitude from health staff (98.8%), guaranteed confidentiality (98.8%), a free or low cost test (98.2%), higher HIV/AIDS knowledge (98.0%), advice from a doctor/nurse (97.8%), anonymity (96.3%), including testing in a standard public health or medical visit (95.5%), availability of medicine for AIDS treatment (94.3%), no discrimination against AIDS in the community (94.1%), and the fact that other MSM had gone for testing (87.8%).

Never having had an HIV test was reported by 205 participants (42%), of whom 203 (99%) reported the actual reasons why they did not do so. The top five reasons were: no perceived HIV risk, not knowing where to get a test, fear of having a positive result, concern about the reporting of a positive result to the government, and having no free time to get tested (Figure 2).
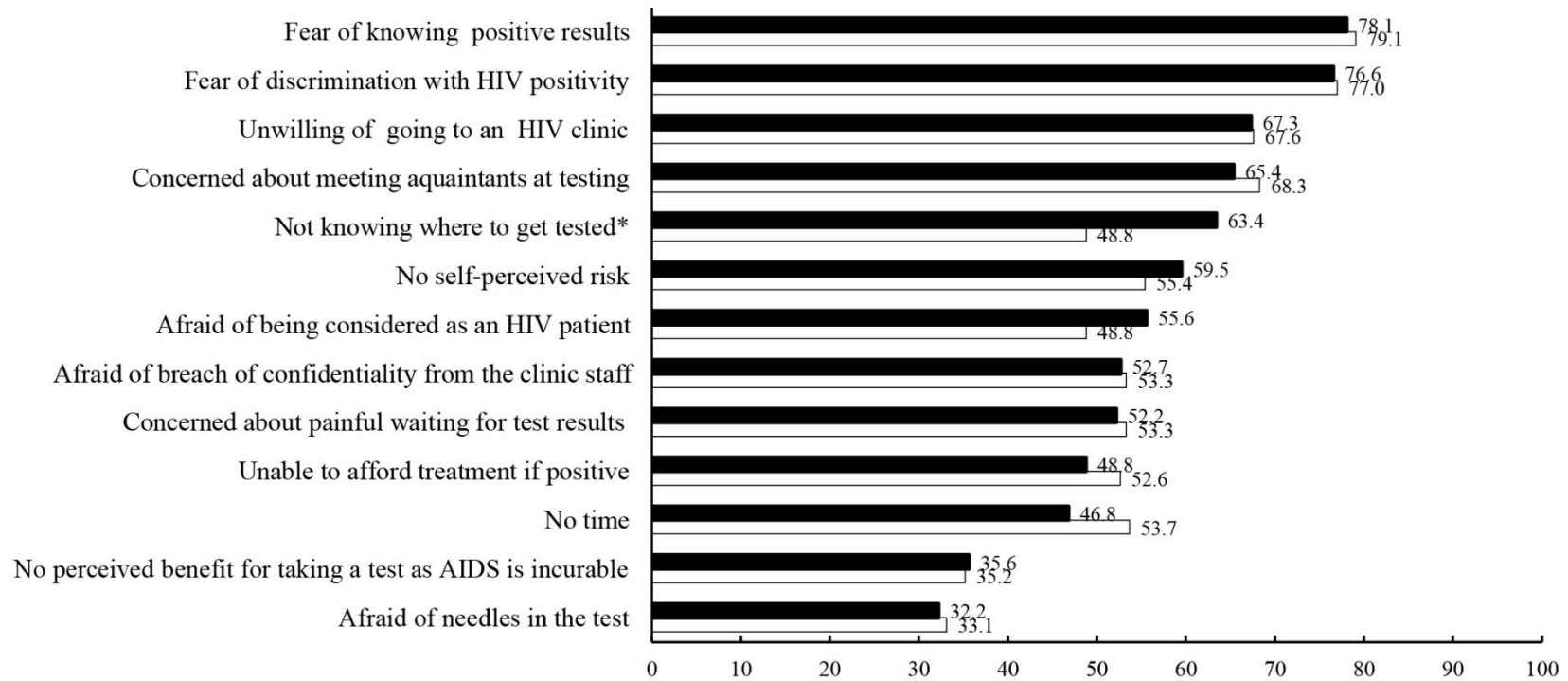
Figure 1. Perceived barriers for taking an HIV test by prior HIV testing experience among 492 MSM, Chongqing, China, 2010
(■ MSM who never took HIV testing; □ MSM who ever took HIV testing; *P<0.05)
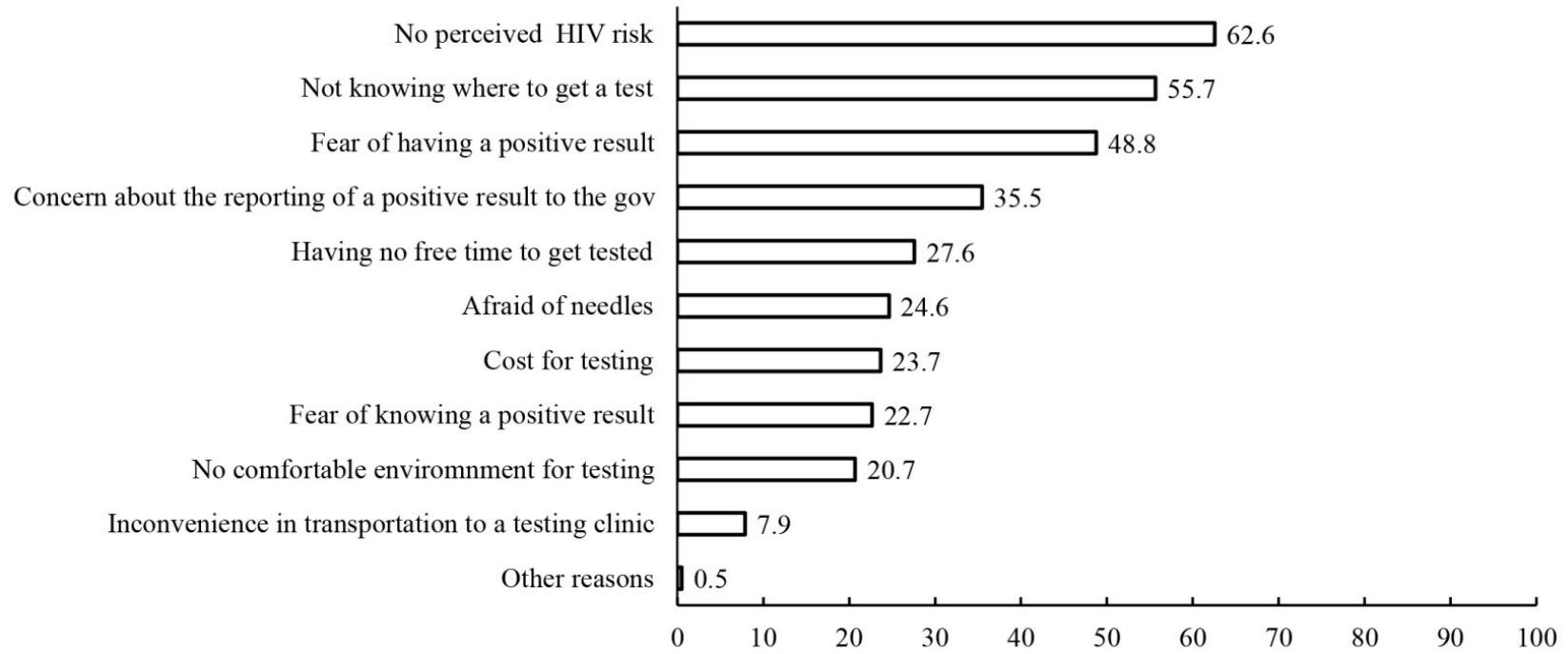
Figure 2. Barriers for HIV testing among 205 MSM who never took HIV testing, Chongqing, China, 2010

Factors associated with prior HIV testing

Of the 58% (287/492) of participants who had ever taken an HIV test, 29% had taken the test once, 29% twice, and 42% three times or more. Forty-five percent reported that their recent test was taken thanks to involvement in government or NGO projects. More persons (47%) were willing to go to a local CDC VCT clinic compared to a VCT clinic in a hospital (8%). Nearly three-quarters (73%) of ever tested MSM had taken their tests in the past 12 months prior to this 2010 survey. Higher educational level, cohabitation with a male partner, preferred insertive role in anal sex, condom use with a recent male sexual partner during the past six months, and self-perceived HIV risk were positively associated with prior HIV testing in the univariate analysis. A multivariable analysis model showed that those who had ever attended a college were more likely to take an HIV test than those who had not (aOR, 1.74; 95% CI, 1.16-2.62; P=0.008), as were MSM who used condoms with the recent male partner during the past six months were more likely to get tested (aOR: 2.87; 95% CI, 1.25-6.62; P=0.01). Those who preferred a receptive role in the anal intercourse were <u>less likely</u> to take an HIV test compared with those who preferred an insertive role (aOR, 0.58; 95% CI, 0.35-0.94; P=0.03), as were men cohabitating with female sexual partners or living alone, compared to those living with a male sexual partner (aOR, 0.62; 95% CI, 0.38-1.28; P=0.06). (Table 1)

Discussion

Our study found that 58% of MSM had a history of HIV testing in Chongqing City in southwestern China with an HIV prevalence rate in MSM of >11.7%. This testing frequency was higher than the national average of 44% in all risk groups estimated in 2011, and was also a bit

higher than the estimated testing rate of 51% among MSM in 2009 (Chow, Wilson, & Zhang, 2012b; Ministry of Health of the People's Republic of China, 2012). China seems to be doing better than many other nations; a weighted average testing rate of 33% was reported from 34 low and middle-income countries in 2008 (Adam et al., 2009). While the continuously increasing HIV testing rates among MSM in Chongqing City since 2006 suggest progress (Chow, et al., 2012b), the rates are still disappointing compared with MSM in some metropolitans in high income countries, e.g., 90% in 21 cities in the United States (Finlayson, et al., 2011) and 80.5% in Australia (Lyons, et al., 2012).

Higher education, insertive roles in anal sex, and condom use were associated with prior HIV testing. Men with a college education were more likely to have been tested, perhaps due to their higher awareness of HIV risk. Well-educated MSM may have been oversampled with our respondent driving sampling, as the study sample included a significant proportion of college students and college students may be more likely to bring their fellow students to take a test.

Those who preferred receptive anal sex were less likely to have had an HIV test and we think it is important to study why men preferring receptive anal intercourse are less likely to test. That MSM who preferred receptive anal sex perceived themselves to have lower risk of HIV infection than those who preferred insertive anal sex (OR: 2.0, 95% CI:1.3-3.2; *P*=0.003) is especially worrisome (Dosekun & Fox, 2010).

Those who used condoms during anal sex with their recent male sexual partner in the past 6 months were more likely to take a test. Condom use was measured within a timeframe of the last six months while testing experience was a lifetime measurement in our study. It is possible that those who used condoms more often may have gotten information about safe sex in their prior testing and counseling experience and thus increased their condom use.

Chongqing is one of the large cities in China where MSM are more visible and HIV prevalence is much higher than middle and small cities (Xiao, et al., 2009). MSM prefer to seek sexual partners in large cities, often hiding their sexual identities from their families and friends in their hometowns (Lau, Lin, Hao, Wu, & Gu, 2011). HIV prevalence in the 2010 survey was 11.7%, higher than syphilis (4.7%). This difference was also seen in the 2009 survey (15.7% HIV vs.6.6% syphilis) (Zhang, Ding, et al., 2012). This may reflect local public health interventions targeting at HIV/STD prevention and care among MSM (Zhang, Chen, et al., 2012).

We found that fear of finding out about a positive result was the No.1 perceived barrier for taking an HIV test, followed by fear of discrimination, a closely related fear. These testing barrier findings have been seen worldwide, from Beijing migrant workers (Song et al., 2011) to Peruvian MSM (Blas, Alva, Cabello, Carcamo, & Kurth, 2011) to high-income country MSM (Lorenc et al., 2011). Such universal reported barriers suggested that psychological support, modifying general social attitudes, and education about the benefits of early therapy are essential to motivate MSM for HIV testing. Unwillingness to go to an HIV clinic and concern about meeting acquaintances at the testing clinic were additional barriers to testing. Rapid oral testing has become available in recent years in the Chinese market, and could be considered an alternative for a clinic-based ELISA testing strategy (Chen et al., 2010). Its advantages include less invasiveness, easy access and application, ease of maintaining confidentiality, and elimination of anxiety associated with the waiting period for results (Chen, et al., 2010). However, linkage to counseling and care may be more difficult if self-testing becomes a norm. For persons getting clinic-based testing, high quality counseling and non-judgmental staff attitudes can help the clients to reduce their fear and concerns and can facilitate the linkage of seropositive persons to care.

The current version of Chinese HIV testing guidelines requires two ELISAs for screening and Western Blot for confirmatory testing; Chinese policy makers realized the limitations of this expensive and time consuming strategy, and a new version of HIV testing guidelines is being developed .Naturally, MSM who had no history of prior HIV testing were less likely to know where to get a test than those who had been tested before. Educating MSM about access to HIV service is important, particularly among male migrants (i.e., non-residents of Chongqing) who are unfamiliar with available services in their new environment.

More than half of the participants perceived themselves not at risk of HIV infection, particularly those who had never tested. About 90% (176/196) of those who never tested used condom during anal sex with their recent male partner in the past six month and 18% (36/196) reported always using a condom. Those men using condoms during sex might have considered themselves at lower risk of infection. Equally likely, men taking preventive precautions might not seek HIV testing due to their lower perception of HIV risk.

Education about HIV/AIDS and safer sex can motivate HIV testing. A study from Shenyang, China demonstrated that recently acquired knowledge about HIV might be a trigger for HIV testing (Zhou, Guo, Fan, Tian, & Zhou, 2009). In comparison, the two main reasons for not taking an HIV test in our study were low perceived risk of HIV infection and not knowing where to get tested. According to the Health Belief model, perceived susceptibility (potential risk to contract HIV) and perceived severity (understanding risk of AIDS and death) are positive predictors for behavioral change (National Cancer Institute, U.S. Department of Health and Human Services, & National Institutes of Health, 2012). This emphasizes that both HIV education and counseling are top priorities to improve HIV testing in Chinese MSM; education can increase risk awareness and counseling can help reduce fear of taking HIV testing. Future

intervention strategies should encourage MSM to go for HIV testing (cues to action) while helping establish confidence to achieve a long-term goal of reduced risk (self-efficacy). A study from Hong Kong found that cognitive variables such as attitudes, subjective norms, perceived control and behavioral intentions that were derived from the Theory of Planned Behaviors (TPB) were independently associated with lifetime and 12-month uptake of VCT (Gu, Lau, & Tsui, 2011).

In China, VCT clinics offer free HIV testing while health care settings provide paid testing (Wei, Ruan, et al., 2011). The coverage of the testing clinics has been extended to all 31 provinces, autonomous regions and municipalities, though many Chinese live far from testing centers (Ministry of Health of the People's Republic of China, 2010). In addition, the Chinese government has implemented guidelines for provider-initiated testing and counseling in medical facilities to further expand VCT to routine medical services (Ministry of Health of the People's Republic of China, 2010). The percentage of MSM who had been tested for HIV increased from 32.7% in 2007 to 44.9% in 2009, but has not risen markedly since (Ministry of Health of the People's Republic of China, 2010, 2012). The Chinese government has launched a "Five Year Plan" to strengthen the prevention and control for new HIV infections in most at-risk groups. In addition, the government also collaborated with international organizations to develop large-scale public health programs for HIV/AIDS prevention and care. For example, achieving universal access to prevention, treatment and care for HIV infected people is the goal of Chinese engagement with the Global Fund to Fight HIV, Tuberculosis and Malaria (Dr. Shaodong Ye, personal communication). Despite efforts to date, the MSM testing rate lags that of higher income nations, though VCT for MSM in China is highly cost-effective (Wang, Moss, & Hiller, 2011).

Several limitations existed in our study. First, self-reported information about the prior HIV testing experience may be subject to recall bias and social desirability bias, especially for sensitive questions that challenge social norms. CASI likely reduced, but did not eliminate these biases. Second, we could not disaggregate the motivations for taking an HIV test in our survey. Nearly half of the participants took a test due to enrollment in a public health project and may not do so of their own initiative.

Innovative interventions for improving uptake of HIV testing are needed among Chinese MSM. Multimedia social marketing campaigns can be effective intervention approaches to increase HIV testing (Wei, Herrick, et al., 2011). Internet-delivered interventions via chat room, websites or short message service could be further developed for their acceptability and feasibility to promote testing in Chinese MSM (Noar, 2011). Additionally, mobile vans for HIV testing in communities may provide easier access to testing (Lahuerta et al., 2011).

In summary, the HIV testing rate in the MSM population of Chongqing is still low. Mental and psychological support from health providers, family and friends, and the society as a whole are critical to encourage MSM to get tested. Education and social marketing need to be emphasized and expanded (Hong & Li, 2009). Structural interventions such as oral testing, and expanded, convenient test sites are important strategies to increase HIV testing, as are behavioral, contingency management, and social marketing interventions.

Predictors of HIV Infection among Men Who Have Sex with Men

in a Large City in Southwestern China

Abstract

Background: Despite interventions, the HIV epidemic is expanding among MSM in Chongqing, China's largest city. We studied factors associated with prevalent HIV infection in MSM.

Methods: Using respondent-driven sampling, we recruited MSM into annual serial cross-sectional surveys (2009 and 2010). Demographic, behavioral, and psychosocial information was collected through computer-assisted self-administered surveys, and behaviors summarized with an HIV Risk Score. We screened MSM with HIV/syphilis serologies, with confirmatory testing. We examined dimensionality and internal reliability of the psychosocial constructs using principal component analysis and assessed HIV predictors through multivariable logistic regression analyses.

Results: The median age of the 975 unique participants from both surveys was 23 years old (interquartile range: 21-27 years; range: 18-65 years). Most were of Han ethnicity (97%), never unmarried (89%), living alone or with roommates/parents (74%), and local area residents (79%), i.e., not internal migrants. Educational status was: students (mostly college) 31%, non-student non-college graduates 28%, and college graduates 41%. The mean age of first male-to-male sex was 21 years. Two-thirds of MSM self-identified as gay. Of 936 reporting sexual partners in the last six months, 98% had anal sex and 52% had multiple male partners. HIV prevalence was 15.1% and syphilis 5.7%. HIV seropositivity was associated with non-Han ethnicity (aOR: 0.22, 95%

CI: 0.08-0.59), non-student MSM with (aOR: 2.68, 95% CI: 1.22-5.88) or without a college degree (aOR: 6.94, 95%CI: 3.17-15.21), and syphilis (aOR: 5.81, 95% CI: 2.96-11.41). Conclusion: HIV and syphilis prevalence were high among MSM in Chongqing. Non-students, ethnic minorities, and syphilis seropositive MSM had the highest odds of HIV infection. Effective combination intervention packages to control sexually transmitted infections like HIV and syphilis are needed urgently to curb transmission among Chongqing MSM.

Key words: HIV; syphilis; men who have sex with men; homosexual men; bisexual men; HIV risk; sexual behavior; China; educational level

Introduction

HIV prevalence reported in 2011 among MSM ranged from 3.0% to 25% throughout the world (Beyrer, et al., 2012). Excluding PWID, HIV prevalence among MSM is typically 50 times higher than in other men (Beyrer, et al., 2012; UNAIDS, 2011). Furthermore, MSM have shown stable, high HIV incidence from 1995 to 2010 and continue to represent a majority of new cases in the Americas, Western Europe, Australia, and much of Asia (Beyrer, et al., 2012). Both biological and behavioral factors increase risk for HIV acquisition. In the absence of ART use in the infected partner or PrEP with antiretroviral drugs in the uninfected partner, risk of HIV acquisition per homosexual contact is estimated to be ≈18-times higher (1.4%) than the risk per heterosexual contact (0.08%) (Beyrer, et al., 2012; Boily, et al., 2009).

Risky sexual behaviors such as URAI, multiple and/or concurrent sexual partners, high frequency of sex acts, and drug use (such as stimulants) are factors contributing to the rapid increase in HIV transmission among MSM (Beyrer, et al., 2012). Co-infections (e.g., syphilis,

gonorrhea, Chlamydia, genital herpes virus, hepatitis C virus, and human papillomavirus) and attendant immune activation are biological co-factors that likely increase the risk of acquisition, transmission, and/or disease progression (Chow, Wilson, & Zhang, 2011a; Dougan, Evans, & Elford, 2007; Freedman & Mindel, 2004; Kim, Onofrey, & Church, 2013; Modjarrad & Vermund, 2010).

In China, MSM represent the sub-group with the fastest growing HIV epidemic in the 21st century, with a 6-fold increase in estimated national HIV prevalence in 2011 (6.0%) compared to 2003 (1.0%), exceeding estimates for PWID (4.0%) who had been the historically dominant sub-group in the Chinese HIV epidemic (Ministry of Health of the People's Republic of China, 2012). MSM comprised at least 29% of the estimated 48,000 new HIV cases in 2011 (Ministry of Health of the People's Republic of China, 2012). Syphilis is also on the increase in China and prevalence was estimated to be 8.4% among MSM in 2011 (State Council AIDS Working Committee Office China, 2012). Survey data have indicated that almost 90% of Chinese MSM report multiple male sexual partners within the last six months, and about one-third of Chinese MSM are bisexual, particularly common in the south of the country (Chow, Wilson, & Zhang, 2012a; Yun et al., 2011). An astonishing 80% of MSM have been estimated to have eventually gotten married to women, reflecting social and family pressures, though future trends may differ due to changing societal attitudes (Chow, Wilson, et al., 2011b; Yun, et al., 2011). Low rates of consistent condom use with both male (36.3%) and female partners (25.6%) are likely contributors to ongoing HIV/STI transmission both among MSM and into the heterosexual population (Chow, Wilson, et al., 2011b; Chow, et al., 2012a).

Chongqing City is a highly populous southwestern municipality that has China's highest HIV prevalence among MSM (Wu, et al., 2013; Zhang, Chen, et al., 2012). A large national

survey among MSM in 2009 showed that Chongqing, along with Guizhou Province's Guiyang City (234 miles-377 km from Chongqing) and Zunyi City (located in between Guiyang and Chongqing), were urban centers with disproportionately high HIV prevalence (17%-19%) (Wu, et al., 2013). In 2009, HIV prevalence reached an alarming 20% in Chongqing City, up from 0.5% in 2004 (Feng, et al., 2009; Zhang, Ding, et al., 2012; Zhang et al., 2013; Zhang, Chen, et al., 2012). The estimated annual incidence in Chongqing was 8.3 per 100 person-years between 2006-2008, roughly 2 times higher than an aggregation of all other Chinese cities that had surveys in the 2005-2010 period (Li, et al., 2011). From 2006 to 2009, the HIV (19.1%-34.5%) and syphilis (8.9%-12.3%) prevalence had continued to rise even though a reported 71.6% of the estimated MSM population were receiving interventions such as free condoms and lubricants, STI exams, and HIV/STI treatment through the China Global Fund AIDS Program (Zhang, Chen, et al., 2012).

In this study, we sought to use survey data to identify predictors for HIV infection among MSM in Chongqing City. We were especially interested to see whether low condom use and selected partner characteristics predicted infection.

Methods

Study procedures

The original project encompassed three consecutive cross-sectional MSM studies in 2009, 2010, and 2011 in Chongqing City. In this paper, we used survey data collected in 2009 and 2010, excluding 2011 data because only 391 participants were recruited in the 2011 survey, limiting representativeness for that year. A sample size of about 500 individuals per survey was

needed to have 80% power for detecting changes of a risk behavior of 10% or more between any two surveys with a design effect of 2.0 at a 95% significance level. Detailed information about the study population, sample approach, survey procedures, and laboratory tests has been presented elsewhere (Zhang, Ding, et al., 2012; Zhang, et al., 2013). In brief, a RDS approach was implemented to recruit participants (Heckathorn, 1997). Key informants at several local gay-friendly CBO helped select a few individuals (<10) as initial seeds in each survey, who subsequently chose their peers. The referred peers then selected their friends and this chain-referral process continued until desired sample size was reached. Each seed and each referral was allowed to refer up to 3 participants each. All referred participants needed to be within a given recruiter's social network and meet the eligibility criteria for the study (age ≥ 18 years old and ability to provide consent).

Each enrolled MSM completed a CASI questionnaire on their demographic characteristics, perceived social norms, situational efficacy towards condoms, attitudes and perceptions towards safer sex and risk behaviors, and personal sexual behaviors in the past six months. Venous blood specimens were drawn for standard HIV screening using rapid test plus ELISA and confirmation using Western blot; and for syphilis screening using RPR and confirmation using TPPA. Each enrolled participant was compensated with 30 *Yuan* (≈US $4.50) for his participation in the study and an additional 20 *Yuan* (≈US $3.00) for referral of one eligible MSM who subsequently completed the study interview. All eligible persons provided written consent prior to enrolling in the study. The study protocol was reviewed and approved by the institutional review boards of the National Center for AIDS/STD Control and Prevention, China CDC, University of California, San Francisco, and Vanderbilt University.

Measures

HIV Risk Score for partner type, sexual act, and condom use

An HIV Risk Score was created for MSM from the following questions: 1) whether the participant had sex with up to three male partners in the past 6 months (yes/no); 2) the participant's relationship with each partner (primary/casual); and 3) condom use frequency with each partner during insertive anal sex and during receptive anal sex [never, sometimes, always, no insertive (or receptive) sex], respectively. The assumptions for establishing the HIV Risk Score were that higher risk was associated with more total partners, more casual partners, and lower condom use, especially with receptive anal intercourse.

The value for each parameter was selected based on current biological evidence. A meta-analysis about HIV transmission through anal intercourse suggested that HIV transmission probability of MSM practicing unprotected anal sex with a primary partner was 39.9% (95% CI 22.5–57.4) (Baggaley, White, & Boily, 2010). A study among MSM in Amsterdam showed that without any treatment, an average of 6% (95% CI: 1-14%) of new infections were transmitted from steady partners and 35.1% (95% CI: 11.5-60.7%) were from casual partners (Xiridou, Geskus, de Wit, Coutinho, & Kretzschmar, 2004). We chose to assign an ordinal HIV Risk Score value of 3 for every casual partner, 1 for the primary partner and 0 for no partner. The HIV transmission rate for insertive sex has been estimated to be 6.5 per 10,000 acts and for receptive anal sex, 50 per 10,000 acts (Centers for Disease Control and Prevention, 2012). We thus assigned an HIV Risk Score value of 1 for insertive anal sex and 8 for receptive anal sex per partner. Those who did not have either insertive or receptive anal sex were coded 0, as they did not have risks of getting infected sexually. Consistent condom use could prevent HIV acquisition by 76% (Golden, Stekler, Hughes, & Wood, 2008). Therefore, we assigned an HIV risk score

value 1 for always using condom, 8 for never using condom, and 4 for sometimes using condom.

The assigned value for each variable is listed in Table 2.

Table 2. Assigned value for variables used to create the score

Variables	Assigned value
Partner type (P)	
Casual	3
Primary	1
No partner	0
Insertive sex with this partner (I)	
Yes	1
No	0
Receptive sex with this partner (R)	
Yes	8
No	0
Condom use frequency during insertive or receptive sex (CI or CR)	
Never	8
Sometimes	4
Always	1

The HIV Risk Score for each participant was calculated by $\sum_{i=1}^{3} P_i(I_i CI_i + R_i CR_i)$ i represented the number of the partner; P indicates type or partner; I indicated insertive sex and R receptive anal sex with the given partner; and CI and CR refer to condom use frequency during insertive and receptive anal sex, respectively. The HIV Risk Score ranged from 0 [having no sexual partner or having no anal sex with all partner(s)] to 648 (having three casual partners with

each of them engaging both insertive and receptive anal sex without condoms). Our HIV Risk

Score is analogous to other condom, partner, and risk activity assessments in the literature

(Beadnell et al., 2005; Harlow et al., 1998; Noar, Cole, & Carlyle, 2006). The score was then

classified into four categories according to quartiles (0-9, 10-36, 37-81, >81). The distribution of

the score was left-skewed with the majority being equal to or less than 100. As a precise attribute

of the score was not clear, we used a categorized score in the model.

Psychosocial variables

All psychosocial variables (social norms, self-efficacy and situational efficacy) had a 4-

point Likert scale ranging from disagree completely to agree completely, and were coded such

that higher values indicated less risky relevant levels for each variable. An average score (one to

four) for each variable was created by averaging the sum of the cluster of items representing each

variable.

Social norm towards safe sex was assessed with seven items (e.g., "My friends always

use condoms when having anal sex with new partners."). A higher score indicated that protected

anal sex was more likely the norm for the individual's sexual activities.

Self-efficacy regarding safe sex was measured with six items (e.g., "I am able to avoid

behavior that may put me at risk of HIV infection."). Higher score indicated that the individual

self-reported being more likely to be able to engage in protected anal sex with his partner(s).

Situational efficacy regarding safe sex was measured with four items (e.g., "I have

trouble letting a sex partner know I want to have safer sex."). Higher score indicated that the

individual was more likely to be able to engage in protected anal sex and/or to persuade his

partner(s) to engage in protected anal sex in a specific situation.

Statistical methods

Seven seeds recruited 503 respondents in 2009 and six seeds recruited 492 respondents in 2010. We excluded the 13 seeds from all analyses because they were not recruited by peers according to current RDS methodological recommendations (Volz & Heckathorn, 2008). Sixteen people enrolled in both surveys and their survey data in 2010 were removed because they participated in the 2009 survey which may have an impact on their behaviors and perceptions toward safe sex. The following individuals were also deleted because the persons: 1) had missing values in key scales (n=2 from 2010 survey); 2) had an incorrect value of self-reported age of homosexual debut (n=2 from 2009 survey). This yielded a final sample size of 975 (98% of the interviews).

We conducted a principal component analysis (PCA) to extract items and examine the reliability for each psychosocial variable. Items that had an eigenvalue great than one were considered unidimensional; a Cronbach's alpha great than 0.7 and an average inter-item correlation greater than 0.3 were considered reliable (Netemeyer, Bearden, & Sharma, 2003).

We used a RDSAT to calculate adjusted diseases prevalence and to generate individual weights for outcome variables (survey year in table 3 and HIV status in table 5). Logistic regression analyses were conducted to examine the demographic, sexual behavioral, and psychosocial characteristics by survey year. Univariate and multivariable logistic regression analyses were performed to explore the predictors of HIV infection (outcome). Variables significantly associated with each outcome variable at the level of P<0.1 in the univariate analyses entered in the multivariable analyses for independent predictors of HIV infection to calculating aOR and 95% CIs. Variables with a P-value of 0.1 were reported in the univariable

analyses, and included in the multivariable models, for which 0.05 was considered significant. We applied RDS generated individual weights to the outcome variables when performing logistic regression analyses. All analyses were performed with STATA/SE™ V12.1 (StataCorp LP, College Station, Texas, USA).

Results

Socio-demographic characteristics

Of the 975 individuals, 51% (501/975) were from the 2009 survey and 49% (474/975) from the 2010 survey. The median age of the participants was 23 years old (IQR: 21-27; range: 18-48 years in 2009 and 18-65 years in 2010); 87% of 975 MSM were 30 years old or younger. Participants in 2009 (median: 23 years; IQR: 21-26 years) were younger than those in 2010 (median: 24 years; IQR: 21-28 years). The majority of participants were of Han ethnicity (97%), unmarried (89%), living alone (74%), local citizens (78%); this means that they were not in-migrants with legal residence elsewhere), and residents of the downtown area in Chongqing City (91%). About one-third were current students enrolled in high schools or colleges at the time of survey; 41% were college graduates and 28% were non-student non-college graduates. The mean age of HIV positives was 21 years old (range: 18-23 years) for student MSM and 27 years old (range: 20-48 years) for non-student MSM. The median duration of living in Chongqing City was 9 years. Half of participants (49%) had no health insurance. (Table 3)

Table 3. Demographic, sexual behavioral, and psychosocial characteristics of 975 MSMin Chongqing, China, from respondent driven sample surveys in 2009 and 2010[*].

Characteristics	2009 (N=501) N (%)	2010 (N=474) N (%)	Total N (%)	P-value 2009 vs. 2010
Age (median, IQR)	23 (21-26)	24 (21-28)	23 (21-27)	0.03
Ethnicity				0.08
Han	483 (96.4)	462 (97.5)	945 (96.9)	
Other minority	18 (3.6)	12 (2.5)	30 (3.1)	
Current marital status [a]				0.43
Currently Single	459 (91.6)	413 (87.1)	872 (89.4)	
Ever married [b]	42 (8.4)	61 (12.9)	103 (10.6)	
Cohabitation Status				0.15
Living with male/female sexual partner	136 (27.2)	118 (24.9)	254 (26.0)	
Living alone, with roommates/parents	365 (72.8)	356 (75.1)	721 (74.0)	
Education status				0.02
Current student	181 (36.1)	118 (24.9)	299 (30.7)	
College graduates	196 (39.1)	208 (43.9)	404 (41.4)	
Non-student, non-college graduates	124 (24.8)	148 (31.2)	272 (27.9)	
Hukou (Chongqing household legal registration)				0.13
Yes	392 (79.0)	369 (77.8)	761 (78.5)	
No	104 (21.0)	105 (22.2)	209 (21.5)	
Current living area				0.05
Downtown Chongqing	447 (89.2)	438 (92.4)	885 (90.8)	
Other	54 (10.8)	36 (7.6)	90 (9.2)	
Duration (yrs) living in Chongqing (median, IQR)	8 (3-21)	10 (3-22)	9 (3-22)	<0.001
Having income in the last year (RMB) [c]				0.11
Yes	324 (64.7)	337 (71.1)	661 (67.8)	
No	177 (35.3)	137 (28.9)	314 (32.2)	
Enrolled in health insurance				0.001
Yes	219 (43.7)	256 (54.0)	475 (48.7)	
No	282 (56.3)	218 (46.0)	500 (51.3)	
Ever have sex with a woman				0.50
Yes	199 (39.7)	190 (40.1)	389 (39.9)	
No	302 (60.3)	284 (59.9)	586 (60.1)	
Age in years of homosexual debut (mean±SD, range)	20.4±4.2 (11-43)	21.4±5.6 (9-61)	20.9±4.9 (9-61)	0.38
Self-reported sexual orientation				0.50
Homosexual	340 (67.9)	315 (66.5)	655 (67.2)	
Heterosexual/Bisexual	161 (32.1)	159 (33.5)	320 (32.8)	
HIV Risk Score				0.35
≤9	160 (31.9)	139 (29.3)	299 (30.7)	
10-36	136 (27.2)	129 (27.2)	265 (27.2)	
37-81	84 (16.8)	89 (18.8)	173 (17.7)	
>81	121 (24.2)	117 (24.7)	238 (24.4)	
Social norm score (mean±SD)	3.5±0.5	3.3±0.5	3.4±0.5	<0.001
Self-efficacy score (mean±SD)	2.5±0.8	2.8±0.6	2.6±0.7	<0.001
Situational efficacy score (mean±SD)	3.4±0.5	3.2±0.5	3.3±0.5	<0.001
HIV				0.85
Confirmed seropositive	58 (11.6)	73 (15.4)	131 (13.4)	
Negative	443 (88.4)	401 (84.6)	844 (86.6)	
Syphilis				0.39
Confirmed seropositive	26 (5.2)	23 (4.9)	49 (5.0)	
Negative	475 (94.8)	451 (95.2)	926 (95.0)	
HIV/Syphilis co-infection				0.46
Yes	7 (1.4)	14 (3.0)	21 (2.1)	
No	494 (98.6)	460 (97.1)	954 (97.9)	

SD: standard deviation; [*]No men were sampled in both years, i.e., all are unique
[a] Male-male marriage is not legal in China; [b] including currently married, divorced, or widowed; [c] 6.2 RMB per US$ on January 1, 2013

Sexual behaviors and psychosocial characteristics

Sixty percent of the 975 participants reported never having had a heterosexual encounter. The mean age of homosexual debut with a male partner was 21 ± 5 years old (range: 9-61 years). The age of having first sex with a male partner was younger in 2009 (20 ± 4 years) than in 2010 (22 ± 6 years). Sixty seven percent of MSM self-identified as homosexual. In the last six months, 936 MSM had sexual partners, 98.1% (918/936) of whom had insertive or receptive anal sex with their partner(s) and 52% (490/936) had at least two male partners in the past six months. The median HIV Risk Score was 36 (IQR: 9-81). Nearly 60% of MSM who had anal sex with their partners during the last 6 months had an HIV Risk Score of 36 or less. Approximately one quarter of participants had an HIV Risk Score > 81. The HIV Risk Score did not differ significantly between the two survey years. (Table 3)

The items measuring each psychosocial construct were unidimensional and the internal reliability of each construct was acceptable for research purposes (Table 4). In general, the average scores of social norms and situational efficacy towards safer sex in the 975 MSM were 3.4 out of 4 while that of the self-efficacy regarding safer sex was 2.6 out of 4. The average scores of social norm and situational efficacy were significantly higher in 2009 than those in 2010 while the score of self-efficacy was lower in 2009 compared to 2010 (Table 3).

Table 4. Dimensionality and reliability of scales for psychosocial constructs

Construct	Number of items	Eigenvalue	Cronbach's alpha	Inter-item correlation
Social norms	7	4.24	0.86	0.47
Self-efficacy	6	1.90	0.75	0.43
Situational efficacy	4	3.25	0.82	0.42

HIV/syphilis infection status and predictors for HIV infection

The HIV prevalence (Western blot confirmed and RDS adjusted) was 15.1% (95% CI: 12.7-17.5%) combining both years' surveys, higher in 2009 (16.5%, 95% CI: 13.7-20.7%) than in 2010 (12.3%, 95% CI: 4.1-23.5%; P=0.85). The syphilis prevalence (TPHA confirmed and RDS adjusted) was 5.7% (95% CI: 4.1-7.2%) for both years, higher in 2009 (6.2%, 95% CI: 3.3-6.1%) than in 2010 (4.1%, 95% CI: 1.7-11.3%; P=0.39). The prevalence of HIV/syphilis co-infection (RDS adjusted) was 2.7% (95% CI: 1.7-3.9%) for both years, lower in 2009 (1.8%, 95% CI: 0.5-1.5%) than in 2010 (2.7%, 95% CI: 1.5-9.4%; P=0.46).

Predictors for HIV infection

In the univariate analyses, several demographic, behavioral, and psychosocial (self-efficacy and situational efficacy) characteristics were significantly correlated with HIV infection with a statistical criteria of P<0.1. Older MSM were more likely to be infected with HIV while MSM who were never married had lower risk of HIV infection. The HIV prevalence was lower in MSM of Han majority ethnicity (13%) compared to ethnic minorities such as Yi and Tujia

ethnicity (21%; *P*=0.09); it was also lower in those who were single (12%) compared with those who were married (23%; *P*=0.001). Student MSM had lower HIV prevalence (7%) than college graduates (11%) (*P*=0.04) or non-student non-college graduates (24%) (*P*<0.001). MSM were equally affected by HIV regardless of their cohabitation status (15% for MSM who lived with male or female sexual partner vs. 13% for MSM who lived by themselves), legal residency (13% for local residents vs. 15% for internal migrants) and living area in Chongqing (13% for those living in downtown area vs. 13% for others).

MSM who had their first homosexual intercourse at an older age had higher HIV prevalence. Those who self-identified with homosexual orientation (13%) had a similar HIV prevalence with those who self-reported as hetero/bisexual (14%). HIV prevalence was 9% among MSM with an HIV Risk Score of 36 or less; 17% among those with an HIV Risk Score between 37-81 (*P*=0.20) and 21.0% among those with a score >81 (*P*=0.045). The average score of social norms towards safer sex was high for both HIV positives (3.3) and negatives (3.4). MSM who were more confident in their ability to engage in safer sex in a specific situation and who were more confident in their ability to engage in safer sex with their partner(s) were less likely to be infected. Syphilis seropositivity was also a strong predictor for HIV infection (*P*<0.001).

In the multivariable model assessing the independent predictors for HIV infection, higher probability of HIV seropositive status was noted in MSM who were college graduates (aOR: 2.68, 95% CI: 1.22-5.88, *P*=0.01) and who were non-student and non-college graduates (aOR: 6.94, 95% CI: 3.17-15.21, *P*=0.001) compared with student MSM. Both student MSM (aOR: 0.14, 95% CI: 0.07-0.32, *P*<0.001) and college graduates (aOR: 0.39, 95% CI: 0.23-0.64, *P*<0.001) had much lower HIV prevalence than the non-student non-college graduates (not

shown). MSM who were of Han majority had lower HIV prevalence (aOR: 0.22, 95% CI: 0.08-

0.59, *P*=0.003) while those with concomitant syphilis infection were more likely to be HIV

positive (aOR: 5.81, 95% CI: 2.96-11.41, *P*<0.001). None of the psychosocial predictors nor the

HIV Risk Score contributed significantly to the final model. (Table 5)

Table 5. Univariate and multivariable analyses of the predictors for HIV infection among 975 unique MSM in Chongqing, China, from respondent driven sampling surveys in 2009 and 2010

Predictors	HIV(-) (N=844) N (%)	HIV(+) (N=131) N (%)	Crude OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Age (median, IQR)	23 (21-26)	25 (21-29)	1.05 (1.02-1.08)	0.001		
Ethnicity						
Other minority	23 (76.7)	7 (23.3)	reference		reference	
Han	821 (86.9)	124 (13.1)	0.40 (0.14-1.14)	0.09	0.22 (0.08-0.59)	0.003
Current marital status [a]						
Ever married [b]	79 (76.7)	24 (23.3)	reference			
Currently single	765 (87.7)	107 (12.3)	0.37 (0.20-0.66)	0.001		
Cohabitation Status						
Living with male/female sexual partner	217 (85.4)	37 (14.6)	reference			
Living alone, with roommates/parents	627 (87.0)	94 (13.0)	1.00 (0.60-1.68)	0.99		
Education Status						
Student	279 (93.3)	20 (6.7)	reference		reference	
College graduates	358 (88.6)	46 (11.4)	1.91 (1.02-3.56)	0.04	2.68 (1.22-5.88)	0.01
Non-student non-college graduates	207 (76.1)	65 (23.9)	5.52 (3.03-10.06)	<0.001	6.94 (3.17-15.21)	<0.001
Hukou (Chongqing household legal registration)						
No	177 (84.7)	32 (15.3)	reference			
Yes	664 (87.3)	97 (12.8)	0.75 (0.46-1.23)	0.26		
Current living area						
Other	78 (86.7)	12 (13.3)	reference			
Downtown	766 (86.5)	119 (13.5)	1.07 (0.53-2.14)	0.85		
Duration (yrs) in Chongqing (median, IQR)	10 (3-22)	7 (3-20)	0.98 (0.96-1.00)	0.10		
Having income in the last year (RMB)[c]						
No	284 (90.5)	30 (9.5)	reference			
Yes	560 (84.7)	101 (15.3)	1.73 (1.04-2.87)	0.04		
Enrolled in health insurance						
No	429 (85.8)	71 (14.2)	reference			
Yes	415 (87.4)	60 (12.6)	0.82 (0.52-1.27)	0.37		
Ever have sex with a woman						
No	518 (88.4)	68 (11.6)	reference			
Yes	326 (83.8)	63 (16.2)	1.30 (0.84-2.03)	0.24		
Age in years of homosexual debut (mean±SD, range)	20.7±4.7 (9-61)	22.5±5.9 (15-50)	1.07 (1.03-1.11)	0.001		
Self-reported sexual orientation						
Heterosexual/Bisexual	275 (85.9)	45 (14.1)	reference			
Homosexual	569 (86.9)	86 (13.1)	0.85 (0.53-1.34)	0.48		
HIV Risk Score						
≤9	273 (91.3)	26 (8.7)	reference	1.00		
10-36	240 (90.6)	25 (9.4)	0.71 (0.35-1.44)	0.34		
37-81	143 (82.7)	30 (17.3)	1.53 (0.80-2.94)	0.20		
>81	188 (79.0)	50 (21.0)	1.87 (1.01-3.46)	0.045		
Social norm score (mean±SD)	3.4±0.5	3.3±0.5	0.88 (0.61-1.28)	0.50		
Self-efficacy score (mean±SD)	2.7±0.7	2.5±0.7	0.66 (0.48-0.92)	0.02		
Situational efficacy score (mean±SD)	3.4±0.5	3.2±0.5	0.62 (0.42-0.92)	0.02		
Syphilis						
Negative	816 (88.1)	110 (11.9)	reference		reference	
Confirmed seropositive	28 (57.1)	21 (42.9)	6.04 (2.93-12.45)	<0.001	5.81 (2.96-11.41)	<0.001
Year of Survey						
2009	443 (88.4)	58 (11.6)	reference			
2010	401 (84.6)	73 (15.4)	1.05 (0.66-1.67)	0.84		

SD: standard deviation;
[a] Male-male marriage is not legal in China and respondents were referring to marriage with a woman; [b] including currently married, divorced, or widowed; [c] 6.2 RMB per US$ on January 1, 2013

Discussion

Our study showed that HIV prevalence was high in the MSM population in Chongqing City, considerably higher than syphilis prevalence, consistent with existing evidence for this region (Li, Jia, Ding, Liu, & Xiao, 2009; Xiao, et al., 2009; Zhang, Chen, et al., 2012). The HIV prevalence in our sample was 15.1%, more than 2-fold higher than either the 2011 national prevalence among MSM (6%) (Ministry of Health of the People's Republic of China, 2012) or the average prevalence noted in a recent study in 61 Chinese cities in 2009 (5%) (Wu, et al., 2013). Other studies in Chongqing City have documented that HIV prevalence in Chongqing MSM has remained >10% since 2006, 2-3 times as high as is typical in other Chinese cities (Wu, et al., 2013; Xiao, et al., 2009; Zhang, Chen, et al., 2012), with the exception of urban areas in nearby Guizhou Province where ≥18% prevalence is reported (Wu, et al., 2013). The Chongqing/Guizhou epidemic is now comparable to some cities in high income countries where MSM has long dominated the HIV epidemic, e.g., 18% in Paris (Velter et al., 2013) and 15% in Rome (Girardi et al., 2011). The syphilis prevalence was 5.7%, differing from most of other cities in China, where syphilis prevalence is typically 2 or more times that of HIV prevalence in MSM (Hong et al., 2009; Huan et al., 2013; Wang, Li, Stanton, Liu, & Jiang, 2013; Zhong, et al., 2011). One speculation is that some HIV prevalence might be fueled by early introduction to MSM communities via drug injection, but this was rare in our population -- only 0.6% of 975 MSM injected drugs under skin or into veins in the past year (data not shown) (Li, et al., 2011; Muessig & Cohen, 2013; Zhang, Ding, et al., 2012). The comparative frequency of HIV and syphilis in MSM was similar to 2010 surveillance data in 13 cities in Yunnan Province [Pr(HIV)=8% and Pr(syphilis)=4%] (Luo, et al., 2012). The syphilis prevalence was also considerably lower than the average prevalence in a study of 61 Chinese cities in 2009 (12%).

43

The fact that HIV and syphilis prevalence rates do not reliably correlate even within the same vulnerable population in the same country is further evidence that syphilis serves as an unreliable surrogate for HIV. The overall HIV/syphilis co-infection prevalence (2.7%) was slightly lower than a pooled estimate of 2.7% during 2007-2008 in Chinese MSM (Chow, Wilson, et al., 2011a).

The yearly HIV prevalence in this study was slightly higher (16.5% in 2009 vs. 15.7%; 12.3% in 2010 vs. 11.7%) and yearly syphilis prevalence was slight lower (6.2% in 2009 vs. 6.6%; 4.1% in 2010 vs. 4.7%) compared with our previous work from the same study project (Zhang, Ding, et al., 2012; Zhang, et al., 2013) . The possible reason likely to explain the gap was the different denominators for calculation due to data cleaning.

Our study suggested that HIV prevalence was much higher among non-student non-college graduate MSM (24%) than among student MSM (7%; P=0.001) who also are young on average. In a preliminary analysis of HIV prevalence from 2009 survey data alone, we had compared risk behaviors between student and non-student MSM (Zhang, Ding, et al., 2012). We subsequently realized the limitation of the arbitrary classification of student/non-student status and its potential impact on the results: categorization of recent college graduates into a non-student category could lead to a misrepresentation of the risk for various MSM sub-groups (Zhang, Ding, et al., 2012). In this study, we extended our earlier preliminary analysis by using three (not just two) categories, further classifying non-student MSM into college graduates and non-student non-college graduates. Non-student MSM without college degrees may have less access to HIV/AIDS knowledge and prevention approaches and may have been less aware about HIV infection risk through homosexual behaviors. Nonetheless, HIV prevalence among Chongqing student MSM was still higher than university student MSM in other cities such as Beijing (Xu et al., 2011; Zheng, Wu, Poundstone, Pang, & Rou, 2012). It was also higher than a

US national survey of university student in 2009 (3.1% among gay and bisexual male students) (Oswalt & Wyatt, 2013). Surveillance data from 2006 to 2009 among Chinese college students aged 15 to 24 years old showed that HIV cases were increasingly commonly reported (0.4% in 2006 to 1.0% in 2009), with MSM representing the major risk (Wang et al., 2010). The large difference of mean age of HIV positives between student MSM (21 years old) and non-student MSM (27 years old) in this study is an obvious source of differences in HIV prevalence rates. Nonetheless, that students have such a high prevalence rate is a concern for the productivity of this educated labor force in China.

In our study, we developed an innovative HIV Risk Score to assess HIV acquisition risks. It captured multi-dimensions of risky anal sexual activities including type of partner, type of sex act, and condom use frequency. The basic concepts for our new HIV Risk Score were based on evidence that HIV acquisition risk for MSM is dependent on the multiplicative risks of type of partner, type of sexual act, and condom use frequency, along with the additive risks of each single act in this period, combining to represent the overall risk in a certain time period. We extrapolated the overall HIV acquisition risk for each individual from calculating the risks for one's last three sexual activities in the past 6 months. Similar applications of other scores have been helpful in the literature (Benn, Fisher, & Kulasegaram, 2011; Fox et al., 2011), so we hope this MSM-specific approach can be validated and modified for use in other studies. One study developed an HIV risk transmission score using a Bernoulli model to assess the relative risk of HIV acquisition between HIV-serodiscordant partners, incorporating several behavioral (the type and frequency of specific sex acts) and biological factors (the index case HIV plasma viral load and stage of disease, and the presence of genital ulcer disease in either partner and pregnancy, HSV-2 seropositivity, and male circumcision status) as "risk multipliers" (Fox, et al., 2011). In a

UK guideline for post-exposure prophylaxis to HIV, an individual's HIV acquisition risk following a single exposure is calculated as the HIV prevalence among a specific population in a certain area multiplied by the risk of a specific exposure from an HIV-positive individual (cofactors such as STIs and viral load) (Benn, et al., 2011).

Our HIV Risk Score is designed for realistic data that can be secured in a low cost survey. It was not correlated with HIV infection in the final model, limited perhaps by the lack of important biological factors such as partners' viral load. In the univariate analysis, that persons with a higher HIV Risk Score were at significantly higher risk for HIV infection is a first step towards validating this score. Its calibration will require additional studies. Future research could enhance the HIV Risk Score by including biological co-factors, but this would increase the costs of data acquisition and may be less practical for large-scale public health assessments. In addition, mathematical models could be applied to include as many risk-related parameters as are available in a survey, taking into consideration of potential interactions and correlations between multiple co-factors, notably the background HIV prevalence in a given MSM sexual network. That our Risk Score correlated with HIV prevalence suggests that the Risk Score is a valid way to estimate the probability of HIV acquisition, though it was not significant as a predictor in the multivariable model.

Accurate measurement of condom use during sexual intercourse is complex and difficult (Crosby, 1998; Noar, et al., 2006). Almost all of the existing research has assessed condom use via self-reports that are commonly subject to recall bias and social desirability bias (Noar, et al., 2006; Sheeran & Abraham, 1994). Our study is no exception. Condom usage is often measured using frequency (e.g. never, sometimes, always), dichotomous measurements (e.g., yes/no), condom use during last sex, and percentage calculated from count data about protected sex over

46

the total number of recent sexual encounters (Noar, et al., 2006). Frequency measurement, as used in our study, may provide more insights about how often condoms are used because condom usage itself is not dichotomous or discrete as implied in other assessment approaches(Reynolds, Luseno, & Speizer, 2012). The recall period of sexual behaviors in this study was six months, longer than optimal for minimizing recall bias (Noar, et al., 2006).

Syphilis infection also increased the odds of testing HIV seropositive. This finding mimic results from other studies in Chongqing (Feng, et al., 2009; Xiao, et al., 2009; Zhang, Chen, et al., 2012), in other Chinese cities (Wu, et al., 2013), and in the international MSM community (Beyrer, et al., 2012). HIV prevalence among syphilis positive (43%) MSM were three and one-half times higher than that in the syphilis negatives (12%), similar to findings from the 2009 national MSM survey in 61 cities(Wu, et al., 2013). As has been reported in other cities in the southwest region (Chow, Wilson, et al., 2011a; Wu, et al., 2013), syphilis prevalence among MSM was lower than HIV prevalence in Chongqing. Syphilis is nonetheless still a strong predictor of HIV infection, reinforcing the importance of STI screening and HIV screening in the context of STIs.

Although none of the psychosocial variables were independent predictors for HIV infection, these factors deserved further investigation. In the univariate analysis, both HIV seropositive and seronegative men got high scores for social norms, indicating that protected anal sex was a likely norm among Chongqing MSM regardless of HIV serostatus. However, HIV infected MSM tended to have lower self-efficacy and situational efficacy towards safe sex than the uninfected MSM, suggesting that HIV-infected individuals may have lacked confidence in their ability to use or negotiate use of condoms. Application of behavioral theories such as the information-motivation-and behavioral skills (IMB) model may disentangle the active

component that inhibits a given MSM from employing risk-reduction behaviors; such work can assist development of targeted interventions (DiClemente, Crosby, & Kegler, 2002). For example, The IMB model proposes three factors that are fundamental and critical for AIDS-preventive behaviors: information (knowledge related to preventive behavior enactment), motivation (personal attitudes and social norms towards a given behavior), and behavioral skills (individual's objective abilities and sense of self-efficacy to enact a given behavior) (Fisher & Fisher, 2002). In the model, information and motivation are considered as two independent constructs to activate behavioral skills and thus help enact preventive behavior; this is important because information, skills, and behaviors are not always related, e.g., well-informed individuals may not be prepared or motivated (Fisher & Fisher, 2002). At the same time, information and skills can directly affect a behavior, particularly when the behavior requires simple technical performance (Fisher & Fisher, 2002). In-depth understanding of how psychosocial factors have influence on health-compromising behaviors are extremely important in China because of the long history of a prohibited social environments for homosexuality (Kang, 2009; Kong, 2010).

In conclusion, HIV and syphilis prevalence among MSM in Chongqing are high. The strongest predictors for HIV were familiar ones having to do with lower education and higher sexual risk taking. Appropriate and available education or counseling by public health staff or through the mass media should target non-student, non-college graduate MSM whose lower educational levels may make them harder to reach. At the same time, students are at risk and could be the focus of peer outreach. Physical, psychological, and mental care and support are need for MSM; accessible preventive resources are yet effective. Combination prevention strategies combining biological and behavioral approaches that are acceptable to MSM are needed urgently to address this growing challenge within the Chinese HIV epidemic.

Predictors of HIV and Syphilis among Men Who Have Sex with Men

in a Chinese Metropolitan City: Comparison of Risks among Students and Non-Students

Abstract

Background: MSM are at a substantial risk of HIV, given rising HIV prevalence in urban China. Adolescent and adult students often take HIV-related risk as part of sexual exploration. We compared the risks of HIV and syphilis infections and risky sexual behaviors between students and non-students among urban MSM.

Methods: Respondent driven sampling approach was used to recruit men who were self-identified as MSM in Chongqing Metropolitan City in southwestern China in 2009. Each participant completed a computer-assisted self-interview which collected demographic and behavioral data, and provided blood specimens for HIV and syphilis testing. Multivariable logistic regression analyses identified predictors for HIV and syphilis infections while comparing student and non-student MSM.

Results: Among 503 MSM participants, 36.4% were students, of whom 84.2% were in college. The adjusted prevalence of HIV infection was 5.5% (95% CI: 2.1%-10.2%) in students and 20.9% (95% CI: 13.7%-27.5%) in non-students (*P*=0.001); the adjusted prevalence of syphilis was 4.4% (95% CI: 0.7%-9.0%) in students and 7.9% (95% CI: 3.6%-12.9%) in non-students (*P*=0.12). Two groups had similar risky sexual behaviors such as number of sexual partners and exchanging sex for money. Multivariate analysis showed that both college graduates (aOR: 3.5; 95% CI: 1.3-9.5) and non-student college graduates (aOR: 5.7; 95% CI: 1.8-18.4) had higher risk of HIV infection compared with student MSM adjusting for age, ethnicity and other variables.

Conclusion: Student MSM have lower HIV and similar syphilis prevalence compared with non-student MSM. However, due to a shorter duration of sexual experience and high prevalence of at-risk sexual behaviors among student MSM, HIV risk might become as high in students as in non-students.

Keywords: Human immunodeficiency virus; men who have sex with men; college students; respondent driven sampling; China

Introduction

MSM represent an increasing proportion of newly reported HIV infections in China (Gao, Zhang, & Jin, 2009; Ministry of Health of the People's Republic of China, Joint United Nations Programme on HIV/AIDS, & World Health Organization, 2010). National surveillance data associated 32.5% of total new HIV cases to the MSM group in 2009, up from 12.2% in 2007 (Ministry of Health of the People's Republic of China, et al., 2010). HIV prevalence among MSM is particularly high in some large Chinese cities, varying from 0.4-9.9% in Beijing (Gao et al., 2010; Ma et al., 2007; Ruan, Luo, et al., 2009) to 8.5-16.8% in Chongqing (Feng, et al., 2009; Feng et al., 2008; Xiao, et al., 2009). In comparison, it remains relatively low in other cities: 0.9-2.2% in Harbin, Heilongjiang Province (Zhang, Bi, Lv, Zhang, & Hiller, 2007) and 0.5-3.1% in Jinan, Shandong Province (Ruan et al., 2008; Ruan, Yang, et al., 2009). Sociodemographic and behavioral characteristics, e.g. older age, less education, UAI, multiple male and/or female sex partners, and co-infection with other STIs, may be associated with prevalent HIV infection (Feng et al., 2010; Li, et al., 2009; Xiao et al., 2010). Some studies suggest that a significant proportion of MSM in large Chinese cities are college students (Ouyang, et al., 2009; Zhong, et al., 2011),

50

and that college student MSM may have a lower risk of syphilis compared with non-student

MSM (Zhong, et al., 2011). The magnitude of HIV infection in Chinese college student MSM is

unknown. We compared HIV risk between student and non-student MSM in a large metropolitan

city in southwestern China with high background HIV prevalence among MSM (Feng, et al.,

2009; Feng, et al., 2008; Xiao, et al., 2009).

Methods

From October-December 2009, MSM were recruited in Chongqing, a city with 34

universities and colleges (Chongqing Municipal Goverment, 2007a). Inclusion criteria for

participation were men 18 years or older, living and/or working in Chongqing at the time of

survey, self-reported oral/anal sex or mutual masturbation with another man during the past 12

months, and willing to provide written informed consent. We used an eligibility screening form

to assess whether these criteria were met.

Participants were recruited using the RDS approach (Heckathorn, 1997, 2002;

Heckathorn, Broadhead, & Sergeyev, 2001). Seven MSM were selected as initial seeds, based on

the evaluation of their diversity with respect to demographic characteristics and sub-group

memberships, active social networks, and high motivation to recruit peers in their social

networks. "Seeds" were each asked to recruit up to three participants, who in turn were asked to

recruit a subsequent round of up to three participants until the target sample size was reached and

equilibrium was achieved on variables including age, ethnicity, education, marital status,

occupation, duration of living in Chongqing City, having incomes in the last year, and having

health insurance. Equilibrium is defined as the estimates of key variables converging around a

stable sample composition that does not change during the following waves of recruitment and becomes independent of the initial seeds (Heckathorn, 1997, 2002). All referred participants had to be members of the recruiter's social network and meet the study eligibility. Study information was printed on the coupons for participants' reference. Participants were compensated 30 *Yuan* (US$4.50) for their participation in the study and an additional 20 *Yuan* (US$3.00) if they successfully recruited other eligible participants. The study was approved by the institutional review boards of the National Center for AIDS/STD Control and Prevention, China CDC, University of California, San Francisco, and Vanderbilt University.

Each participant completed a CASI in a private room. The interview collected information on demographics, sexual behaviors, psychosocial behaviors, HIV testing history, and alcohol and drug use. The CASI system was pilot-tested among MSM volunteers in the real-life survey setting prior to its application to this survey. We followed the protocols of standard screening, confirmatory and quality assurance for HIV-1 and syphilis testing (Jiang, et al., 2010). All serological specimens collected from participants were screened for HIV-1 antibody using ELISA (Vironostika HIV Uni-Form plus O™, bioMerieux, Holland), and for syphilis using RPR (Shanghai Rongsheng Biotech, China). Positive HIV-1 samples were then confirmed by Western Blot for HIV-1 (HIV Blot 2.2 WBTM™, Genelabs Diagnostics, Singapore) and reactive syphilis samples were then confirmed by TPPA (Serodia-TP™, Fujirebio Inc., Tokyo, Japan). All the tests were conducted in certified laboratories at Chongqing CDC. All participants received pre- and post-test HIV counseling. HIV negative individuals were referred to local health providers as needed. HIV positive ones were evaluated by Chongqing CDC staff for eligibility of enrollment into a sponsored ART program. Syphilis positive individuals were referred to the STD clinics in Chongqing CDC or other local hospitals.

Because seven seeds were not recruited by their peers, they were excluded from all analyses (Abdul-Quader, Heckathorn, Sabin, & Saidel, 2006; Volz & Heckathorn, 2008). The primary objective of the analyses was to compare HIV prevalence between student and non-student MSM. Therefore, the primary outcome variable was HIV sero-status and the primary predictor variable was occupation, which was categorized as students who were registered as full time students in high school or university/college when the survey was conducted versus non-students. We considered certain demographic and behavioral variables as potential confounders. The RDSAT (V 5.6.0; www.respondentdrivensampling.org) was used to estimate characteristics of MSM and HIV and syphilis prevalence adjusting for personal social network size and recruitment pattern (Heckathorn, 2002). To compare the crude values of social demographics and sexual behaviors by occupation, Chi-square tests were performed for categorical variables or t-tests with unequal variances for continuous variables. To compare the RDS adjusted values of social demographics and sexual behaviors, univariate logistic regression analyses were conducted, in which RDSAT-generated individual weights for occupation were applied. To assess the relationship between predictor variables and HIV serostatus, univariate logistic regression analyses were performed using RDSAT-generated individual weights for HIV serostatus. Variables significantly associated with both occupation and HIV serostatus at the level of $P<0.1$ in the univariate analyses were included in the multivariable analyses. Multivariable logistic regression model was also constructed using RDSAT-generated individual weights of HIV serostatus. Statistical analyses were carried out using STATA/SE™ V11.2 (StataCorp LP, College Station, Texas, USA).

Recruitment chains, or RDS diagrams, were drawn to show the occupation and HIV serostatus of all network members recruited by the seven seeds using NetDraw software (V2.097; www.analytictech.com).

Results

Sampling seeds and their recruits

Study participants were recruited by the RDS approach with seven "seeds" who were also MSM. All seven seeds were single and of Han ethnic, the major ethnic group in Chongqing. Their age ranged from 19 to 34 years. Two seeds had high school education, and the rest had college education, including one current college student. One seed was HIV-positive. The final sample reached equilibrium on variables including age, ethnicity, education, marital status, occupation, duration of living in Chongqing City, having incomes in the last year, and having health insurance at the 4th wave of recruitment, and we actually stopped sampling procedures at the 14th wave to have a sufficient sample size for statistical analysis purpose. A total of 506 MSM visited the study clinic for eligibility assessment, 3 were found to be ineligible, and 503 participated in the study. The numbers of MSM recruited by the seven seeds were 216, 112, 84, 43, 35, 12, and 1 (Figure 3).

Socio-demographics of MSM participants

Of 503 participants, 183 (36.4%) were students, of whom 84.2% were in college. Non-student MSM included college graduates (39%) and non-student non-college graduates (24.7%). The median age was 23 years (IQR: 21-26 years); 21 years (IRQ: 19-22 years) among students
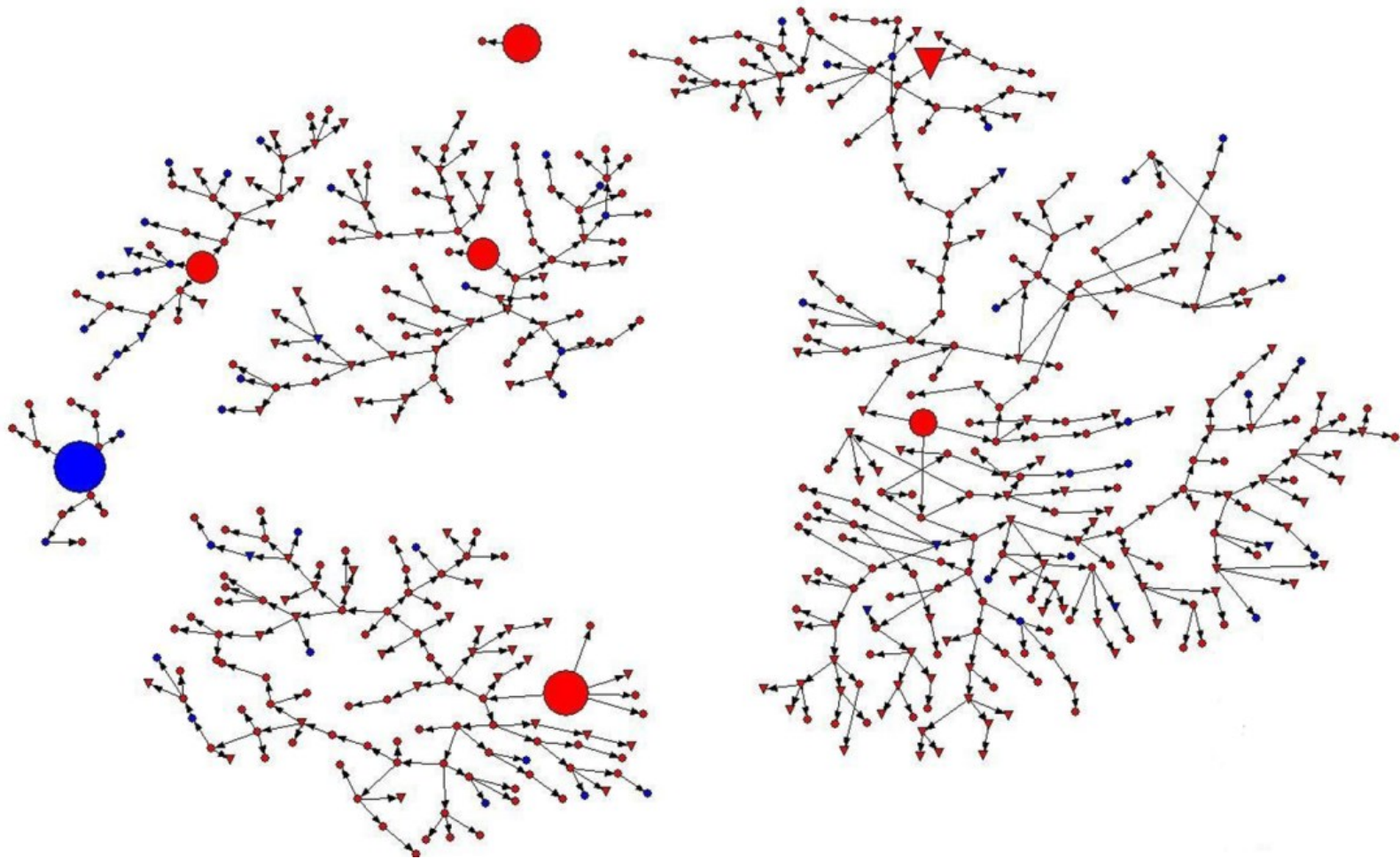
Circles represent non-students while triangles represent students

Larger circles or triangles represent the seeds

Blue color for HIV-positive and red color for HIV-negative participants

Figure 3. Diagram of respondent driven sampling procedures among MSM in Chongqing City, China.

and 24.5 years (IRQ: 22-28 years) among non-students (*P*<0.001). The median age of having first sex with a man was 20 years (IQR: 18-22 years), 18 years (IQR: 17-20 years) among students and 20 years (IQR: 18-23 years) among non-students (*P*<0.001). More than 90% of participants were of Han ethnicity. More student MSM (86%) received college educations than non-student MSM (61%) (*P*<0.001). Fewer student MSM (0.6%) were married than non-students (15%) (*P*<0.001). Fewer student MSM (15%) were living with male sexual partners than non-student MSM (26%) (*P*=0.008). Students were less likely to have incomes in the past year than non-student MSM (23% versus 88%, *P*<0.001) and less likely to be enrolled in a health insurance plan (32% versus 47%, *P*=0.008). (Table 6)

HIV risk behaviors

Over one in four (28%) of MSM participants perceived themselves as bisexual; 6.5% of students had female sexual partners while 11.6% of non-students did (*P*=0.20). Non-student MSM were more likely to have had sex with a woman (*P*=0.048) and to have had sex with men for >5 years than students (*P*<0.001) (Table 6). Of the 480 MSM who had ever had anal sex with their partners, 73% practiced receptive anal intercourse. In the past six months, 48% of MSM had >1 male partner and 5% had exchanged sex for money. The Internet was the means of finding their last sexual partner for 71% of MSM.

Table 6. Demographic and behavioral characteristics of 503 men who have sex with men in Chongqing City, China, 2009

Variable	Unadjusted				Adjusted [a]			
	Students N=183 (%)	Non-students N=320 (%)	Total N=503 (%)	P-value	Students (%, 95% CI)	Non-students (%, 95% CI)	Total (%, 95% CI)	P-value
Age (year)				<0.001				<0.001
≤23	163(89.1)	121(37.8)	284(56.5)		(85.3, 77.4-92.5)	(39.5, 31.7-47.9)	(55.8, 49.0-62.5)	
>23	20(10.9)	199(62.2)	219(43.5)		(14.7, 7.5-22.6)	(60.5, 52.1-68.3)	(44.2, 37.5-51.0)	
Ethnicity				0.033				0.076
Han majority	172(94.0)	313(97.8)	485(96.4)		(90.5, 83.5-96.6)	(96.9, 93.5-99.5)	(94.7, 91.4-97.6)	
Other minorities	11(6.0)	7(2.2)	18(3.6)		(9.5, 3.4-16.5)	(3.1, 0.5-6.5)	(5.3, 2.4-8.6)	
Education				<0.001				<0.001
High school or below	29(15.8)	124(38.8)	153(30.4)		(13.7, 7.6-21.2)	(39.2, 32.3-48.0)	(30.1, 24.8-36.3)	
College or above	154(84.2)	196(61.2)	350(69.6)		(86.3, 78.8-92.4)	(60.8, 52.0-67.8)	(69.9, 63.7-75.2)	
Marital status				0.001				0.001
Never married	182(99.4)	279(87.2)	461(91.7)		(99.4, 98.2-100.0)	(84.8, 78.3-90.7)	(90.0, 85.7-94.0)	
Ever married [b]	1(0.6)	41(12.8)	42(8.3)		(0.6, 0.0-1.8)	(15.2, 9.3-21.7)	(10.0, 6.0-14.3)	
Currently living with a male sexual partner				<0.001				0.008
No	162(88.5)	239(74.7)	401(79.7)		(85.4, 77.4-92.9)	(73.6, 65.1-79.0)	(77.8, 71.4-82.3)	
Yes	21(11.5)	81(25.3)	102(20.3)		(14.6, 7.2-22.6)	(26.4, 21.1-35.0)	(22.2, 17.7-28.6)	
Duration of living in Chongqing City (year)				<0.001				<0.001
≤21	166(90.7)	215(67.2)	381(75.7)		(93.5, 89.5-96.7)	(74.5, 67.0-80.3)	(81.4, 76.1-85.5)	
>21	17(9.3)	105(32.8)	122(24.3)		(6.5, 3.4-10.6)	(25.5, 19.7-33.1)	(18.6, 14.5-23.9)	
Having incomes in the past year				<0.001				<0.001
No	147(80.3)	32(10.0)	179(35.6)		(77.0, 68.1-85.7)	(11.8, 6.7-17.4)	(35.1, 28.8-41.2)	
Yes	36(20.7)	288(90.0)	324(64.4)		(23.0, 14.3-31.9)	(88.2, 82.6-93.4)	(64.9, 58.8-71.2)	
Having a health insurance				<0.001				0.008
No	127(69.4)	157(49.1)	284(56.5)		(68.3, 59.1-76.8)	(52.9, 44.4-61.0)	(58.4, 52.0-64.2)	
Yes	56(30.6)	163(50.9)	219(43.5)		(31.7, 23.2-40.9)	(47.1, 39.0-55.6)	(41.6, 35.8-48.0)	
Ever having sex with a woman				<0.001				0.048
No	134(73.2)	170(53.1)	304(60.4)		(66.5, 56.5-77.1)	(54.1, 45.7-62.1)	(58.7, 52.0-64.9)	
Yes	49(26.8)	150(46.9)	199(39.6)		(33.5, 22.9-43.6)	(45.9, 37.9-54.3)	(41.3, 35.1-48.0)	
Duration of having had sex with a man (year)				<0.001				<0.001
≤5	169(92.3)	221(69.1)	390(77.5)		(92.6, 87.4-97.1)	(75.5, 68.7-82.1)	(81.9, 77.3-86.9)	
>5	14(7.7)	99(30.9)	113(22.5)		(7.4, 2.9-12.6)	(24.5, 17.9-31.3)	(18.1, 13.1-22.7)	
Self-reported sexual orientation				0.727				0.754
Homosexual	137(74.9)	244(76.3)	381(75.7)		(71.9, 62.1-81.2)	(72.8, 65.2-79.9)	(72.5, 66.7-78.2)	
Heterosexual	46(25.1)	76(23.7)	122(24.3)		(28.1,18.8-37.9)	(27.2, 20.1-34.8)	(27.5, 21.8-33.4)	

Role in anal sex, if any (n=480) [c]				0.455				0.452
Largely insertive	49(26.8)	97(30.3)	146(29.0)		(25.6, 17.9-33.7)	(27.9, 21.1-35.9)	(27.2, 22.0-32.9)	
Largelyreceptive	124(73.2)	210(69.7)	334(71.0)		(74.4, 66.3-82.1)	(72.1, 64.1-78.9)	(72.8, 67.1-78.0)	
Number of male partners in the past 6 months				0.965				0.984
≤1	81(44.3)	141(44.1)	222(44.1)		(52.7, 42.9-62.3)	(52.2, 44.8-60.8)	(52.5, 46.7-59.3)	
>1	102(55.7)	179(55.9)	281(55.9)		(47.3, 37.7-57.1)	(47.8, 39.2-55.2)	(47.5, 40.7-53.3)	
Exchanging sex for money in the past 6 months				0.641				0.706
No	175(95.6)	303(94.7)	478(95.0)		(96.1, 92.8-98.8)	(95.2, 91.2-98.3)	(95.5, 92.6-97.8)	
Yes	8(4.4)	17(5.3)	25(5.0)		(3.9, 1.2-7.2)	(4.8, 1.7-8.8)	(4.5, 2.2-7.4)	
Venue for finding the last male sexual partner in the past 6 months (n=477) [d]				0.675				0.940
Others	53(30.3)	86(28.5)	139(29.1)		(27.1, 19.0-34.4)	(28.7, 21.7-37.3)	(28.9, 23.5-35.0)	
Internet	122(69.7)	216(71.5)	338(70.9)		(72.9, 65.6-81.0)	(71.3, 62.7-78.3)	(71.1, 65.0-76.5)	
Syphilis infection				0.307				0.333
No	176(96.2)	301(94.2)	477(94.8)		(95.6, 91.0-99.3)	(92.1, 87.1-96.4)	(93.4, 89.9-96.5)	
Yes	7(3.8)	19(5.9)	26(5.2)		(4.4, 0.7-9.0)	(7.9, 3.6-12.9)	(6.6, 3.5-10.1)	

[a] Adjusted values using RDSAT-generated weights for a respondent driven sample

[b] Including married, divorced and widowed

[c] 23 men reported oral sex or masturbation only

[d] 26 men reported no male sexual partner in the past 6 months

We saw no differences in self-reported role in anal sex (i.e., insertive vs.receptive), number of male partners and exchanging sex for money in the past 6 months, and the venue for finding the last male sexual partner in the past 6 months between student and non-student MSM (Table 6). Only 26.2% (123/462) of MSM always used condom with their male partner in the past 6 months and there were no difference between students and non-students ($P=0.43$). In the past twelve months, 77.5% (314/405) reported drinking alcohol at least monthly, and there was no difference between students and non-students ($P=0.977$). Drug use was uncommon with 3.0% (12/405) reporting ever using non-injection drugs and only 0.5% (2/404) reported injecting drugs in the past 12 months.

HIV/syphilis co-infections and predictors for HIV infection

The overall adjusted prevalence of HIV infection was 15.7% (95% CI: 10.8%-21.8%), syphilis was 6.6% (95% CI: 3.5%-10.2%), and co-infection was 2.0% (95% CI: 0.4%-4.3%). The adjusted prevalence of HIV infection was 5.5% (95% CI: 2.1%-10.2%) in students and 20.9% (95% CI: 13.7%-27.5%) in non-students ($P=0.001$). Adjusted syphilis rates were 4.4% (95% CI: 0.7%-9.0%) in students and 7.9% (95% CI: 3.6%-12.9%) in non-students ($P=0.12$). (Table 6) Multivariable logistic regression analysis showed that both college graduates (aOR: 3.5; 95% CI: 1.3-9.5) and non-student college graduates (aOR: 5.7; 95% CI: 1.8-18.4) had higher risk of HIV infection than student MSM; and non-student college graduates had greater risk than college graduates compared with student MSM; ethnic minorities had a higher risk of HIV infection than Han ethnics (aOR: 8.2; 95% CI: 2.3-28.8); and older age was associated with a higher risk of HIV (aOR: 2.1; 95% CI: 0.9-4.7) (Table 7).

Table 7. Factors associated with HIV infection among 503 men who have sex with men in Chongqing City, China, 2009

Factors	No. of participants	No. of HIV positives (%)	Crude OR (95%CI)	*P-value*	Adjusted OR (95%CI) [a]	*P-value*
Age (year)				0.001		0.067
≤23	284	21 (7.4)	1.00		1.00	
>23	219	37 (16.9)	3.7 (1.7-8.1)		2.1(0.9-4.7)	
Ethnicity				0.05		0.001
Han majority	485	53 (10.9)	1.00		1.00	
Other minorities	18	5 (27.8)	4.0 (1.0-16.2)		8.2 (2.3-28.8)	
Marital status				0.01		
Ever married [b]	42	9 (21.4)	1.00			
Never married	461	49 (10.6)	0.3 (0.1-0.7)			
Currently living with a male sexual partner				0.36		
No	401	45 (11.2)	1.00			
Yes	102	13 (12.8)	0.6 (0.2-1.7)			
Occupation						
Student (secondary/college)	183	9(4.9)	1.00		1.00	
College graduates	196	26 (13.3)	3.8 (1.4-10.2)	0.009	3.5 (1.3-9.5)	0.014
Non-student non-college graduates	124	23 (18.6)	6.9 (2.5-19.4)	<0.001	5.7 (1.8-18.4)	0.003
Duration of living in Chongqing City (year)				0.16		
≤21	381	47 (12.3)	1.00			
>21	122	11 (9.0)	0.6(0.3-1.3)			
Having incomes in the last year				0.10		
No	179	13(7.3)	1.00			
Yes	324	45(13.9)	2.1(0.9-5.2)			
Having a health insurance				0.66		
No	284	34(12.0)	1.00			
Yes	219	24(11.0)	0.8(0.4-1.8)			
Ever having sex with a woman				0.59		
No	304	29(9.5)	1.00			
Yes	199	29(14.6)	1.2(0.6-2.7)			
Duration of practicing homosexual sex with a man (year)				0.68		
≤5	390	42 (10.8)	1.00			
>5	113	16 (14.2)	1.2(0.5-3.0)			
Self-reported sexual orientation				0.58		
Homosexual	381	45(11.8)	1.00			
Heterosexual	122	13(10.7)	1.3(0.5-3.2)			
Role in anal sex, if any (n=480)[c]				0.55		
Largely insertive	146	10(6.9)	1.00			
Largely receptive	334	48(14.4)	1.4(0.5-3.7)			
Number of male partner in the past 6 months				0.81		
≤1	222	17(7.7)	1.00			
>1	281	41(14.6)	1.1 (0.5-2.3)			
Exchanging sex for money in the past 6 months				0.34		
No	478	55(11.5)	1.00			
Yes	25	3(12.0)	2.3 (0.4-13.0)			
Venue for finding the last male sexual partner in the past 6 months (n=477)[d]				0.90		
Non-internet	139	13(9.4)	1.00			
Internet (ever)	338	40(11.8)	1.1(0.4-2.8)			
Syphilis infection				0.12		
No	477	51(10.7)	1.00			
Yes	26	7(26.9)	2.8(0.8-10.3)			

[a] Adjusted values using RDSAT-generated weights for a respondent driven sample; [b] Including married, divorced and widowed
[c] 24 men reported oral sex or masturbation only; [d] 26 men reported no male sexual partner in the past 6 months

Discussion

Our study found high HIV and syphilis prevalence rates among MSM in Chongqing City. Our finding of high HIV prevalence was consistent with earlier data (range of 10.4-16.8%) in Chongqing MSM (Feng, et al., 2009; Ouyang, et al., 2009; Xiao, et al., 2009), and was higher than in most other Chinese cities (Feng, et al., 2010; Gao, et al., 2010; Ruan, Yang, et al., 2009). It is difficult to explain why HIV prevalence in Chongqing City was higher than in other Chinese cities based on the behavioral data in our study sample. We speculated lower use of condoms during sex and more receptive anal intercourse among MSM, but our study showed that 26.2% of participants consistently used condom with the last partner, which is nearly similar to that in other Chinese cities (33.1%-41.5%) (Chow, et al., 2012a). Receptive anal intercourse was reported by 71% of our respondents, comparable to the higher range of reports from other cities (42.1%-79%) (Guo, et al., 2011). Chongqing City is near a major drug trafficking route in southwest China, and the neighboring regions are heavily affected by HIV due to injection drug use (Liu et al., 2009; Yin et al., 2007; Zhang et al., 2010). Since very few MSM in Chongqing were involved in injection drug use (Feng, et al., 2009; Xiao, et al., 2009), the HIV epidemic might first be introduced to the MSM group through sexual contact with HIV-positive drug users and could thereafter increase due to high transmission efficiency via unprotected anal sex (Dosekun & Fox, 2010). However, this hypothesis needs to be validated by carefully scrutinizing previous surveillance data and exploring the similarity of HIV genotypes between infected MSM and local drug users.

Another main study finding was that college students constituted a large proportion of MSM in Chongqing and that they had lower prevalence of HIV infection than non-student MSM. Student MSM had no difference in the number of male partners compared with non-student

MSM, indicating they were equally actively engaged in homosexual activities. Homosexual behaviors have been increasingly common among Chinese college students in recent years. Just 20-30 years ago, sex was a taboo topic in public in China, and sexual encounters were rare among college students (Kong, 2010; Liu, et al., 2006). However, since the implementation of the "open door policy" in 1978 and market-oriented economic reforms in the 1980s, Chinese society has undergone dramatic economic development and social changes that greatly transformed social norms and attitudes toward sexuality (Wong et al., 2009). Western lifestyles and culture such as openness in talking about sex and tolerance toward pre-marital and homosexual sex have flooded the Chinese mass media (Lieber et al., 2009). Consequently, the Chinese have become more tolerant toward various sexual practices like homosexuality and pre-marital sex among youths (Lieber, et al., 2009; Zhang et al., 2004; Zhang, et al., 1999). When students enter college, they are relieved from highly intensive study pressure in high school, escaping their parents' supervision. Students have ready access to information via the Internet and can connect to social networks, e.g., the gay community. These factors may facilitate a proportion of students' involvement in homosexual activities with other men, including selling sex to earn money for school or other financial needs or desires (Liu, Liu, Cai, Rhodes, & Hong, 2009; Tao et al., 2010).

The RDS-adjusted HIV prevalence among student MSM is 5.5%, which is about one quarter of that among non-students (20.9%). However, the actual difference of HIV risk might not be so large for the following reasons: the median age interval between having first sex with a male partner and participating in the study among student MSM is only 3 years (21-18 years), which implies that HIV incidence rate among students might be quite high; in addition, the

majority of risk behaviors, such as number of male sexual partners and exchanging sex for money, are not different between students and non-students.

In contrast to the difference of HIV prevalence in two groups, there is no statistically significant difference of syphilis prevalence. The possible reason for these different findings might be that: syphilis is a curable disease, and large scale public health programs, as conducted in Chongqing City in the past several years, could significantly reduce its prevalence in a relatively short time period; in comparison, HIV prevalence is unlikely to decline significantly in a short period even though the intervention programs reduce its incidence rate, as the existing HIV cases may not be removed from this pool of MSM population due to the long survival of the viral reservoirs in the body and uneasiness of eradication of the virus from the body.

Study strengths include the novelty of addressing student vs. non-student risk and prevalence. To our knowledge, we are the first to explicitly compare HIV risks in student versus non-student MSM. Existing studies including student MSM sample either did not have HIV prevalence (Cong et al., 2008; Ruan et al., 2007; Zhang, et al., 2007) or did not compare HIV infection among students versus non-students (Xu, et al., 2011; Zheng et al., 2011). Another strength of this study is its rigorous sampling method. RDS is the best available approach for recruiting hidden populations that has been applied successfully in recruiting injection drug users, female sex workers, and MSM in both developed and developing countries (Abdul-Quader et al., 2006; Li et al., 2010; Mahfoud et al., 2010; Reisner et al., 2010). The RDS method constructed sampling frame during the sampling process that distinguishes itself from traditional non-probability methods such as snowball sampling (Heckathorn, 2002; Heckathorn, et al., 2001). The final sample composition is independent of the initial, purposefully selected seeds after 5 to 6 waves of recruitment (Heckathorn, 1997, 2002). The recruitment biases can be assessed by

calculation of selection probability and adjusted for in the analysis (Heckathorn, 2002; Volz & Heckathorn, 2008).

Limitations are also noted. First, the RDS method might not recruit a representative sample of the whole MSM population in Chongqing. In theory, the RDS method should generate unbiased estimates (Heckathorn, 2002; Volz & Heckathorn, 2008). In practice, any violations of the assumptions under which the RDS is applied could result in biased sample (Heckathorn, 2007; Volz & Heckathorn, 2008). As we rarely know the accurate characteristics and the size of the MSM population, we could hardly verify whether the sample included all MSM networks (Goel & Salganik, 2010). Moreover, both univariate and multivariate analyses in this study were conducted by applying RDSAT-generated weights to dependent variables only (e.g., HIV infection) as much of the comparable literature has done (Liu, Qu, Guo, & Sun, 2011; Wei, Ruan, et al., 2011; Xu et al., 2010). However, such application is still under development and requires further validation. Second, the students were defined as those who were registered as full time students in high school or college when the survey was conducted; therefore, it is arbitrary categorization of students versus non-students. Recent graduates might have an HIV prevalence rate close to that among current students; this misclassification is likely to result in an underestimation of the difference of HIV prevalence rates between student and non-student MSM. We could not fully exclude the possibility that some students might not have homosexual behaviors but stated they had in order to participate in the study under peer manipulation, which could lead to an underestimation of HIV prevalence. If this happened, the actual HIV prevalence among student MSM would be higher than 5.5%. Finally, interviews on sensitive information such as sexual behaviors are often subject to underreporting (information bias) due to stigma. However, our use of the CASI approach should have reduced this bias.

64

In conclusion, college students were well represented in MSM population in Chongqing. Student MSM were at high risks of HIV and syphilis acquisition despite of their shorter sexual experience compared with non-students.

Internet-based Behavioral Interventions for Preventing HIV Infection

in Men Who Have Sex with Men

Abstract

Background

MSM have been affected by the HIV epidemic for three decades and continue to contribute to new cases globally. The Internet has become a powerful tool for social networking and sexual partner seeking among MSM. Meanwhile, provides a unique virtual space to deliver prevention interventions. An increasing number of studies have used Internet-delivered interventions to reduce risky behaviors among MSM in the past ten years, but its effectiveness has yet to be confirmed.

Objectives

To assess the effectiveness of Internet-based behavioral interventions for HIV prevention among MSM populations.

Search methods

We submitted a literature search strategy to Cochrane Review Group on HIV/AIDS who performed the literature search in the Cochrane Central Register of Controlled Trials (The Cochrane Library 2011, Issue 4), PubMed (January 1985 to December 2011), EMBASE (January 1985 to December 2011), BIOSIS Preview (January 2001 to December 2011), clinictrials.gov (Janurary 1985 to December 2011), ERIC (January 1985 to December 2011), ProQuest (January 2001 to December 2011), PsycINFO (January 1985 to December 2011), Web of Knowledge (January 1985 to December 2011), WPRIM (January 1985 to December 2011), AIDS Education Global Information System (January 1981 to December 2011), International

AIDS Society Website (January 2009 to December 2011) with no restrictions on language or publication status. We also searched reference lists of existing reviews and included studies to identify additional studies.

Selection criteria

Inclusion criteria consisted of 1) randomized controlled trials (RCTs) and rigorously designed quasi-experimental studies; 2) Internet-based behavioral interventions; 3) adult MSM ≥18 years old; and 4) comparison group of MSM who received no intervention or other interventions.

Data collection and analysis

Two authors independently reviewed 1504 records and selected seven full journal articles for data extraction and methodology assessment. We contacted study authors for additional information when necessary.

Main results

Six RCTs and one quasi-experimental study were included, involving 5128 eligible participants at enrollment. Five were conducted in United States. Participants were mainly recruited through banner ads on the gay websites. Drop-out rate varied from 1% - 34% after randomization. More than 50% of participants were <30 years of age. Over half of participants in five studies had a college degree. Three RCTs enrolled HIV negative or unknown status participants and one enrolled HIV positive participants. Four studies applied behavioral theories. Intervention delivery modes included online video, modules, tutorials, e-card, and email. A variety of the behavioral and cognitive outcomes were reported with the most studied outcomes of UAI and HIV testing. No studies reported HIV incidence. All included studies had high risk of bias, particularly in random sequence generation and incomplete outcome data. Initial efficacy

67

was demonstrated for each of the following outcomes in at least one study: reducing UAI, having casual or multiple partners at last sex; increasing HIV testing, disclosure, knowledge, and self-efficacy and outcome expectancy towards safer sex. Evidence was the strongest for reducing UAI, with three out of four studies finding an effect. Summary measures could not be estimated, however, due to heterogeneity of the interventions and outcome assessed.

Authors' conclusion

Internet-based behavioral interventions may be effective in reducing risky behaviors such as UAI. Rigorously designed and implemented trials are still insufficient, especially in developing countries and among important sub-groups of MSM. Development of the intervention to achieve optimal effects needs in-depth explorations. Standardized outcome measurements and sufficient trial reports would facilitate meta-analyses and interpretation of the impact of the interventions.

Plain language summary

Behavioral interventions delivered through the Internet to reduce HIV infection among MSM

MSM are one of the sub-populations most affected by HIV and contribute to the majority of annual new infections. MSM are also frequent users of the Internet. Delivering HIV prevention interventions through the Internet is an increasingly common application of technology-enabled health services and several studies have applied this approach to behavioral interventions for MSM. We conducted a comprehensive literature search and systematically reviewed six eligible RCTs and one quasi-experimental study, of which five were conducted in

the United States. The seven studies enrolled a total of 5128 eligible MSM aged 18 years or older and about 40% completed all the required procedures. All studies were subject to methodological challenges. Internet-based behavioral interventions may be effective in reducing risky behaviors such as UAI, but due to the variation of the interventions and the outcomes reported, we were unable to estimate a summary effect and thus cannot make a definitive conclusion about the efficacy of the intervention.

Background

Description of condition

MSM have been disproportionately affected by the HIV for over three decades (Centers for Disease Control and Prevention (CDC), 1981; UNAIDS, 2010b). In recent years, the HIV epidemic among MSM has been continuously expanding in some high income countries such as the United States, northern countries in Western Europe, Australia, and New Zealand (Vermund & Leigh-Brown, 2012), while rapidly emerging in some low- and middle- income countries (LMIC) in Asia, Africa, eastern Europe, and Latin America (Beyrer, et al., 2011). The global HIV prevalence among MSM ranged from 3·0% to 25·4% by the end of 2011 and the incidence continuously increased across continents from 1995 to 2010 (Beyrer, et al., 2012). Risky sexual behaviors are largely responsible for the rapid increase in HIV transmission among MSM, such as URAI, concurrent sexual partners, frequency of sex acts, and drug use (Beyrer, et al., 2012). In particular, the risk of HIV transmission through unprotected anal sex in MSM is nearly 18-fold higher than vaginal sex (Beyrer, et al., 2012).

The high incidence of other STIs including syphilis, chlamydia, gonorrhea, HPV, HSV, hepatitis B, and hepatitis C indicates on-going risky sexual activities and also serves as co-factors for more efficient acquisition of HIV (Mayer, 2011; Mayer, et al., 2012). High STI rates among MSM in high HIV prevalence settings create a vicious circle of synergism (Beyrer, et al., 2012) .

Only a few biomedical prevention interventions were found to be effective for MSM after 2005 (Sullivan et al., 2012). Condom use and daily oral PrEP have been proved to be effective in reducing HIV infection, but require high usage compliance (Sullivan, et al., 2012). Male circumcision prevents HIV transmission from female-to-male but not for male-to-male transmission (Mills, Cooper, Anema, & Guyatt, 2008; Wiysonge et al., 2011). Other biomedical interventions such as vaccine have failed to demonstrate their significant preventive efficacy in MSM population (Bartholow et al., 2005; Padian, Buve, Balkus, Serwadda, & Cates, 2008).

Behavioral prevention interventions have succeeded in reducing risk behaviors among MSM, particularly during the early stage of the HIV epidemic, but not in remarkably lowering HIV/STI incidence (Higa et al., 2013; Sullivan, et al., 2012). Face-to-face outreach is the major intervention delivery mode of these interventions (Brown & Diclemente, 2011; Higa, et al., 2013), and the vast majority of these studies were conducted in North America and Western Europe (Sullivan, et al., 2012). Nonetheless, a recent review by Higa and colleagues found only 13% (47/353) of behavioral interventions published between 1988-2010 in the US targeted at the MSM population, of which only two were Internet-based behavioral interventions (Higa, et al., 2013). Discrimination and violence against MSM, criminalization of same-sex behavior, scarcity of financial and infrastructural resources, and lack of cultural adapted training for health providers hampered the conduction of behavioral research, particularly in low and middle

income countries (Sullivan, et al., 2012). Efficient, sustained and adequate behavior interventions are challenging and critical to successfully reduce HIV transmission among MSM (Hong & Li, 2009; Johnson et al., 2008; Vergidis & Falagas, 2009).

EHealth, an emerging concept in the late twentieth century, is defined as using information and communication technology (ICT)—such as computers, mobile phones, and satellite communications—for health services and information, which integrates public health, medical informatics, and business (ICT Applications and Cybersecurity Division, Policies and Strategies Department, & ITU Telecommunication Development Sector, 2008; Vital Wave Consulting, 2009). Internet-based intervention is one of the technology-assisted strategies of eHealth and has been applied widely in health promotion, such as stress management, smoking cessation, and increasing physical activity (Ritterband & Tate, 2009). Its application in the HIV prevention intervention is new and needs further exploration and evaluation.

Description of the intervention

An Internet-based intervention, online counseling, Internet-operated therapeutic software, and other online activities (blogs, online support groups and social networks, podcasts) are four categories of Internet-supported therapeutic interventions (Barak, Klein, & Proudfoot, 2009). Internet-based intervention, or web-based intervention, is defined as

"*A primarily self-guided intervention programme that is executed by means of a prescriptive online programme operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention programme itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via*

the provision of sound health-related material and use of interactive Web-based components."(Barak, et al., 2009)

Internet-based interventions are broadly classified into three types: Internet-based education interventions, self-guided Internet-based therapeutic interventions, and human-supported Internet-based therapeutic interventions, based on the program content, multimedia options, online interactive activities, and supportive feedback and guidance (Barak, et al., 2009). Internet-based behavioral interventions to prevent HIV infection often fall into the category of therapeutic interventions, which combines the innovative technology and the health behavior theories to intervene in the self-management of chronic conditions, health promotion, and for mental health by changing cognitive, behavioral and emotional outcomes (Barak, et al., 2009; Murray, 2012; National Cancer Institute, et al., 2012).

Several advantages make the Internet as a tool for behavioral interventions: its ability to reach geographically dispersed or stigmatized individuals; recruitment of large samples in a short time period; timeless communication; anonymity; multiple modes and formats of communications (multimedia); interactivity; customization of contents; flexibility; and cost-effectiveness (Mathieu, McGeechan, Barratt, & Herbert, 2013; National Cancer Institute, et al., 2012; Noar, Black, & Pierce, 2009). There are also arguments about the disadvantages of Internet-delivered interventions: inequity access to the Internet both within a country and between countries and inadequate accessibility. The first disadvantage could widen health disparities in the sense that those individuals who do not have access to the Internet could not get the information (Murray, 2012). Even being able to log onto the Internet cannot guarantee completion of the intervention due to low literacy (accessibility) (Murray, 2012).

How the intervention might work

A wide variety of empirical studies have demonstrated the feasibility and efficacy of Internet-based interventions on clinical outcomes through behavioral changes (Bennett & Glasgow, 2009). Internet-based interventions hold promise through nine core components to produce behavior changes that ultimately lead to improvements of clinical outcomes: user characteristics, environment, the website program, website use, support, mechanisms of change, behavior change, symptom improvement, treatment maintenance (Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009) (Figure 4). Interventions grounded in a behavioral theory framework that use multiple behavior change techniques are more likely to be effective (Albarracin et al., 2005; Murray, 2012; Webb, Joseph, Yardley, & Michie, 2010). There are a number of health behavior theories available to help inform interventions development but whether and how these theories could affect the effectiveness of the Internet-based intervention are unclear. Whether an intervention achieves optimal effect is influenced by user characteristics, environmental factors, mechanisms of changes, and many other factors (Bennett & Glasgow, 2009; Ritterband, et al., 2009). Detailed explanations of each component and the relationships between each component are explicitly explained by Ritterand and colleagues (Ritterband, et al., 2009) (Figure 4).

Why it is important to do this review

Internet-based intervention studies to promote risk-reduction behaviors including RCTs and quasi-experimental intervention studies have been increasingly published in the past 10 years (Mathieu, et al., 2013; Ritterband, et al., 2009; Webb, et al., 2010). The overall effects of the Internet-based interventions on a variety of behavioral and clinical outcomes
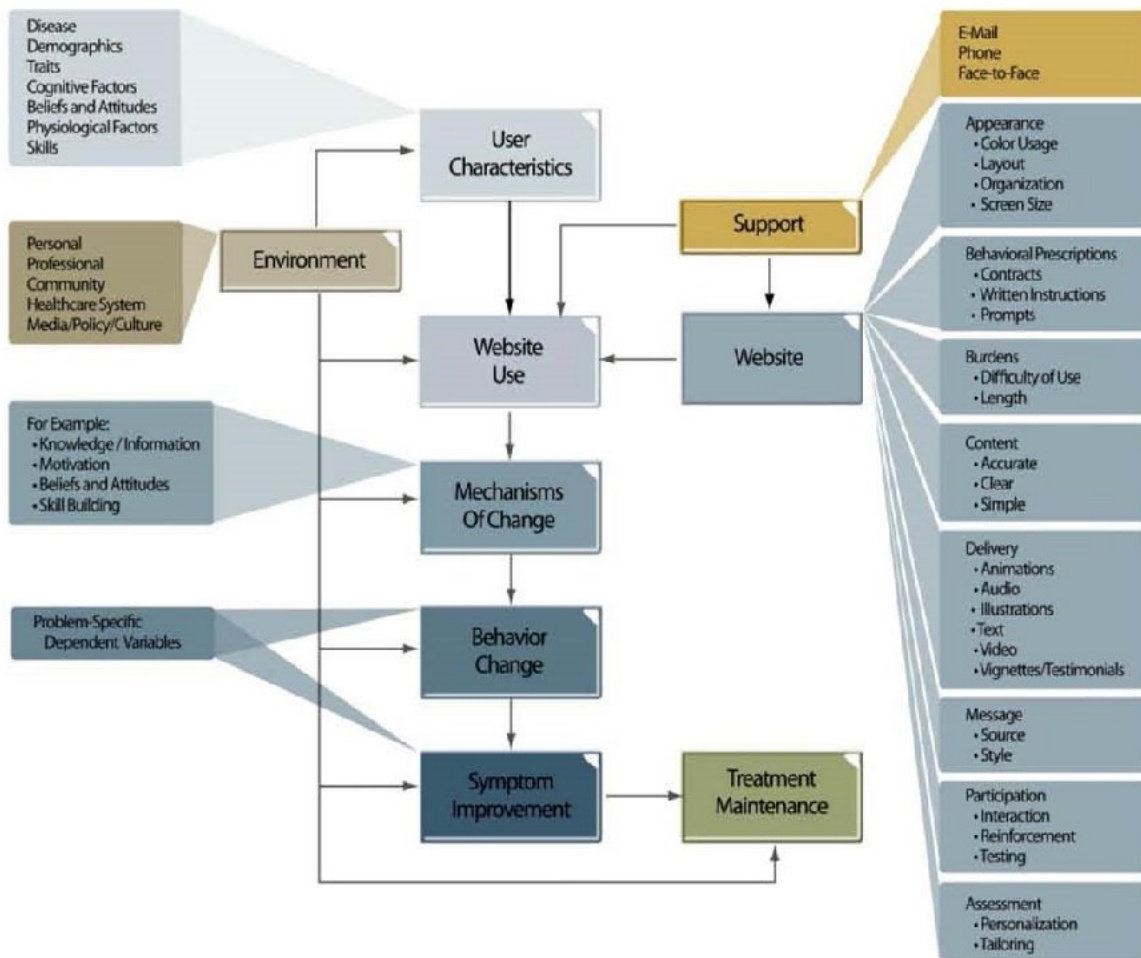
Figure 4. Model of Internet-based behavioral interventions (Ritterband, et al., 2009)

(Mathieu, et al., 2013; Murray, 2012; Webb, et al., 2010) and the effects on some behaviors such

as smoking cessation (Hutton et al., 2011; Myung, McDonnell, Kazinets, Seo, & Moskowitz,

2009) and physical activity (Lau, Lau, Wong del, & Ransdell, 2011; Vandelanotte, Spathonis,

Eakin, & Owen, 2007) are well documented in the literature. Despite expanding research on

Internet-based interventions in HIV prevention since the early 21st Century (Ybarra & Bull,

2007), little is known about its efficacy. Most of the existing literature is limited to general

descriptions of the applications and barriers of the Internet technology for HIV prevention interventions (Pequegnat et al., 2007; Rietmeijer & McFarlane, 2009; Swendeman & Rotheram-Borus, 2010). A recent meta-analysis of 12 RCTs reported that computer technology-based behavioral interventions (delivery via computer on screen or the Internet) was effective in increasing condom use, reducing frequency of sexual behavior and number of partners, and reducing incident STIs among various at-risk populations, two of which included MSM population (Noar, et al., 2009).

The global MSM community has been overwhelmingly affected by HIV infection and continues to contribute to the majority of the new HIV infections worldwide (De Cock, Jaffe, & Curran, 2012). Without many available and effective options of biomedical interventions for MSM, behavioral interventions are critical to curb HIV transmission (Berg, 2009; Johnson, et al., 2008; Vermund et al., 2013). Unlike other MARPs, MSM, young MSM in particular, frequently visit websites to seek sexual partners and engage in other activities. This, in turn, gives health care providers and public health professionals an unique opportunity to provide HIV prevention intervention via the virtual space in an anonymous, non-judgmental fashion (Bull, McFarlane, Lloyd, & Rietmeijer, 2004; Hospers, Kok, Harterink, & de Zwart, 2005; Swendeman & Rotheram-Borus, 2010). Behavioral interventions delivered through conventional methods (e.g., face-to-face) have demonstrated their effectiveness on reducing the number of partners for unprotected anal sex by 27% compared with minimal or no interventions; and by 17% beyond changes observed in the comparisons of standard or other interventions (Johnson, et al., 2008), particularly at group- and community-level (Lorimer et al., 2013). With increasing interventions delivered to MSM through the Internet, there is no clear evidence of their effectiveness compared with other interventions or standard care. Here, we present a systematic literature

review of the Internet-based behavioral interventions for reduction of HIV risk in the MSM population.

Objectives

To systematically review the literature on the effectiveness of Internet-based behavioral interventions for reducing risky sexual behaviors and preventing HIV infection compared with standard care, other, or no interventions in MSM population. The following key elements of the Internet-based HIV interventions among MSM were examined:

- Intervention strategies implemented in the studies

- Theoretical bases applied to these interventions

- Measurements of intervention outcomes

- Cultural and geographical differences of the interventions

- Methodological quality

Methods

Criteria for considering studies for this review

Types of studies

We included RCTs with both intervention and control groups and had a minimum of two study arms with participants randomly assigned to each arm. The comparison group received a different intervention or standard care or no intervention. We also included rigorously designed quasi-experimental studies which did not use comparison; specifically, they use one-group pre-

post design (Harris et al., 2004). All the interventions, regardless of publication status (published, unpublished, or in press) or language, were published between January 1985 and December 2011.

Types of participants

The target population was MSM aged 18 years or older, including homosexual or bisexual men, and male commercial sex workers who have sex with male clients, without restrictions on other demographic characteristics, e.g. race/ethnicity, educational level, social economic status, marital status, and nationality. Both HIV/STI positive and negative participants were included. Men who are born male but subsequently identifies themselves as females after undergoing gender transformation surgery (often referred to as 'transgender women') were not eligible for this review.

Types of interventions

Interventions delivered via the Internet were those designed to change behaviors and thus likely reduce HIV/STI incidence, including online video, chatroom, emails, and tutorials.

Comparison interventions included inactive interventions (e.g. routine standardized intervention, no intervention or wait list control) or active interventions (e.g. a different intervention approach).

Types of outcome measures

Any biomedical, behavioral or cognitive measurements related to the risk-reduction interventions were included.

Primary outcomes

Biomedical outcomes included:

- HIV incidence or prevalence

- STI incidence or prevalence

Secondary outcomes

Behavioral outcomes included:

- UAI

- UOI

- Condom use during UAI or UOI

- Number of regular or casual male sex partners

- Substance use during sex

- PrEP use

- Prior HIV testing

- HIV disclosure

Cognitive outcomes included:

- HIV- or STI-related knowledge

- Self-efficacy

- Outcome expectancies

- Willingness

Search methods for identification of studies

Global use of the Internet initiated in the late 80's and early 90's (Campbell-Kelly, Aspray, Ensmenger, & Yost, 2013). The earliest connection between the Internet and STIs was found in the MSM population in the late 90's (Bull & McFarlane, 2000; Klausner, Wolf, Fischer-Ponce, Zolt, & Katz, 2000; McFarlane, Bull, & Rietmeijer, 2000). Thus, the literature search was restricted to publications from January 1985 to December 2011, with no restrictions on language or publication status (published, unpublished, in press and in progress).

We first proposed a comprehensive search strategy according to *Cochrane Handbook of Systematic Reviews of Interventions* 5.1.0 (Lefebvre, Manheimer, & Glanville, 2011). We then submitted the strategy to Cochrane Review Group (CRG) on HIV/AIDS who helped identify all relevant literatures in the bibliographic databases and registered trials.

Electronic searches

Bibliographic database searches

The following electronic databases were searched for peer-reviewed journal articles, book/book sections, theses/dissertations, and grey literatures:

- CENTRAL (Cochrane Central Register of Controlled Trials)

- MEDLINE (via PubMed)

- EMBASE

- Africa: African Index Medicus

- CBM (Chinese Biomedical Literature Database)

- CNKI (China National Knowledge Infrastructure)

- Eastern Mediterranean: Index Medicus for the Eastern Mediterranean Region

- LILACS (Latin America and the Caribbean)

- IMSEAR (South-East Asia: Index Medicus for the South-East Asia Region)

- WPRIM (Western Pacific: Western Pacific Region Index Medicus)

- BIOSIS

- ERIC (Education Resources Information Center)

- PsycINFO

- PsycEXTRA

- World Health Organization Library Information System (WHOLIS)

- ProQuest Dissertations & Theses Database

- Web of Knowledge

- OpenSIGLE (System for Information on Grey Literature)

Appendix 1 details the search strategy for PubMed, which was modified for other electronic databases as needed.

Searching other resources

Non-bibliographic database searches

We searched the following electronic sources for conference abstracts or proceedings:

- Aegis archive of HIV/AIDS conference abstracts

  o British HIV/AIDS Association (2001-2011)

  o The European AIDS Clinical Society (2001-2005)

  o Conference on Retroviruses and Opportunistic Infections (1993-2008)

  o IAS HIV Pathogenesis and Treatment (2001-2009)

  o National AIDS Prevention Conferences (1999-2005)

  o National AIDS Update Conferences (2000-2005)

  o International AIDS Conferences (1985-2010)

- IAS HIV Pathogenesis and Treatment 2011 website

- Conference on Retroviruses and Opportunistic Infections websites (2009-2011)

Unpublished and ongoing study searches

ClinicalTrials.gov register was searched for ongoing registered trials.

Appendix 2 details the search strategy for the trial register.

Data collection and analysis

We conducted data collection under the guidance of *Cochrane Handbook of Systematic Reviews of Interventions* 5.1.0 (Higgins & Deeks, 2011).

Selection of studies

Two authors independently screened the titles and abstracts obtained from the comprehensive literature search. We then retrieved full texts of the potentially relevant reports. After careful examination for compliance with the eligibility criteria, we made final decisions about inclusion in the review. Disagreements during any steps were resolved by consensus through discussion between the two reviewers and the senior authors. See Figure 5 for the study screening and selection process.

Data extraction and management

We created a data extraction form according to the sample form on the Cochrane Review Group on HIV/AIDS website (Cochrane Review Group on HIV/AIDS, 2012) and *Cochrane Handbook of Systematic Reviews of Interventions* 5.1.0 (Higgins & Deeks, 2011; Schünemann et al., 2011). The data extraction form was pilot tested in ten of the selected articles for full text review and was revised as needed.

Two authors independently extracted data from the selected studies. Disagreements were resolved by consensus through discussion between the two reviewers and a senior author.

Assessment of risk of bias in included studies

Two authors independently assessed the risk of bias for each selected study using the domain-based evaluation tool recommended in *Cochrane Handbook for Systematic Reviews of Interventions* 5.1.0 (Higgins, Altman, & Sterne, 2011). Disagreements were resolved by discussions between the reviewers on each criterion and by consultations with senior authors. We

used standardized tables and figures to summarize "risk of bias" assessment (Higgins, et al., 2011).

We evaluated each study for seven domains to identify risk of 1) selection bias introduced from inappropriate random sequence generation and allocation concealment; 2) risk of performance bias introduced from inadequate blinding of participants, personnel; 3) detection bias introduced from inadequate blinding of outcome assessors; 4) attrition bias resulted from incomplete outcome data; 5) reporting bias due to selective reporting; and 6) other potential bias. For each domain an assessment of low risk of bias, high risk of bias, or uncertain risk of bias was determined according to domain-specific criteria (Higgins, et al., 2011).

- Random sequence generation
  - Low: investigators described a random component in the sequence generation process, such as the use of random number table, computer random number generator, coin tossing, etc.
  - High: investigators described a non-random component in the sequence generation process, such as the use of odd or even date of birth, pre-specified rules based on the day or date of admission, hospital, or clinic record number, judgment of the clinician, etc.
  - Unclear: insufficient information to permit judgment of bias.
- Allocation concealment
  - Low: participants and investigators enrolling participants cannot foresee assignment due to the use of central allocation, sequentially numbered, opaque, sealed envelopes, etc.

82

- High: participants and investigators enrolling participants can foresee assignment due to the use of an open random allocation schedule, unsealed or non-opaque assignment envelopes, date of birth, etc.
- Unclear: insufficient information to permit judgment of bias or the method not described.

- Blinding of participants and personnel
  - Low: no blinding or incomplete blinding that is not likely to introduce bias; blinding of participants and key study personnel that could have been unlikely to be broken.
  - High: no blinding or incomplete blinding that is likely to introduce bias; blinding of participants and key study personnel that could have been likely to be broken.
  - Unclear: insufficient information to permit judgment of bias or no description of this information.
- Blinding of outcome assessment
  - Low: no blinding of outcome assessment but is unlikely to introduce bias; blinding of outcome assessment that could have been unlikely to be broken.
  - High: no blinding of outcome assessment that is likely to introduce bias; blinding of outcome assessment that could have been likely to be broken.
  - Unclear: insufficient information to permit judgment of bias or no description of this information
- Incomplete outcome data
  - Low: no missing outcome data; reasons for missing outcome data unlikely to be related to true outcome; missing outcome data balanced in number across groups;

the proportion of missing outcomes is not enough to have clinically relevant impact on the effect estimates compared with observed event risk for binary outcome data; plausible effect size among missing outcomes is not enough to have a clinically relevant impact on observed effect size for continuous outcome data; missing data is appropriately imputed.

- o High: reason for missing outcome data is likely to be related to true outcome, with either imbalance in number across groups or reasons for missing data; the proportion of missing outcomes is enough to have clinically relevant impact on the effect estimates compared with observed event risk for binary outcome data; plausible effect size among missing outcomes is enough to have a clinically relevant impact on observed effect size for continuous outcome data; missing data is inappropriately imputed.
- o Unclear: insufficient reporting of attrition or exclusions to permit judgment of bias; no description of the missing data.

- Selective reporting
  - o Low: a protocol is available which clearly states all the outcomes as the same as in the final trial report; a protocol is unavailable but the published reports including all expected outcomes are clear
  - o High: the primary outcome differs between the protocol and final trial report (e.g., incomplete report of pre-specified outcomes or report of outcomes that are not pre-specified) Unclear: insufficient information to permit judgment of this bias.

- Other bias
  - o Low: no evidence of other sources of bias.

- o High: potential bias related to a specific study design or being fraudulent or other problems.

- o Unclear: insufficient information to permit judgment of from other sources or insufficient rationale for identified problems that will introduce bias.

Main Results

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies;

Characteristics of ongoing studies; Characteristics of studies awaiting classification

Results of the Search

Bibliographic databases yielded 487 peer-reviewed journal articles, books/book sections, and theses/dissertations. Non-bibliographic sources searches identified 1009 conference abstracts and 8 registered RCTs. Screening of the title and abstracts removed 110 duplicates and 1365 irrelevant references, a majority of which used Internet as a recruitment approach for non-intervention studies. Twenty-nine potential eligible references were retrieved for full-text scrutiny and seven of them were finally included in the review. (Figure 5)

487 records identified through bibloigraphic database searching

- PubMed 75
- PsycINFO 265
- Web of Knowledge 11
- CENTRAL 8
- EMBASE 25
- ERIC 6
- WPRIM 11
- ProQuest Dissertations & Theses Database 40
- BIOSIS 46

1017 records identified through non-bibliographic database searching

- 1009 conferences abstracts
  - 62 from 5th IAS Conference on HIV Pathogenesis and Treatment in 2009
  - 177 from 6th IAS Conference on HIV Pathogenesis and Treatment in 2011
  - 643 from XVIII International AIDS Conference in 2010
  - 127 from Aegis archive
- 8 registered trials at Cinicaltrials.gov

1394 records after duplicates removed

- 110 identical journal articles

1365 records excluded

- 306 journal articles not eligible
- 57 theses/dissertations not eligible
- 8 books/book sections not eligible
- 1003 conference abstracts not eligible

1394 records screened

22 records excluded

5 full-text articles did not meet the eligibility

- 2 papers not rigorously designed quasi-experimental study
- 1 paper not studying the efficacy of the intervention itself
- 1 paper not a RCT, just a programmatic intervention
- 1 paper merely a description of an intervention without efficacy results

1 eligible dissertation containing the same information as one included paper

2 conference abstracts that are identical with full journal articles included

1 eligible conference abstract showing result of long-term efficacy of an original included study

1 eligible conference abstract showing result of a sub-group analysis of an original included study

4 registered trials that have completed and published results in journals

4 records awaiting classifications

4 eligible conference abstracts without full manuscripts

4 ongoing records

4 eligible registered trials for ongoing studies

29 records assessed for eligibility through full-text searching

- 12 full-text articles
- 1 dissertation
- 8 conference abstracts
- 8 registered radomized controlled trials

7 studies included in systematic review

Figure 5. Flowchart of study screening and selection

Included studies

Study design

Six of the seven included studies (86%) were RCTs (Blas et al., 2010; Bowen, et al., 2007; Carpenter, Stoner, Mikko, Dhanak, & Parsons, 2010; Kerani, Fleming, DeYoung, & Golden, 2011; Lau, Lau, Cheung, & Tsui, 2008; Rosser et al., 2010) and one was a quasi-experimental, single-group pretest-posttest design (Chiasson, et al., 2009). Of the six RCTs, five had two arms with one intervention and one control arm (Blas, et al., 2010; Bowen, et al., 2007; Carpenter, et al., 2010; Lau, et al., 2008; Rosser, et al., 2010) while the other had three intervention arms and one control arm (Kerani, et al., 2011). All studies but one (no report of the study year) (Lau et al., 2008) were conducted between 2004 and 2009. The majority of the participants were recruited via banner advertisement through popular gay websites in six studies (Blas, et al., 2010; Bowen, et al., 2007; Carpenter, et al., 2010; Chiasson, et al., 2009; Lau, et al., 2008; Rosser, et al., 2010). Face-to-face recruitment (Bowen, et al., 2007) and outreach in MSM venues (Lau, et al., 2008) were also implemented to reach additional individuals in two studies. The number of participants recruited through these complimentary approaches, however, was small relative to those recruited on-line. One study selected participants from case reports submitted by medical providers to the county public health department for partner notification and follow-up (Kerani, et al., 2011). Each study developed its own study website for the intervention and other study procedures such as enrollment and baseline and follow-up surveys. Study duration lasted between three and twenty months and the follow-up period varied from one week to one year. Two studies followed participants for three months after interventions (Carpenter, et al., 2010; Chiasson, et al., 2009), and two for six months (Blas, et al., 2010; Lau,

et al., 2008). Only one study obtained repeated measures of the outcome during follow-up (Rosser, et al., 2010).

Study setting

Five studies (71%) were conducted in US (Bowen, et al., 2007; Carpenter, et al., 2010; Chiasson, et al., 2009; Kerani, et al., 2011; Rosser, et al., 2010). Four of them were conducted in multiple cities or states with three in urban cities (Carpenter, et al., 2010; Chiasson, et al., 2009; Rosser, et al., 2010) and one in rural areas (Bowen, et al., 2007); one was in Seattle, Washington (Kerani, et al., 2011). The other two studies were performed in Peru (Blas, et al., 2010) and Hong Kong Special Administrative Region (Lau, et al., 2008) (Table 8).

Four studies (three RCTs and one quasi-experimental study) were fully conducted online from participant recruitment through outcome measurement (Blas, et al., 2010; Carpenter, et al., 2010; Chiasson, et al., 2009; Rosser, et al., 2010). Three RCTs were partially completed online (Bowen, et al., 2007; Kerani, et al., 2011; Lau, et al., 2008). Bowen 2007 and Lau 2008 performed all the procedures online plus adding outreach methods to recruit participants (Bowen, et al., 2007; Lau, et al., 2008). Kerani 2011 conducted the study face-to-face with an Internet-delivered intervention (Kerani, et al., 2011).

Sample size

A total of 2,076 eligible participants were enrolled in the six RCTs, 1,950 (94%) of whom were randomized, and 1,536 (74%) completed the study. Participants dropped out of the study at different rates in different stages after randomization, ranging from 1% to 34% (Blas, et al., 2010; Bowen, et al., 2007; Rosser, et al., 2010). Only the study in Peru had 100% retention (Blas, et al., 2010). In the quasi-experimental study, a total of 3,052 participants were enrolled, 2,707 (89%) of whom completed the pre-intervention assessment and 522 (17%) completed the

Table 8. Summary of the study setting, participants and study design of the seven included studies.

Study [a]	Country	City/ region	Recruitment method(s) of participants	Eligibility [b]	Period	Duration	Incentives
Blas 2010	Peru	Lima	Banner ads on 5 commercial gay websites and 2 advocacy gay websites redirecting to the study website	Being a man who reported having had sex with men; resident of Lima, Peru; answer the survey from Lima, Peru; not having been tested for HIV during the last year; having a confirmed email address; self-reporting HIV-	Oct 2007-Apr 2008	6 months	No
Bowen 2007	USA	rural areas from 29 states	Banners at a popular website + face-to-face (6.7%)	Being man who had sex with another man in the last year; living in a rural area ("town of 75000 or less and more than 60 min drive from an urban area")	Apr 2004-June 2004	3 months	Yes
Carpenter 2010	USA	multi-cities of large- and medium-sized	Banner ads on 4 same-sex community websites	Being man having engaged in unprotected sex (oral or anal) with a man within the last 3 months; HIV-/unknown; were willing to provide an active email address for study-related contact; being able to read and understood English; residing in the US; and having not participated in other HIV intervention study in the past year	June 2006 -Feb 2007	8 months	Yes
Chiasson 2009	USA	48 states	Banner ads on one of the largest gay subscription-based sexual meeting websites	Not reported	Oct 2005-Jan 2006	4 months	No
Kerani 2011	USA	King County, Seattle, WA	Contacting MSM infected with gonorrhea or chlamydial from the PHSKC's case report submitted by medical providers	Being English-speaking, reported that not all of their partners were treated, and that they had had sex with a man in the 60 days preceding diagnosis, the case report of gonorrhea or chlamydial infection was received <2 weeks after the patient's treatment, and the patient had not been diagnosed with HIV or syphilis in the 90 days before their gonorrhea or chlamydia diagnosis	July 2007-Mar 2009	20 months	No
Lau 2008	China	Hong Kong, SAR	Ads on local MSM websites + venues (bars, saunas, beaches) frequented by MSM	Being males who had engaged in either oral or anal sex with another man in the last 6 months, self-reporting to be regular Internet users, being HK residents of and able to read Chinese	Not Reported	6 months for intervention	Yes
Rosser 2010	USA	N/A	Banner ads on 2 of the nation's largest gay websites and invitation emails to previous participants leading to the study site	Being male, a US resident who had a recent history of engaging in unprotected anal sex with at least one other man	Dec 2007-Jan 2009	13 months	Yes

[a] Study by Chiasson MA, et al. (2009) is a quasi-experimental single group pretest-posttest study, all the others are randomized controlled trials
[b] Participants in the study by Carpenter KM, et al. (2010) were 18-39 years old, all the others were ≥18 years old.

68

post-intervention assessment (Chiasson, et al., 2009). Three studies had retention rates over 75% (Blas, et al., 2010; Bowen, et al., 2007; Rosser, et al., 2010) (Table 9).

Participants

All studies included adult MSM aged 18 years or older but differed in a number of other characteristics, including eligibility criteria. The majority of participants were between 18 and 30 years old in the RCTs; 20% of participants were between this age range in the quasi-experimental study (Chiasson, et al., 2009). One study specifically recruited only young MSM aged 18-39 years old (Carpenter, et al., 2010). Among the five studies reporting educational attainment, over half of participants had attended college or university. In the five studies conducted in the US, over 70% of participants were Caucasians; 6-15% were Hispanic/Latinos; and only 4-6% were African American (Bowen, et al., 2007; Carpenter, et al., 2010; Chiasson, et al., 2009; Kerani, et al., 2011; Rosser, et al., 2010). Three RCTs included HIV negative or HIV status unknown participants (Blas, et al., 2010; Carpenter, et al., 2010; Kerani, et al., 2011), one included HIV-infected participants (Rosser, et al., 2010), and three did not report participants' HIV status (Bowen, et al., 2007; Chiasson, et al., 2009; Lau, et al., 2008) (Table 9).

Interventions and comparisons

The specific delivery modes of the interventions included online video (Blas, et al., 2010; Chiasson, et al., 2009), modules (Bowen, et al., 2007; Rosser, et al., 2010), tutorials (Carpenter, et al., 2010), e-card (Kerani, et al., 2011), and email (Lau, et al., 2008). Four studies reported a behavioral theory that was applied to the intervention developments, including health-belief model (Blas, et al., 2010), social cognitive theory (Bowen, et al., 2007), information-motivation-behavioral skills (IMB) model (Carpenter, et al., 2010), and sexual health model (Rosser, et al., 2010). Three interventions were interactive, either requiring participants to engage in activities

90

Table 9. Summary of the interventions and participants demographic characteristics.

Study[a]	# randomized	Retention rate	Online Intervention	Behavioral theory applied	Comparison	Age	Education	Ethnicity	Sex orientation[b]	HIV[c] infection
Blas 2010 [b]	239 (97 NGI+ 142 GI) in the intervention	100%	5-minutes video for NGI and GI, respectively	health-belief model & stage of change	Standard public health text obtained from an intervention to increase HIV testing in Mexico	NGI Mean=26.4 Range: 18-50 GI Mean=26.9 Range: 18-52	NGI <High School: 6.3% High school graduate: 13.5% University/Technical non-graduate: 34.4% University/Technical graduate: 45.8% GI <High School: 2.1% High school graduate: 12.8% University/Technical non-graduate: 39.0% University/Technical Graduate: 46.1%	N/R	NGI Homosexual:21.6% Bisexual: 78.4% GI Homosexual: 91.5% Bisexual: 78.4%	100% HIV-/unknown
	220 (90 NGI+ 130 GI) in the control	100%	5-minutes video			NGI Mean=26.2 Range: 18-54 GI Mean=25 Range: 18-61	NGI <High School: 2.2% High school graduate: 4.4% University/Technical non-graduate: 42.2% University/Technical Graduate: 41.1% GI <High School: 3.9% High school graduate: 17.3% University/Technical non-graduate: 41.7% University/Technical Graduate: 37.0%		NGI Homosexual:30.0% Bisexual: 70.0% GI Homosexual: 97.7% Bisexual: 2.3%	
Bowen 2007	90 (39 in the intervention and 51 in the control)	87%	Two ~20-minutes' interactive modules including dialogue and interactive activities and graphics each	N/A	Wait-list	Intervention 18-21: 18% 22-25: 41% 26-33: 23% 34+: 18% Control 18-21: 22% 22-25: 22% 26-33: 26% 34+: 31%	N/R	Intervention Non-White: 23% White: 77% Control Non-White: 16% White: 84%	Intervention Gay: 92% Bisexual: 8% Control Gay: 91% Bisexual: 9%	N/R
Carpenter 2010	199 (99 in the intervention and 100 in the control)	56%	1.5-2 hours interactive tutorials including interactive exercises, multi-media presentation, audio clips, and didactic	Social cognitive theory	A stress reduction training program (eTranquility)	N/R	<12th grade or GED: 2.7% 12th grade or GED: 13.4% 1 year college/tech school: 11.6% 2 years college/tech school: 13.4% > 2 years college/tech school: 58.9%	Hispanic/Latino:15.2% African American: 6.3% Asian American: 5.4% Hawaiian Pacific Islander: 0.9% Native American:7.1% White: 80.4% Other: 2.7%	N/R	HIV-: 83.9% HIV+: 0% Unknown: 16.1%

Study	N	%	Intervention	Theory	Comparison	Age	Education	Race/Ethnicity	Sexual orientation	HIV status
			materials							
Chiasson 2009	2707 completed baseline survey	19%	9-minutes video ("The Morning After")	Information-Motivation - Behavioral skills-model	Self-comparison	18-29: 20% 30-39: 36% 40+: 44%	No college degree: 45% College degree+: 55%	White: 74% Black: 4% Hispanic: 14% Asian and other: 6% Multi-race: 2%	Homosexual:92% Bisexual:8%	N/R
Kerani 2011	75 (16 in PDPT, 17 in inSPOT, 24 in inSPOT/ PDPT, 18 in standard care)	70%	InSPOT website	Developmental, social and cognitive-constructivist learning theories and strategies	Standard partner management (public health staff assist patients in partner notification)	Mean ± SD= 31.1±9.0	N/R	White: 76.9% Black: 5.8% Asian/Pacific Islander: 7.7% Latino: 5.8% Other: 3.9%	N/R	100% HIV-/unknown
Lau 2008	477	59%	Educational emails; risk behavior log forms via emails; direct online /email contact	N/A	Null control	Intervention ≤20:2.1% 21-30:3.6% 31-40:2.1% ≥41:2.1% Control ≤20:27.1% 21-30:4.3% 31-40:8.6% ≥41: 0%	Intervention form 1-5: 32.9% form 6-7: 8.6% University or above: 58.6% Control form 1-5: 30.0% form 6-7: 6.4% University or above: 63.6%	Intervention Chinese: 99.3% non-Chinese: 0.7% Control Chinese: 99.3% non-Chinese: 0.7%	N/R	N/R
Rosser 2010	650 (337 in the intervention and 313 in the control)	76%-99%	Interactive modules for active learning (*Sexpulse* Program)	N/A	Null control	18-25:3.5% 26-35:4.5% 36-45:7.7% >45:14.3%	<high school or high school graduate: 7.9% Some college education: 34.3% College degree: 22.6% Graduate/professional school: 35.2%	White: 68.2% African American: 6.3% Latino/Spanish: 15.1% Asian: 3.5% Other: 6.9%	Homosexual: 91.4% Bisexual: 8.6%	HIV+: 21.6% HIV-: 78.4%

[a] Study by Chiasson MA, et al. (2009) is a quasi-experimental single group pretest-posttest study, all the others are randomized controlled trials

[b] Results were reported with the first row in the cell for the intervention group and the second row for the control group; [bc] These characteristics were self-reported.

NGI: non-gay identified; GI: gay identified; SD: standard deviation; N/A: not applicable; N/R: not reported

during interventions (Bowen, et al., 2007; Carpenter, et al., 2010), or requiring participants to send confirmation emails upon receiving interventions (Lau, et al., 2008). The duration of the intervention varied from several minutes to several weeks. The comparison arms in the RCTs were classified into two types: active interventions which entailed a training program unrelated to HIV prevention (Carpenter, et al., 2010); inactive interventions including standard public health text (Blas, et al., 2010), a standard partner notification plan (Kerani, et al., 2011), waitlist (Bowen, et al., 2007), and null control (Lau, et al., 2008; Rosser, et al., 2010). All the studies received ethical approval and informed consent prior to participant enrollment.

Outcomes

The major outcomes studied were risky sexual behaviors: 1) unprotected anal sex (Carpenter, et al., 2010; Chiasson, et al., 2009; Lau, et al., 2008; Rosser, et al., 2010); 2) consistent condom use during anal sex (Lau, et al., 2008); 3) unprotected oral sex (Lau, et al., 2008); and 4) sexual partners (Chiasson, et al., 2009; Lau, et al., 2008). HIV testing was another common outcome reported in four studies (Blas, et al., 2010; Chiasson, et al., 2009; Kerani, et al., 2011; Lau, et al., 2008). Two studies reported HIV knowledge (Bowen, et al., 2007; Lau, et al., 2008). Other outcomes of interests were other STIs (Kerani, et al., 2011; Lau, et al., 2008), drug and alcohol use (Chiasson, et al., 2009), HIV disclosure (Chiasson, et al., 2009), and self-efficacy and outcome expectancy towards safe sex (Bowen, et al., 2007). We contacted the authors if necessary to clarify the results presented in the paper (Table 10).

Table 10. Summary of the study outcomes.

Study [a]	Outcome	Statistical methods used	Results
Risky sexual behaviors			
Carpenter 2010	Number of UAI with male partners **in the past 3 months**	Multivariate analysis of variance (MANOVA) with repeated measures	With any partner, time effect: F=12.64, P=0.001; group*time effect: N/A With partner of HIV+/unknown, time effect: F=7.59, P=0.007; group*time effect: F=7.59, P=0.007
Chiasson 2009	Having UAI **at last sex**	Exact McNemar test	OR=0.55, 95%CI: 0.38-0.79, P=0.001
Rosser 2010 [b]	Self-reported number of male partners with whom a participant engaged in UAI (UAIMP) **in the last 3 months**	Random effects negative binomial regression models	At 3-month, IRR=0.844, 95%CI: 0.704-1.013, P=0.068 At 12-month, IRR=0.998, 95%CI: 0.952-1.046, P=0.937
Lau 2008 [c]	Consistent condom use when having anal sex with regular MSM partner (among those having anal sex with non-regular MSM partner)	Chi-square test	RR=0.98, 95% CI: 0.81-1.18, P=0.81
	Consistent condom use when having anal sex with non-commercial non-regular MSM partner (among those having anal sex with regular MSM partner)	Chi-square test	RR=1.01, 95% CI: 0.82-1.44, P=0.54
	Consistent condom use when having oral sex with non-commercial non-regular MSM partner (among those having oral sex with non-regular MSM partner)	Chi-square test	RR=0.83, 95% CI: 0.26-2.67, P=0.76
	Consistent condom use when having oral sex with regular MSM partner (among those having anal sex with regular MSM partner)	Chi-square test	RR=0.58, 95% CI: 0.24-1.44, P=0.23
Chiasson 2009	Having casual partner **at last sex**	Exact McNemar test	OR=0.53, 95%: 0.34-0.80, P=0.002
	Having multiple partners **at last sex**	Exact McNemar test	OR=1.50, 95%CI: 0.99-2.30, P=0.06
Lau 2008 [c]	Having anal sex with non-commercial non-regular MSM partner	Chi-square test	RR=0.93, 95%CI: 0.68-1.26, P=0.62
	Having anal sex with regular MSM partner	Chi-square test	RR=0.88, 95%CI: 0.65-1.19,P=0.39
	Having oral sex with non-commercial non-regular MSM partner	Chi-square test	RR=0.92, 95%CI: 0.71-1.20, P=0.55
	Having oral sex with regular MSM partner	Chi-square test	RR=0.88, 95%CI: 0.69-1.14, P=0.34
	Having regular MSM partner	Chi-square test	RR=0.83, 95% CI: 0.66-1.05, P=0.12
	Having commercial MSM partner	Chi-square test	RR=0.50, 95% CI: 0.21-1.20, P=0.11
	Having non-commercial non-regular MSM partner	Chi-square test	RR=0.93, 95% CI: 0.74-1.17, P=0.55
	Having recruited MSM partner via the Internet	Chi-square test	RR=1.12, 95% CI: 0.86-1.46, P=0.40
	Having sex partner in Mainland China	Chi-square test	RR=1.33, 95% CI: 0.47-3.74, P=0.58
HIV Testing			
Blas 2010	Planning to get tested for HIV in the next 6 months	Mantel Haenszel adjusted RR	RR=1.75, 95% CI: 0.77-3.97

Gay identified MSM	Planning to get tested for HIV in the next 30 days	Mantel Haenszel adjusted RR	RR=1.54, 95% CI: 0.74-3.20
	Made an Internet appointment	Mantel Haenszel adjusted RR	RR=1.11, 95% CI: 0.88-1.39
	Attended the clinic	Mantel Haenszel adjusted RR	RR=1.07, 95% CI: 0.40-2.85
Blas 2010	Planning to get tested for HIV in the next 6 months	Mantel Haenszel adjusted RR	RR=1.43, 95% CI: 0.87-2.36
Non-gay identified	Planning to get tested for HIV in the next 30 days	Mantel Haenszel adjusted RR	RR=2.77, 95% CI: 1.42-5.39
MSM[d]	Made an Internet appointment	Mantel Haenszel adjusted RR	RR=1.48, 95% CI: 1.13-1.95
	Attended the clinic	Mantel Haenszel adjusted RR	NA[e]
Chiasson 2009	Self-reported HIV testing	Exact McNemar test	OR=1.45, 95% CI: 1.02-2.07, P=0.03
Kerani 2011 [f]	Mean number of partners tested for HIV	Poisson regression with robust standard errors	PDPT: adjusted means = 0.72, 95%CI: 0.37-1.43; inSPOT: ratio of adjusted means = 0.54, 95%CI: 0.24-1.22
Lau, JTF 2008[c]	Self-reported having VCT in the last 6 months	Chi-square test	RR=1.29, 95% CI: 0.72-2.33, P=0.49
HIV knowledge			
Bowen 2007	HIV knowledge grounded in 13 questions	Repeated measures of analysis of covariance	B=2.08, 95% CI: 1.15-2.71
Lau 2008[c]	number of appropriate responses given HIV knowledge ≥4 (out of 6)	Chi-square test	RR=0.99, 95%CI: 0.94-1.05, P=0.80
Other outcomes			
Bowen 2007	Self-efficacy on safe sex assertiveness (SSA)	Repeated measures of analysis of covariance	B=0.31, 95%CI: 0.08-0.53
	Self-efficacy on safe sex communication (SSC)	Repeated measures of analysis of covariance	B=0.31, 95%CI: 0.09-0.51
Bowen 2007	Outcome expectancy on condom use (OCU)	Repeated measures of analysis of covariance	B=0.30, 95%CI: 0.09-0.51
	Outcome expectancy on insisting on safer sex (OISS)	Repeated measures of analysis of covariance	B=0.34, 95%CI: 0.06-0.43
Chiasson 2009	Used any drugs at last sex	Exact McNemar test	OR=1.84, 95%CI: 1.21-2.82, P=0.003
Chiasson 2009	Used any alcohol at last sex	Exact McNemar test	OR=0.88, 95%CI: 0.60-1.30, P=0.51
Chiasson 2009	HIV disclosure (asks and tells HIV status)	Exact McNemar test	OR=3.37, 95%CI: 1.20-5.95, P<0.001
Kerani 2011 [f]	Mean number of partners tested for syphilis	Poisson regression with robust standard errors	PDPT: adjusted means= 0.63, 95%CI: 0.29-1.39; inSPOT: adjusted means= 0.44, 95%CI: 0.17-1.11
Lau 2008[c]	Contracting STD in the last 6 months	Chi-square test	RR=0.67, 95%CI: 0.19-2.31, P=0.75

[a] Study by Chiasson MA, et al. (2009) is a quasi-experimental single group pretest-posttest study, all the others are randomized controlled trials.

[b] RR was adjusted for age, race and income.

[c] RR and 95%CI were calculated from Chi-square test results provided.

[d] RR was adjusted for age and sexual orientation.

[e] RR cannot be estimated due to zero cell.

[f] Adjusted means were produced by including both PDPT and inSPOT in the Poisson regression model. No other covariates were adjusted for.

RR: risk ratio; OR: odds ratio; IRR: incident rate ratio; N/A: not applicable

Excluded studies

We excluded five journal articles and four conference abstracts that were initially included after screening because they appeared to meet the eligibility criteria. Two of the studies were ineligible quasi-experimental studies (Adam et al., 2011; Rhodes, et al., 2011). The pre-test and post-test studies involved two separate cross-sectional studies with different sample. Both of the studies collected pre-test data in one group of participants and post-test data in another. We excluded the third study because it tested different ordering of 3 individual modules within a complete intervention package and as a result all participants received the intervention and there was no control group (Bowen, Williams, Daniel, & Clayton, 2008). The remaining two excluded studies were a programmatic intervention (Klausner, Levine, & Kent, 2004) and development of an intervention without reporting efficacy results (Kok, Harterink, Vriens, Zwart, & Hospers, 2006). Two of the excluded conference abstracts were published in full journal articles that were included in the review (Chiasson, Shaw, Humberstone, & Hirshfield, August, 2006; Smolenski, Wilkerson, & Rosser, July, 2010a). The other two reported results of the long-term efficacy of an original included study (Daniel, Bowen, Williams, Clayton, & Ross, 2008) and results of a sub-group analysis of an original included study (Smolenski, Wilkerson, & Rosser, July, 2010b). We also excluded one dissertation that had the same information as an included study (Blas, 2009).

Ongoing studies

We included four ongoing registered trials (Hunter College, 2011; Nova Southeastern University, 2011a, 2011b; University of Illinois, 2009). One trial intervened bisexual MSM with African descent (Nova Southeastern University, 2011b). Three of them targeted young MSM aged 18-29 years old (Hunter College, 2011; Nova Southeastern University, 2011a; University of

Illinois, 2009), of which one specifically focused on Latino young men (Nova Southeastern University, 2011a). The ongoing trials are exclusively pilot studies in the United States, with the targeted sample sizes being no more than 200 individuals (40-200).

Studies awaiting classification

We included four conference abstracts without full manuscripts published in the 'studies awaiting classification (Catalani & Castaneda, July, 2011; Davidovich, de Wit, & Stroebe, July, 2004; De Wit & Adam, August, 2008; Harterink, Hospers, Vriens, Kok, & De Zwart, August, 2006).

Risk of bias in included studies

See: risk of bias description in 'Characteristics of included studies', illustration in Figure 6 and Figure 7.

Allocation

Among six RCTs, only two studies reported their approaches for random sequence generation: one used a random number generator (Blas, et al., 2010) and the other applied the random number table (Carpenter, et al., 2010). The remaining studies described random assignment of intervention by computer without specifying the exact method (Bowen, et al., 2007; Kerani, et al., 2011; Lau, et al., 2008; Rosser, et al., 2010).

Most RCTs had low risk of bias for the sequence allocation concealment. Three studies reported using computer algorithms for intervention assignments (Blas, et al., 2010; Carpenter, et al., 2010; Rosser, et al., 2010) and three reported using computer to automatically assign the interventions (Bowen, et al., 2007; Kerani, et al., 2011; Lau, et al., 2008). Thus, the allocation sequence could be protected before and until assignment without any human foreknowledge.
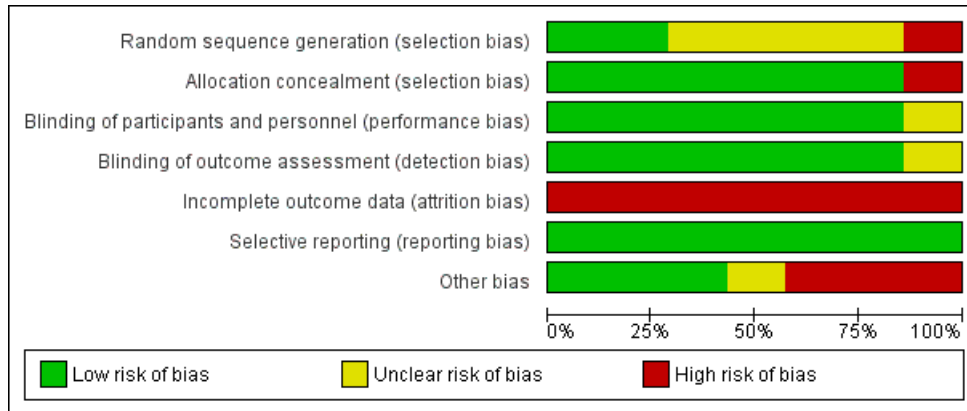
Figure 6. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies


Figure 7. Risk of bias summary: review authors' judgments about each risk of bias item for each included study

However, adequate concealment of the allocation sequence is not sufficient to prevent selection bias if assignments are not random. Risk of bias was high for the quasi-experimental study because it was not an RCT by design (Carpenter, et al., 2010).

Blinding

No specific information on blinding was reported for participants, personnel or outcome assessors in all studies. It is unrealistic to blind participants from the behavioral interventions they receive. However, these domains had low risk of bias in all studies except Kerani 2011. Intervention assignment, implementation, and self-reported outcomes all occurred via the Internet, thereby ensuring complete anonymity of participants. It is unlikely that there were any interactions between study personnel and the participants during the intervention implementations.

In Kerani 2011 study, participants completed the study procedure either through face-to-face or telephone communication and the outcome were assessed by disease intervention specialists and original patient interview (Kerani, et al., 2011). The authors did not mention blinding of participants, personnel or outcomes assessors. It is likely that some or all of them were not blinded to the intervention information.

Incomplete outcome data

Incomplete outcome data are subject to high risk of bias across all studies due to attrition and exclusions in all studies. Attrition rates were relatively high and missing values were also common in the analyses of the outcome variables.

Although some studies reported intent-to-treat (ITT) analysis, certain outcome variables were still missing (Blas, et al., 2010; Bowen, et al., 2007). Ideally, in an ITT analysis, all outcome data on all participants after randomization should be included in the analyses

regardless of the interventions received (Higgins, et al., 2011). In reality, however, missing values still occur for outcome variables, particularly in behavioral research where self-reported outcomes are missing for all participants lost to follow-up (Higgins, et al., 2011; Johnson, 2009). Thus, the results of these studies are still subject to attrition bias.

There are several reasons leading to high risk of bias in the included studies. First, baseline characteristics differed for study completers and non-completers. Completers and non-completers in Carpenter 2010 differed according to race and HIV status (Carpenter, et al., 2010). If these two factors were associated with the outcome measurements and such differences were not balanced in the intervention group and control group, the outcomes could be biased. For example, non-completers were more likely to be African American. If they were more likely to drop out in the intervention group and they actually had higher risk of unprotected sex, the intervention effect on UAI could be biased away from the null. Second, attrition of participants differed across intervention groups. In Rosser and colleagues' study, the attrition rates tended to be higher in the intervention group compared with the control group at each outcome measurement time point (Rosser, et al., 2010). No statistical analyses or reasons for attrition between the intervention and control groups were reported in the manuscript. Assuming the intervention has an effect, it could be underestimated if those who dropped out of the study also tended to have fewer sexual partners. Third, inappropriate imputation-last observation carried forward, was done by Bowen et al. The outcomes measured at baseline (T_1) were assumed to hold for subsequent measures at follow-up time (T_2) among those who were missing data at T_2 (Bowen, et al., 2007). There were 13% and 14% of the participants lost to follow-up at T_2 in the intervention and control groups, respectively. When carrying the scores at T_1 to T_2 for these non-

completers, the intervention effect could be biased towards the null because the intervention is expected to improve the outcome measures, but these improved outcomes were missing.

Selective reporting

All included studies had low risk of bias. The authors reported results for all outcomes pre-specified in their methods. However, since only one protocol was available (Blas, et al., 2010), we were unable to assess any selective reporting of outcomes in the methods section compared to the protocols.

Effects of interventions

We were unable to estimate a summary effect estimate of the interventions due to the heterogeneity of the interventions developed and the outcomes measured and reported. It is also impossible to convert many of the reported outcome variables to standard outcome measures to calculate a pooled estimate. Instead, we provide a narrative summary of the results with further details in Table 10.

There were no studies that reported on the outcome of HIV and STIs incidence.

Risky sexual behaviors

Three trials and one quasi-experimental study assessed the intervention effects on unprotected anal sex with male partners by measuring UAI or consistent condom use. Carpenter 2010 found out that the number of UAI acts with male partners of HIV positive/unknown status decreased 3 months after the intervention, but this effect was not observed with all male partners (Carpenter, et al., 2010). Chiasson 2009 also found a reduction in UAI at last sex in the 3 months following the intervention (Chiasson, et al., 2009). Rosser 2010 found an initial reduction in the number of male partners with whom the participant engaged in UAI, expressed as the rate of

male UAI partners per person-month (Rosser, et al., 2010). This lower (but not statistically significant) rate of male UAI partners during the first 3 months of follow-up was not sustained, however, over the entire 12-month follow-up. Lau 2008, however, did not demonstrate any effects on consistent condom use (Lau, et al., 2008).

One trial (Lau, et al., 2008) and the quasi-experimental study (Chiasson, et al., 2009) examined the intervention effects on different types of male sexual partners. Chiasson 2009 and colleagues found a significant reduction in having a casual partner, but found an increase in having multiple partners in the last sex encounter (Chiasson, et al., 2009). In contrast, Lau 2008 did not find any effects of their intervention on reduction of regular, commercial, non-commercial non-regular partners, partners recruited from the Internet, or partners from the mainland China (Lau, et al., 2008).

HIV testing

Three RCTs and the quasi-experimental study assessed intervention effects on HIV testing. Blas 2010 found non-gay identified participants in the invention group were more likely to report their intention of getting tested for HIV within the next 30 days, to make an Internet appointment, and to attend the study clinic requesting HIV testing than those in the control group (Blas, et al., 2010). No significant effects were observed in gay-identified participants. Chiasson 2009 found that self-reported HIV testing increased following the intervention. Conversely, Kerani 2011observed a decrease in the number of sexual partners taking an HIV test (Kerani, et al., 2011). Lau 2008 did not demonstrate an increase in having VCT in the last 6 months.

HIV knowledge

Of the two RCTs assessing HIV knowledge, one found a significant increase in HIV/AIDS related knowledge seven days after the intervention (Bowen, et al., 2007) while the

other (Lau, et al., 2008) did not find an effect at 6-month follow-up. Both studies measured knowledge using a multi-item index, however, the former study reported in mean and standard deviation and the latter in percentage of appropriate responses.

Other outcomes

Kerani 2011 did not find a significant increase in the number of partners being tested for syphilis after receiving e-card notification from the participants (Kerani, et al., 2011). Lau and colleagues did not show remarkable decrease in contracting STI after getting education emails (Lau, et al., 2008). Chiasson 2009 found that drug use at last sex but not alcohol use at last sex significantly decreased three months after the intervention. They also demonstrated MSM were more likely to disclose their HIV status to their partners after the Internet-based intervention (Chiasson, et al., 2009). Bowen 2007 examined the intervention effects on outcome expectancies on condom use and insisting safer sex and self-efficacy safe sex assertiveness and safe sex communication and found a positive effect for all outcomes at 1-week follow-up (Bowen, et al., 2007).

Discussion

Summary of main results

This review identified six RCTs and one rigorously designed quasi-experiment study of Internet-based interventions at the individual level to prevent HIV infection among MSM, involving a total of 5128 eligible participants at enrollment. Studies in the US were well represented   and the majority of participants were less than 30 years old, Caucasian, and had a college degree or above. A variety of outcomes were assessed, including risky sexual behavior, HIV testing, HIV knowledge, and others, and intervention effects were found to be highly

inconsistent. All the studies were subject to high risk of bias, particularly incomplete outcome data and random sequence generation. Methods and other key elements of RCTs were inadequately reported. The inability to calculate a summary effect estimate hindered our ability to make any conclusive statement for the overall efficacy of Internet-based behavioral interventions, with one possible exception. Unprotected anal intercourse was the most common outcome across studies, assessed in three of the six RCTs (Carpenter, et al., 2010; Lau, et al., 2008; Rosser, et al., 2010) and the one quasi-experimental study (Chiasson, et al., 2009). Of these, three found a reduction in UAI (Carpenter, et al., 2010; Chiasson, et al., 2009; Rosser, et al., 2010), two of which had the lowest risk of bias across all studies, reporting low risk on five of the seven bias domains (Carpenter, et al., 2010; Rosser, et al., 2010). Thus, while the overall efficacy of Internet-based behavioral interventions for reducing HIV infection remains unclear, there appears to be some support for these interventions to reduce UAI immediately following delivery of the intervention.

Overall completeness and applicability of evidence

We included six RCTs and one quasi-experimental study published before the end of 2011 to explore the effect of Internet-based behavioral interventions for preventing HIV infection in MSM at individual level. The target population included was MSM aged 18 years old or older, with a majority of them being young MSM (< 30 years old) and coming from US. Similar to traditional non-technology assisted interventions, the intervention programs were complex and varied in the theories applied, content, multimedia choices, and length; the behavioral and cognitive outcomes were comprehensive and variable and very few biological outcomes (only one by Lau and colleagues) were assessed. The inconsistency of the outcome

measures and variations of the interventions made it impossible to pool data together for a summary effect estimate of the interventions. It is still too early to conclude the efficacy of Internet-based intervention among MSM to reduce HIV infection and transmission.

Quality of the evidence

The body of evidence reviewed was subject to high risk of bias, particularly to selection bias due to insufficient random sequence generation and attrition bias due to incomplete outcome data. No conclusive effect of evidence could be drawn at this point because of the high heterogeneity of the interventions and outcome measurements.

Potential biases in the review process

This review was rigorous in its design and performance. We strictly conducted this review according to the requirements of Cochrane review and our protocol (Zhang et al., 2011). We worked with professional trial search coordinators in CRG to comprehensively search literatures. We extracted data and assessed the risk of bias in a double-blinded way. We communicated with senior authors if disagreements could not be resolved by discussions between the two reviewers. Some domains of the risk of bias assessment were difficult to make judgments for the Internet-based intervention trials following the general Cochrane guidelines and we consulted with Cochrane review expert for further clarification and suggestions.

The major limitation of this review is lack of a summary effect estimate on outcomes of specific behavioral changes. Another potential limitation is the assessment of blinding. Because study protocols were not published for most studies and this procedure was not adequately reported in the paper, we somehow made some inference for what have been done.

Agreements and disagreements with other studies/reviews

To our knowledge, this is the first review about Internet-based behavioral interventions for MSM population to prevent HIV infections. Although incapable of estimating an overall effect, we found out several issues that are across-the-board problems in all behavioral interventions irrespective of the delivery approach. First, rigorously designed and theory-based behavioral interventions are extremely scarce in developing countries. In a comprehensive systematic review of prevention interventions in MSM up to 2011 by Sullivan and colleagues, the majority of the behavioral interventions (conventional and technology-enabled) were studied in North America and Europe (Sullivan, et al., 2012). In our review, five out of seven were conducted in the US. There are several key barriers for scale-up of such interventions in developing countries: initial cost for the intervention development and ongoing cost for maintenance, the need for persistent funding resources from domestic and international revenues, reliable infrastructure such as electricity and Internet access, and users' acceptability and capacity of using the Internet (Blaya, Fraser, & Holt, 2010; Lewis, Synowiec, Lagomarsino, & Schweitzer, 2012). Second, long-term intervention effect could not be easily maintained. Berg reviewed the effectiveness of four behavioral interventions for HIV/STD prevention among European MSM and found an overall effect of the interventions on reduced frequency of UAI (Berg, 2009). Subgroup analyses of two rigorously designed RCTs showed positive effects only occurred over the short-term (3-6 months) but not long-term (12-month) (Berg, 2009). This is consistent with the only study included in our review that examined long-term effects (Rosser, et al., 2010). Third, self-reported behaviors may not be accurate due to recall bias and social desirability bias. Recall bias could arise from the demand of recall task and memory error (Schroder, Carey, & Vanable, 2003), especially when recalling behaviors over the past number

of months. Recall of behaviors over the previous week may be less subject to recall bias. Conducting the interventions on the Internet could possibly reduce social desirability bias because participants had minimal to no interactions with health professionals, researchers, or their peers throughout the procedures (Chiasson, et al., 2009; Lau, et al., 2008; Rosser, et al., 2010). Finally, the optimal length and content of the interventions need to be determined. A systematic review of reviews of behavioral interventions for HIV prevention among MSM found that efficacy was associated with duration and the content of the intervention (Lorimer, et al., 2013). The variation of the length and content may partially determine the inconsistency of the intervention efficacy (Lorimer, et al., 2013). The number of behavior techniques used in the interventions was reported to be positively associated with the effect size (Webb, et al., 2010). Only two studies in this review assessed a single outcome and one of them found a positive effect (Carpenter, et al., 2010; Rosser, et al., 2010).

Delivery of the interventions through the Internet brings up unique issues over the traditional face-to-face interventions. Attrition is particularly high in Internet-based intervention studies, as is consistently observed in this review as well as other web-based interventions (Mathieu, et al., 2013; Noar, et al., 2009; Webb, et al., 2010). Only three studies in our review were able to retain >80% participants (Blas, et al., 2010; Bowen, et al., 2007; Rosser, et al., 2010). Provision of incentives and frequent contact with participants by emails or telephone are potential strategies to improve retention (Horvath et al., 2012), though this contact may compromise the anonymity that is a strength of delivering content online. In our review, incentives did not always work for high retention in Internet-based interventions (Carpenter, et al., 2010; Lau, et al., 2008). Factors related to and effective strategies to reduce high attrition are yet to be explored and could be subject to different sub-population and culture environment (Bull,

Lloyd, Rietmeijer, & McFarlane, 2004; Bull, Vallejos, Levine, & Ortiz, 2008; Glasgow et al., 2007; Kuhns, Vazquez, & Ramirez-Valles, 2008). Compliance with the intervention could also not be guaranteed (Mathieu, et al., 2013). Participants completed the interventions by themselves and had few contacts with the researchers. It is hard to oversee whether participants actually read and see all the modules required, as was discussed in two studies (Blas, et al., 2010; Rosser, et al., 2010). Existing evidence showed that young, well-educated, and high income individuals were more likely access the Internet (Bennett & Glasgow, 2009; Mathieu, et al., 2013; Murray, 2012). This digital divide weakens the generalizability of the intervention results to all MSM. Duplicate registrations often occurred during enrollment in the Internet-based interventions (Chiasson et al., 2006; Mathieu, et al., 2013). Only one study in this review addressed this issue by collecting IP address (Carpenter, et al., 2010). Despite these limitations, however, online delivery of prevention material has the potential to reach a much larger population compared to traditional face-to-face interventions. Thus, concerns about minimal efficacy or attrition should be balanced by the potential to reach a broad audience.

The methodological quality of the RCTs included in the review is poor. We found it difficult to evaluate and draw conclusions on the internal validity of the studies. It was unclear to us whether the researchers did not attempt to address the issues to minimize bias or inadequately reported their methods. Either of these could severely diminish the quality of RCTs which, if well done, provide the most valid approach causal inference, regardless of the delivery medium (Altman, 1996; Mathieu, et al., 2013). Random sequence generation and the allocation concealment are two steps of intervention allocation process and only fulfillment of both could guarantee avoiding selection bias (Higgins, et al., 2011). In our review, random sequence generation rules were vague in four studies out of six. Except one trial reported differences in

race/ethnicity and type of infection across the four arms (Kerani, et al., 2011), the other three had a relatively good balance of measured baseline characteristics between two arms. It might be possible that these studies generated random sequences with a technique but did not report it in their publications. Blinding is a major issue for all the RCTs in this review. There were no reports of blinding of participants, personnel, or outcome assessors in any trials, as typically happened in behavioral studies (Boutron et al., 2007). Blinding of participants, unlike in pharmaceutical trials, is often impossible for behavioral interventions that usually contain complex and variable components, including activities and interaction with the participant. This makes selection or development of a true placebo, which mimics the characteristics of the active intervention, difficult (Friedberg, Lipsitz, & Natarajan, 2010). Use of attention control or a different active intervention in the comparison arm with participants being unaware of the study hypothesis could help prevent the bias introduced by non-blinding of participants (Boutron, et al., 2007). Blinding of personnel is likely to be achieved when the intervention allocation and implementation intervention procedures are conducted online as there is minimum or no interactions between participants and personnel (Mathieu, et al., 2013). Although we found no reports of blinding of personnel, we assumed that it was unlikely to introduce any bias in the three fully online trials and the two partially online studies by Bowen and Lau (Blas, et al., 2010; Bowen, et al., 2007; Carpenter, et al., 2010; Lau, et al., 2008; Rosser, et al., 2010). Blinding of outcome assessors is not feasible if participants, who are their own outcome assessors, report the outcomes online (Boutron, Tubach, Giraudeau, & Ravaud, 2004; Hrobjartsson & Boutron, 2011). The outcomes could be subject to response bias or social desirability bias. However, if participants who did not successfully report the outcomes online are subsequently contacted by researchers for outcome assessments, blinding of the assessors are needed (Mathieu, et al., 2013).

If outcome measures are assessed by persons, certain approaches should also be considered for blinding to avoid detection bias. Incomplete outcome data including exclusions of data of specific participants or attrition is another particular issue in the review. Only one study analyzed data by intention to treat (Bowen, et al., 2007).

Author conclusions

Implications for practice

The body of evidence from this review does not allow us to make a robust conclusion for implication for practice. The preliminary results indicate that Internet-based interventions may be effective in promoting risk-reduction behaviors such as UAI and thereby likely reducing HIV infection. Existing studies were almost exclusively from the US, where behavioral interventions have been substantially investigated. Countries in South America, Africa, and Asia are in need of developing and testing theory-based, culturally appropriate behavioral interventions for MSM. Sub-population analyses of MSM by age groups, HIV status, sexual orientation (bisexual versus homosexual), or substance use are also necessary to better understand the efficacy of Internet-based interventions.

Implications for research

Internet-based behavioral intervention trials to prevent HIV acquisition in the MSM population are still in the initial stage, with preliminary results showing potential efficacy at reducing UAI, although significant variations exist in the interventions used and their effectiveness. A clear, standardized study protocol for an RCT is essential for both research staff and readers/reviewers (Schulz, Altman, Moher, & Group, 2010). It is helpful for researchers to

following the procedures on the protocol before publication of the study and for readers/reviewers to assess adherence to the protocol afterwards (Schulz, et al., 2010). We could only access one study protocol in this review (Blas, et al., 2010). Future studies should make their protocols available to the public. More rigorously designed and implemented studies are needed in future research studies in developing countries. Future studies in the US need to include more MSM from marginalized groups such as minority ethnicity, older age, those living with HIV, and substance use. In view of the variations of the interventions and behavioral theories applied to them, more in-depth studies such as factorial experiment design are needed to identify critical intervention components that trigger behavioral change. Studies could also try to identify the optimal time for intervening among MSM, such as when they seek sexual partners online. Because it is unrealistic to blind participants in behavioral intervention studies, use of active controls instead of inactive ones could reduce bias potentially introduced by not blinding. Future studies should also measure self-reported outcomes with standardized and validated behavioral and psychosocial tools to improve comparisons across studies. It is also necessary to include objective outcomes such as biological measurements when possible. The development, implementation, reporting, and evaluation of future Internet-based behavioral interventions should follow existing guidelines (Craig et al., 2008; Eysenbach & Consort-Ehealth Group, 2011; Proudfoot et al., 2011; Ritterband, et al., 2009) such as CONSORT (Schulz, et al., 2010; Turner et al., 2012). An extension of CONSORT for web-based interventions has been developed for guiding reporting of these interventions (Eysenbach & Consort-Ehealth Group, 2011).

Characteristics of studies

Characteristics of included studies [ordered by study ID]

Blas 2010

Methods	RCT conducted in Lima, Peru in 2007-2008 for about 7 months. Participants were recruited through 5 commercial gay websites and 2 advocacy gay websites. The study website included a link to the online survey, information about risk and benefits of participation, privacy policy information, frequently asked questions, and a phone number for the participants to call if they needed more information. Participants were asked to enter email address twice used to link their profile of each participant. After informed consent and eligibility screening, participants were randomly presented with either a video or a text through study website. The average follow-up duration was 125.5 days (42-209 days).
Participants	Eligibility Males who were ≥18 years old; reported having had sex with men; were resident of Lima, Peru; answered the survey from Lima, Peru; had not been tested for HIV during the last year; had a confirmed email address; and reported HIV negative. Non-gay identified MSM 187 individuals (97 in the intervention and 90 in the control arm) aged 18-54 years old; 82% had college degree or above; 26% were homosexual; 52% had versatile sexual role and 36% had insertive role; 72% never tested for HIV before. Gay identified MSM 272 individuals (142 in the intervention and 130 in the control arm) aged 18-61 years old; 82% had college degree or above; 94% were homosexual; 58% had versatile sexual role and 31% had receptive role; 59% never tested for HIV before (less than non-gay identified MSM).
Interventions	Intervention: 5-minute online video (non-interactive) Generally, the videos were created based on health-belief model and stages of change theory. They incorporated ways to overcome the reasons why MSM don't get tested for HIV: 1) fear of the consequences if positive, 2) feeling not at risk of infection, 3) fear of discrimination, 4) fear of lack of confidentiality of health care personnel, 5) fear of not getting support from family/friends/partner, 6) lack of knowledge of where to get tested, 7) unable to pay for the test, and 8) unable to pay for the HIV treatment. The videos transitioned through the stage of change of precontemplation, contemplation, preparation, and action. Control: standard public health text (active intervention) Obtained from a current intervention to increase HIV testing in Mexico. Both interventions motivated the participants to get tested.
Outcomes	Changes from precontemplation to contemplation, from contemplation to preparation and from any stage to action; Scheduling a clinic appointment

112

		through the Internet; Attending the study clinic for an HIV test

		These stages were defined as following:
		    Precontemplation: Reported not planning to get tested in the next 6 months
		    Contemplation: Reported planning to get tested in the next 6 months
		    Preparation: Reported planning to get tested in next 30 days after being exposed to the intervention

Notes		• Contents of the intervention videos are different for non-gay identified [heterosexual, bisexual, or "flete" (young male prostitutes)] and gay identified MSM [gay or "caleta" (men who are closeted or semi-closeted)]; the former did not show a person testing positive. • The authors did not report the effect of a third intervention video targeted at transgender MSM due to lack of power (sample size=21). • Among gay-identified MSM, participants in the intervention group were older and reported a higher percentage of bisexuals than those in the control group. Education and sexual orientation were adjusted for in the intervention effect estimates for gay-identified MSM. • The retention rate was 100%. • No financial incentives

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Low	Quote: "The randomization was simple, computer-based and was automatically done by an algorithm that evaluated each case and used a random number generator to make an independent assignment." in Methods--Type of interventions Comment: well done
Allocation concealment (selection bias)	Low	Quote: "The randomization was simple, computer-based and was automatically done by an algorithm that evaluated each case and used a random number generator to make an independent assignment." in Method-Type of interventions Comment: well done
Blinding of participants and personnel (performance bias)	Low	Quote: "Our website included a link to the online survey, information about risk and benefits of participation, privacy policy information, frequently asked questions, and a phone number for the participants to call if they needed more information." Comment: No blinding information was reported. It is impossible to blind the participants from the interventions they received. Since both the intervention arm and the control arm were given an intervention, it is unlikely that participants knew which group they were in. Plus, the interventions were

		completed online and so no personnel were responsible for them. So it is unlikely that the outcome is affected by lack of blinding
Blinding of outcome assessment (detection bias)	Low	Quote: "The survey designed using LimeSurvey, documented... In the questionnaires, participants were not asked for any personally identifiable information. However, they were asked to enter their email address twice that was used to link the profile of each participant who attended to the clinic with his intervention arm assignment." in Methods--Study website. Comment: No blinding information was reported. For the 2 objective outcomes (stages of change), participants self-reported them anonymously through online survey. For the 2 objective outcomes, as stated in the quote, the assigned arm was only identified after making an Internet appointment or showing up at the clinic (outcomes of interest). So it is unlikely that the outcome is affected by lack of blinding.
Incomplete outcome data (attrition bias)	High	In non-gay identified MSM group, two outcomes had missing data for both intervention and control groups. Planning to get tested for HIV in the next 6 months after being exposed to the intervention: 2/31 missing in the intervention group and 1/31 missing in the control; Planning to get tested for HIV in the next 30 days after being exposed to the intervention: 32/56 missing in the intervention group and 34/60 missing in the control. In gay-identified MSM group, missing data also occurred in these 2 outcomes.
Selective reporting (reporting bias)	Low	Quote: "The videos had a length of five minutes and were customized for three audiences based on self-identification: non-gay (Video S1), gay (Video S2), and trans (Video S3) . We report in this paper only on the first two audiences because we lacked power to evaluate the third (sample size= 21)." in Methods--Types of interventions. Comment: The study protocol is available and all of the study's pre-specified outcomes have been reported in the Methods and Results. This is not selective report.
Other bias	High	• Quote: "… the video targeted to non-gay identified MSM did not show a person testing positive as in the video targeted to gay-identified MSM. This may have made the possibility of testing positive less evident, which is recognized as the most common reason why MSM don't want to get tested for HIV." in Discussion. Comment: Because the video targeted to non-gay identified

| | | MSM did not show a person test positive, which could be a potential barriers for preventing one taking a test; the positive effect of this video on the watchers may be exaggerated. Should the video content targeted to gay-identified have been the same with the one at non-gay identified, there would possibly have been positive effect as well (null effect reported in the paper).

- Quote:"... we were unable to collect data about participants who may have attended other clinics to receive testing." in Discussion.

Comment: Although 66% participants in video group and 40% in text groups made an Internet appointment for testing, only 11.3% in video group and 0 in text groups actually attended to the study clinic. However, it is possible that they tested elsewhere. This leads to potential misclassification of the outcome "attended to the clinic" as those who may have attended other clinics was treated as they have not been tested for HIV. Regardless whether it is differential (biased towards or away from the null) or non-differential misclassification (biased away towards the null), the magnitude of this outcome is biased. |
| --- | --- | --- |

Bowen 2007

Methods	RCT conducted in rural areas in 29 states in US in 2004. Participants were recruited using Internet banners at a popular website or face-to-face. They completed a screening questionnaire and eligible individuals signed informed consent online by devising their own password and providing contact information. Participants completed pre-test (T1) questionnaire and were randomized into the intervention or control group. Intervention modules were completed within one week and followed by post-test questionnaire 7 days later (T2). Another follow-up assessment was scheduled 7 days after T2 (T3). Wait list controls had a pre-test (T1) questionnaire followed by a second pre-test 7 days later (T2). They completed the intervention after T2 and took the post-test 7 to 14 days after T2 (T3).
Participants	<u>Eligibility</u> Men who were ≥18 years old; had had sex with another man in the last 12 months; live in a rural area (living in town of 75000 or less and more than 60 min drive time from an urban area). 39 MSM in <u>intervention group</u>, 82% aged 18-33 years old, 77% were white, 80% were single/never married, 36% had an annual income of <$15 000 and 54% had $15 000-$49 999, 81% were employed and 24% were students, and 92% self-identified as gay. 51 MSM in <u>control group</u>, 70% aged 18-33 years old, 84% were white, 67% were single/never married, 37% had an annual income of <$15 000 and 51% had $15 000-$49 999, 84% were full-time/part-time employees and 31% were students, and 91% self-identified as gay.
Interventions	<u>Intervention</u>: online Module (interactive) Social cognitive theory was applied to the modules. Each of the 2 modules took 20 minutes to complete. Content included HIV prevention information not generally known to MSM from rural areas and was presented as a conversation between an HIV-positive gay man who represented the 'expert' and an 'inexperienced' HIV-negative man who recently engaged in high-risk sex. Module 1 focused on the inexperienced man's risky sexual encounter and the possibility of having been infected with HIV. The man discussed topics including HIV testing, living with HIV, treatment issues and routes of infection. Module 2 focused on how he might maintain his HIV-negative status after receiving a negative HIV test result 6 months later, including safer sex option, condom types and correct condom application. For both modules, the content included HIV prevention. Dialogue in the two intervention modules was interspersed with interactive activities and graphics illustrating key points <u>Control</u>: Waitlist (inactive)
Outcomes	1. HIV knowledge 2. Outcome expectancy of condom use 3. Outcome expectancy of insisting on safer sex 4. Self-efficacy of safe sex assertiveness 5. Self-efficacy of safe sex communication
Notes	• Only data from T1 and T2 were extracted for this review because

116

interventions in 2 arms between T2 and T3 aimed at whether effectiveness of the intervention would be maintained, not the efficacy of the intervention.

- The retention rate was 79%.
- Separate gift certificates of different values for completion of each assessment

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear	Quote: "...those who matched eligibility requirements viewed an online informed consent form... Consent to participate was indicated when a participant devised his own password and provided online contact information. Participants then completed the pre-test questionnaire (T1) and were randomly assigned by the computer to the 'intervention' group or to the 'wait-list control' group…" in Method-procedure. Comment: Procedures after eligibility screening was conducted online, but no information was reported about sequence generation, despite the computer randomly assigned participants to each arm.
Allocation concealment (selection bias)	Low	Quote: "...those who matched eligibility requirements viewed an online informed consent form... Consent to participate was indicated when a participant devised his own password and provided online contact information. Participants then completed the pre-test questionnaire (T1) were randomly assigned by the computer to the 'intervention' group or to the 'wait-list control' group…" in Method-procedure. Comment: Randomization assignment was conducted online and it is likely to be concealed.
Blinding of participants and personnel (performance bias)	Low	Quote: "...those who matched eligibility requirements viewed an online informed consent form... Consent to participate was indicated when a participant devised his own password and provided online contact information. Participants then completed the pre-test questionnaire (T1) were randomly assigned by the computer…After assignment, participants were shown a schedule of intervention activities..." in Method-procedure. Comment: No blinding information was reported. It is impossible to blind the participants from the interventions they received. However, since the study was completed online from informed consent to the end, it is unlikely for the participants to

117

		know which arm they were in unless they got the chance to communicate with each other; it is also unlikely that personnel would have direct contact with participants. So it's unlikely that the outcome is affected by lack of blinding
Blinding of outcome assessment (detection bias)	Low	No blinding information was reported. The study was completed online. All the outcomes were subjective. Participants self-reported them anonymously through online survey. So it's unlikely that the outcome is affected by lack of blinding.
Incomplete outcome data (attrition bias)	High	"An intention-to-treat model was used to analyze intervention effects… T1 score are pasted in at T2 and T3 for participants who did not complete their intervention post-test within 14 days of their intervention pre-test: in Methods--analyses. Comment: Although an intention-to-treat analysis was performed, the use of 'last observation carried forward' (LOCF) imputation method could lead to serious bias. Attrition also occurred in both groups.
Selective reporting (reporting bias)	Low	The study protocol is not available but it is clear that the reported outcomes are consistent with the pre-specified ones in Methods.
Other bias	High	Quote: "...the two different recruiting methods may have an effect on outcomes. Participants recruited in a face-to-face manner may be more 'out' and thus risk behaviors may be different than Internet recruited men. Additionally, face-to-face recruits may have higher retention rates due to wanting to 'please' (i.e. social desirability) the recruiter. Given that only six were recruited face-to-face in this study, it was impossible to examine these factors, but future studies might look at these and other potential difference.." in Discussion. Comment: No information about whether the 6 persons were randomized all in one group or in two groups. Whatever the scenario is, there is potential imbalances in sexual behaviors across two groups due to the small sample size of each group.

Carpenter 2010

Methods	RCT conducted in multi-cities in US in 2006-2007 for about 8 months. Participants were recruited through 4 same-sex community websites. Intervention was implemented through one study website hosted on an SSL server. All study participation was completed online, including informed consent, enrollment, eligibility screening, baseline survey, intervention, and follow-up survey. Eligible participants completed a baseline assessment within 1 week and then completed the intervention (tutorials) within 1 week. They could return and viewed tutorials without restriction during 3-month follow-up. At the end, they were required to return to the study site to complete a follow-up questionnaire.
Participants	Eligibility Men aged 18-39 years old whose HIV status was negative or unknown, and who had engaged in unprotected sex (oral or anal) with a man within the last 3 months; had access to a Windows-based computer with audio capabilities, Internet service, and Internet Explorer; were willing to provide an active email address for study-related contact; read and understood English; resided in the US; and had not participated in another psychosocial HIV intervention study in the past year. 112 eligible MSM (59 in intervention and 53 in control group) were randomized, 84% had at least 1 year of college/tech school, 80% were white and 15% were Hispanic/Latino (more Asian Americans in the intervention group), 16% had an annual income of <$10 000 and 76% had $10 000-$60 000, and 84% self-reported HIV negative and 16% unknown.
Interventions	Intervention: 90-min online tutorial modules with interactive exercises, multimedia presentation, audio clips of simulated peers and didactic materials (interactive) A website (www.HotandSafeM4M.org) was designed for MSM at higher risk of contracting HIV: younger MSM, including minority MSM, who were having unsafe sex. The IMB model was incorporated to several themes and strategies in the module. 7 modules began with an interactive assessment of HIV risk factors, offering targeted feedback based on individual responses; followed by a series of mini-assessments gauging readiness to change risky behaviors accompanied by interactive stage-based motivational exercises; communication skills training included the topics of sexual rights, differences in communication styles, and sexual safety contracts; information regarding correct condom use was followed by a true/false quiz about condom use myths; triggers for risky behavior and alternatives for unsafe sex were presented through problem-solving exercises and audio narratives; test their knowledge of HIV risk and learn up-to-date information through a quiz-like game; additional themes included the interaction of HIV risk and experiencing depression, trauma, childhood sexual abuse, intimate partner violence, or racism. The intervention aimed at reducing risk of HIV and other STD by increasing knowledge of risk factors, providing skills training for safer behavior, and increasing motivation for behavior change.

	Control: a stress reduction training program (eTranquility) (active) Adapted from a stress reduction training program for the general population but the content was customized for a younger MSM population in this study by substituting representative photographs. The program consisted of a health-related rationale for stress reduction, description of physiological effects of stress and training in 3 types of relaxation exercises: diaphragmatic breathing, progressive muscle relaxation, and guided imagery.	
Outcomes	Number of unprotected sex acts in the last 3 months with their male sexual partners for each of the following sex activities and by partner's serostatus (any, positive/unknown): 1. unprotected anal intercourse (UAI) in general 2. unprotected insertive anal intercourse (UIAI) 3. unprotected receptive anal intercourse (URAI) 4. unprotected insertive oral intercourse (UIOI) 5. unprotected receptive oral intercourse (UROI)	
Notes	• Non-completers were more likely to be African American and self-reported unknown HIV status. • The retention rate was 56%. • Separate incentives for completing intervention tutorials and follow-up	

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Low	Quote: "… Participants were randomly assigned to complete either the experimental intervention or a control intervention that was not specifically focused on HIV risk. The computerized randomization algorithm used random number tables and was designed to produce a comparable racial and ethnic distribution between groups." in Procedures-Methods
Allocation concealment (selection bias)	Low	Quote: "All study participation was completed online … participants were randomly assigned to complete…. The computerized randomization algorithm used random number tables and was designed to produce a comparable racial and ethnic distribution between groups." in Procedures-Methods. Comment: It is likely that randomization assignment was done by computer without any foreknowledge by human
Blinding of participants and personnel (performance bias)	Low	Quote: "Participants were recruited through banner ad posted on same-sex community websites and profiles of the study were posted on …" in Methods-procedures. Comment: Not sure about the extent to which the study profiles were organized, whether information about intervention were exposed here before enrollment. It is impossible to blind the participants from the interventions they received. However,

		since both the intervention arm and the control arm were given an intervention, it is unlikely that participants knew which group they were in. Quote: "All study participation was completed online... " in Methods-procedures Comment: These procedures included informed consent, user key assignment, baseline assessment, and randomization before intervention. So the personnel were more likely to be blinded.
Blinding of outcome assessment (detection bias)	Low	Quote: "The study website was hosted on an SSL server with 128 bit encryption…but the data were store on a separate server not accessible via the Internet or available to the public. Identifiable information was encrypted and store on a third server". Comment: The study was completed online from the beginning to the end. No blinding information was reported. However, all the outcomes were subjective and self-reported via the study website.
Incomplete outcome data (attrition bias)	High	Quote: "Compared to those who completed the follow-up assessment (n = 112), those who did not (n = 87) were more likely to be African American... and to report that their HIV status was unknown... There were no other frequency differences in race or ethnicity between completers and noncompleters, nor were there mean differences in age, income, education, or comfort using a computer and mouse.... to examine whether there were differences between completers and non-completers in prevalence of unprotected sexual activities; no differences were found." in Results--Preliminary analyses. "... it was designed in such a way so as to preclude intent-to-treat analysis" in Discussion. Comment: African American was more likely to dropped out the study and there is no information about whether the drop-out rate of African American was same in two groups. They did "per-treated" analyses to explore the intervention effect.
Selective reporting (reporting bias)	Low	The study protocol is not available but it is clear that the published report included all expected outcomes pre-specified in the measures in the Methods.
Other bias	High	Quote: "Compared to those in the control group (n = 53), those in the experimental group (n = 59) were more likely to be Asian American...With regard to partners of unknown or positive serostatus, the experimental group was more likely to report UAI in general... UIAI in particular... and UIOI…" in

		Results--preliminary analyses. Comment: Imbalanced characteristics in the baseline sexual activities between intervention and control group could exaggerate the effect estimate. Those who were more likely to engage in unprotected sex at baseline may dramatically reduce their behavior after the intervention.

Chiasson 2009

Methods	Quasi-experimental one-group pretest-posttest study conducted in 48 states across US in 2005 for about 4 months. Recruitment, intervention, and evaluation all took place online. Recruitment was performed through banner ad on one of the largest gay subscription-based sexual meeting websites. Participants then completed a baseline structured questionnaire (basic demographics and brief lifetime sexual history) pertaining to the three months before enrollment; watched a 9-minute video; completed a questionnaire eliciting their opinions about the video and intentions to change behavior; provided email address for follow-up; and completed the post-intervention behavioral questionnaire (nearly identical with the baseline questionnaire +date of taking the last HIV test and its result) after 3-month follow-up.
Participants	No eligibility was reported. 1003 eligible MSM completed the study up to the point of providing an email address before follow-up. 522 completed the follow-up and 442 of them reported sex on both baseline and follow-up questionnaires. 56% of these 442 MSM aged 18-39, 55% had college degree or above, 74% were White, 92% self-identified as sexual orientation, 95% had HIV testing prior to the study.
Interventions	Intervention: online video (non-interactive) "The morning after" was a 9-minute video that promoted critical thinking about HIV disclosure, HIV testing, alcohol use, and risky sexual behaviors. Developmental, social and cognitive-constructivist learning theories and strategies were applied to the video.
Outcomes	Self-reported outcomes of : 1. HIV disclosure (asks and tells HIV status) 2. HIV testing 3. Drug use at last sex 4. Alcohol use at last sex 5. Having casual partner at last sex 6. Having UAI at last sex 7. Having multiple partners at last sex
Notes	No incentives were given at any stage in the study. The retention rate was 18%.

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	High	Quote: "It was not a randomized-controlled trial but rather a quasi-experimental one-group pretest-posttest design. Selection bias in recruitment and retention is of primary concern because there was no control group composed of men who did not see the video." in Discussion.

		Comment: high risk of bias due to the nature of this study design.
Allocation concealment (selection bias)	High	Not applicable to a quasi-experimental study
Blinding of participants and personnel (performance bias)	Low	Quote: "Study recruitment, intervention, and evaluation took place online…No personal identifiers were collected… and all e-mail addresses were encrypted and purged from the database after participants completed the three month follow-up questionnaire or failed to respond to three emails containing the link to the follow-up survey." in Methods--Study design. Comment: No blinding information was provided. It is impossible to blind the participants from the interventions they received. Since the study was completed online from informed consent to the end, no personnel would contact with participants. So it's unlikely that the outcome is affected by lack of blinding
Blinding of outcome assessment (detection bias)	Low	Quote: "Study recruitment, intervention, and evaluation took place online…No personal identifiers were collected… and all e-mail addresses were encrypted and purged from the database after participants completed the three month follow-up questionnaire or failed to respond to three emails containing the link to the follow-up survey." in Methods--Study design. Comment: The study was completed online from the beginning to the end. No blinding information was reported. However, all the outcomes were subjective and self-reported via the study website. So the outcomes are not likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	High	Quote: "Overall 522 men completed follow-up. This analysis was limited to the 422 study participants who reported sex on baseline and follow-up questionnaires." in Methods--Statistical analysis. Comment: 80/522, 15% lost to follow-up.
Selective reporting (reporting bias)	Low	The study protocol is not available but it is clear that the published reported included all expected outcomes pre-specified in the measures in the Methods
Other bias	Low	No other potential sources of bias identified

Kerani 2011

Methods	RCT conducted in King County, WA in USA from 2007-2009 for about 21 months. Fifty percent of the cases of Gonorrhea and chlamydia reported to Public Health-Seattle & King County (PHSKC), WA were randomly selected as participants in this study to receive partner services. Eligible participants completed the standard partner services interview before randomization, a short baseline study interview, and a follow-up interview about 2 weeks after enrollment.
Participants	Eligibility Men aged ≥18 years old, English spoken, reported that not all of their partners were treated, or that they had had sex with a man in the 60 days preceding diagnosis, the case reported was received < 2 weeks after the patient's treatment, and if the patient had not been diagnosed with HIV or syphilis in the 90 days before their gonorrhea or chlamydia diagnosis. 75 MSM were randomized to one of four arms (16 in PDPT, 17 in inSPOT, 24 in inSPOT /PDPT and 18 in standard arms). 53 MSM completed follow-ups. These MSM had a mean age of 31 years old, 77% were White, 96% were enrolled in the STD clinic, 47% were diagnosed with chlamydial and 51% with gonorrhea.
Interventions	Intervention: 3 intervention groups: InSPOT, PDPT, InSPOT/PDPT (interactive) *InSPOT* Two sections included: Tell Them and Get Checked. Users choose one of six e-cards, type in recipients' email addresses (up to six), select an STD from a pull-down menu, type in own e-mail address or send anonymously, type in an optional personal msg. When an e-card is clicked on by the recipient, users are linked to a page with disease-specific information. The Get Checked section is divided into STD information, a map of local testing sites, and links to online resources. Participants were given an opportunity to use InSPOT on a computer in the clinic. They also received a small printed card with the site's Internet address that they could use to access the site at a later time. Study staff described the site to persons enrolled over the telephone and informed them of the site's URL. *Patient-delivered partner therapy (PDPT)* Participants were offered prepackaged medication to give to up to 3 different sex partners. Packages included a 1-g dose of azithromycin and, if the participant had gonorrhea, a single 400 mg tablet of cefixime. The packages also included information about STD and the importance of HIV testing, an allergy warning, an invitation to visit at no cost at the STD clinic, and condoms. Persons enrolled through the telephone could pick up similar prepackaged medication at one of several local pharmacies. *InSPOT/PDPT* Participants received both interventions described above MSM in the intervention arms could choose to use the interventions with some partners and not others. Control: 1 group of standard partner management (active) A partner notification plan was developed for each participant's sex partners from the prior 60 days and offered to directly notify each partner for who a participant

		had contact information including a phone number, address, or website chat ID. This service was also offered to the three intervention arms.
Outcomes		Self-reported whether partners were notified or treated and whether partners tested for HIV and/or syphilis
Notes		• The intervention used in this study was to improve partner notification/treatment for those who had any STD infections. Only the outcome of whether partners tested for HIV and/or syphilis were eligible outcomes for this review. • Baseline characteristics of race/ethnicity and type of infection differed across 4 arms and these were not adjusted for in the effect estimates. • The retention rate was 71%.

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear	Quote: "We used a computer to randomly assign participants to one of the following 4 arms after informed consent was obtained…" Comment: No information was reported about sequence generation, despite the computer randomly assigned participants to each arm.
Allocation concealment (selection bias)	Low	Quote: "We used a computer to randomly assign participants to one of the following 4 arms after informed consent was obtained…" Comment: It is likely that randomization assignment was done by computer without any foreknowledge by human.
Blinding of participants and personnel (performance bias)	Unclear	Quote: "MSM diagnosed in our STD clinic underwent all study procedures face-to-face with staff. Potentially eligible men who were not diagnosed in the clinic underwent all study procedures through the telephone. In all study arms, staff attempted to develop a partner notification plan for each of a participant's sex partners from the prior 60 days and offered to directly notify each partner for whom a participant had contact information including a phone number, address, or website chat ID." in Methods. Comment: No blinding information was reported. It is impossible to blind the participants from the interventions they received. Participants completed the study with the assistant from study personnel, who might know the intervention assignments.
Blinding of outcome	Unclear	Quote: "Data on how partners were notified (e.g., through telephone, in person, etc.) and whether they tested for HIV

126

assessment (detection bias)		and/or syphilis were taken from the original patient (OP) interview data. Outcome data on whether partners were notified or treated were taken from data recorded by a disease intervention specialist (DIS) as part of standard partner services procedures; DIS in King County define partners as notified and treated based on either OP report or documentation of clinical evaluation or treatment obtained as part of partner services investigations…In addition to the data collected through these interviews, we used data regarding partner outcomes, gathered through partner management interviews." in Methods. Comment: No blinding information was reported. Outcome data were recorded by DIS and taken from OP report. It is not clear whether DIS or the OP interviewers knew the intervention information.
Incomplete outcome data (attrition bias)	High	Quote: "Of the remaining 393 eligible MSM, 75 (19%) enrolled and 318 (81%) declined enrollment. The study was halted early due to low enrollment. Enrollees were more likely than nonenrollees to be diagnosed in our STD clinic, more likely to have gonorrhea, and less likely to be coinfected with chlamydial infection and gonorrhea. Enrollment did not differ by race, but enrollees were slightly younger than nonenrollees. Among the 75 enrollees, 16, 17, 24, and 18 were assigned to the PDPT, inSPOT, inSPOT/PDPT, and standard arms, respectively. Among them, 53 (71%) completed baseline and follow-up interviews." in Results. "In particular, we were unable to enroll almost any MSM diagnosed outside of our STD clinic." in Discussion. Comment: Large proportion of participants dropped out before randomization. And their diseases infection status (related to the measurement of outcome variable) were different from those who enrolled in the study. Among those small participants in each group, different proportion of enrollees dropped out after randomization. The authors didn't figure out why they failed to enroll MSM diagnosed outside of their STD clinic.
Selective reporting (reporting bias)	Low	The study protocol is not available but it is clear that the published reported included all expected outcomes pre-specified in the measures in the Methods
Other bias	Low	No additional bias was identified.

Lau 2008

Methods	RCT conducted in Hong Kong, SAR in China for more than 6 months. Participants were recruited directly through the Internet or from frequently visited venues by outreach peers (bars, saunas, beaches). Pamphlets were given to all participants during enrollment. A study website was created to serve as a focal point to introduce the study, to recruit participants, and to administer the questionnaires. After randomization, participants were followed-up for 6 months and an online evaluative questionnaire was completed afterwards. Five reminders were sent to those who did not return the questionnaire.
Participants	Eligibility Males who had engaged in either oral or anal sex with another man in the p6m and who self-reported to be regular Internet users, were HK residents of age 18 and above, and were able to read Chinese. 280 eligible MSM out of 477 participants randomized completed follow-up. Over half of the 280 MSM aged 21-30 years old. About 64% received university degree or above. 99% were Chinese.
Interventions	Intervention: Bi-weekly emails and graphical messages related to STD/HIV prevention; monthly risk behavior log form emails; direct online/email contact from peer counselors twice per month to discuss behavior and encourage change in risk behavior (interactive) *Emails & graphics*: visually appealing and professionally designed, educational, related to STD/HIV prevention. The contents covered areas of information and discussion about modes of HIV transmission, correct condom use, HIV testing, 'relationship & love' and the relationship between drugs and sex. Participants sent back a confirmation email to the research team upon receiving them. *Log-form*: automatically sent by computer system. Participants were requested to fill out this form, recording their HIV-related risk behaviors in the last month and return it to be researcher by email. Different versions of electronic feedback, which used a humorous approach, were then automatically sent to those who returned the log form. *Peer counselors*: establish direct contacts with participants at least twice a month via different means (emails, chat rooms, etc.). A telephone hotline was available for counseling. Staff also tried to build up rapport, discussing the participants' risk behavior status and encouraging him to change his risk behaviors via online website. Control: null intervention (inactive)
Outcomes	1. HIV/STD related knowledge 2. Self-reported STD infection in last 6 months 3. VCT in last 6 months 4. Regular MSM partner in last 6 months 5. Commercial MSM partner in last 6 months 6. Non-commercial, non-regular MSM partner in last 6 months 7. Recruited MSM partner via Internet in last 6 months

		8. Having sex partner in Mainland China in last 6 months
		9. Having anal sex with non-commercial, non-regular MSM partner in last 6 months
		10. Having anal sex with regular MSM partner in last 6 months
		11. Having oral sex with non-commercial, non-regular MSM partner in last 6 months
		12. Having oral sex with regular MSM partner in last 6 months
		13. Consistent condom use during anal sex with non-commercial, non-regular MSM partner in last 6 months
		14. Consistent condom use during anal sex with regular MSM partner in last 6 months
		15. Consistent condom use during oral sex with non-commercial, non-regular MSM partner in last 6 months
		16. Consistent condom use during oral sex with regular MSM partner in last 6 months

Except the outcomes 1-3 & 16-19 (Likert scales), all other outcomes were dichotomous (yes/no).

Notes	• The peer counselor portion of the intervention was severely under-utilized. • The retention rate was 59%. • Small souvenir items for completion of the study

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear	Quote: "Participants were then randomized into the intervention or control group" in Methods--Recruitment of participants. Comment: No information about sequence generation process was reported.
Allocation concealment (selection bias)	Low	Quote: "An internet website was specifically created for the project, which served as a focal point to introduce this study to the MSM community, to recruit participants and to administer the questionnaires…Participants were then randomized into the intervention or control group..." in Methods--Recruitment of participants. Comment: The study procedures were conducted online and it is likely that randomization assignment was done by computer without any foreknowledge by human.
Blinding of participants and personnel (performance	Low	Quote: "An Internet website was specifically created for the project, which served as a focal point to introduce this study to the MSM community, to recruit participants, and to administer

| bias) | | the questionnaires..." in Methods--Recruitment of participants.

Comment: No blinding information was reported. It is impossible to blind the participants from the interventions they received. However, the study was completed online from the beginning to the end, it is unlikely for the participants to know which arm they were in unless they got the chance to communicate with each other; it is also unlikely that personnel would have direct contact with participants. So the outcomes are not likely to be influenced by lack of blinding. |
|---|---|---|
| Blinding of outcome assessment (detection bias) | Low | Quote: "Those participants giving informed consent then completed a web-based baseline questionnaire. The study was anonymous…Participants in both groups were followed-up for six months and they completed another online evaluative questionnaire six months afterwards... " in Methods--Recruitment of participants.

Comment: No blinding information was reported. However, the study was completed online from the beginning to the end. All the outcomes were subjective and self-reported via the study website. So the outcomes are not likely to be influenced by lack of blinding. |
| Incomplete outcome data (attrition bias) | High | Quote: "Out of the 477 study participants being recruited and completing the baseline questionnaire, 280 (58.7%) completed the 6-month evaluation questionnaire. Their data were used for data analyses. The attrition rate was not associated with the means of recruitment. "in Methods--Recruitment of participants.

Comment: The reasons for the missing data in both groups were not sufficiently reported and whether they were balanced across groups were unknown. |
| Selective reporting (reporting bias) | Low | The study protocol is not available but it is clear that the published reported included all expected outcomes pre-specified in the measures in Methods. |
| Other bias | Unclear | This study used two sampling approach, Internet and venue outreach. The proportion of the participants recruited via each approach was unknown. It might be possible that certain characteristics related to the measurements of outcomes were different across groups. |

Rosser 2010

Methods	RCT conducted in US in 2007-2009 for about 14 months. The target population was men who use the Internet to seek sex with men (MISM). They were recruited via banner ads placed on two of the nation's largest gay websites and emails directed to the study webpage. Eligible participants were randomized to 2 arms, completed the intervention/control during 3 weeks and were followed up every 3 months for one year.
Participants	Eligibility Males aged ≥18 years old, were US residents, with a recent history of engaging in unprotected anal intercourse with at least one other man, were comfortable viewing sexually explicit materials online, prepared to complete all online activities within 7 days, willing to provide an e-mail add and phone number. 650 eligible MISM were randomized to one of 2 arms. 86% aged 45 years old or younger. 92% received at least some college education. 68% were White and 15% were Latino/Spanish. 75% had an annual income of <$65 000. 76% had a job and 18% were students. 22% self-reported HIV positive.
Interventions	Intervention: online didactic modules (interactive) Sexual Health Model (SHM) was applied to the intervention development. It posits that sexually healthy persons are more likely to make sexually healthy decisions. The interventions were modules with user flexibility to maintain the feeling of control typical in both graphical user interfaces and Web interaction. Module examples include a "hot sex " calculator, which calculates the odds of great sex while demonstrating decision making in dating; a virtual gym where men can explore body image concerns common in this population' an online chat simulation where users can explore ambiguity and evasion; and a reflective journey where participants can identify and graph the effects of past successes and disappointments, identify long-term goals, shed secrets, and deepen spirituality. These modules were supplemented by virtual peers who contributed their experiences from diverse perspectives, reinforcements in the form of 15-second cartoons, polls where participants could compare their answers with those of other participants, and FAQs where learners could seek specific information. Two modules employed personal video vignettes of 3 HIV positive and 3 HIV negative MSM discussing ways they avoid transmitting/acquiring HIV. Other modules covered mental and emotional health, physical health, intimacy, relationships, sexuality, and spirituality aspects of the SHM, with each module addressing implications for safer sex, commitment to reducing risk, and long-term sexual health. Control: null intervention (inactive)
Outcomes	Self-reported number of male partners with whom a participant engaged in unprotected anal sex (UAIMP) during the last 3 months.
Notes	• This study used cash incentives and reminders to improve retention rate. • The retention rate was 76%-99% over the 1-year follow-up.

Risk of bias

Bias	Authors' Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear	Quote: "Banner advertisements placed on two of the nation's largest gay websites and emails to participants from previous research connected MISM to the study webpage...A computer algorithm was used to randomly assign participants to one of two experimental conditions." in Methods--Participant Recruitment Procedures & Experimental conditions Comment: No specification of the sequence generation approach though a computer algorithm was used to randomly assign participants to two arms.
Allocation concealment (selection bias)	Low	Quote: "Banner advertisements placed on two of the nation's largest gay websites and emails to participants from previous research connected MISM to the study webpage...A computer algorithm was used to randomly assign participants to one of two experimental conditions." in Methods--Participant Recruitment Procedures & Experimental conditions. Comment: The study procedures were conducted online and it is likely that randomization assignment was done by computer without any foreknowledge by human
Blinding of participants and personnel (performance bias)	Low	Quote: "Banner advertisements placed on two of the nation's largest gay websites and emails to participants from previous research connected MISM to the study webpage...Potential participants were informed... be prepared to complete all online activities within seven days..." in Methods--Participant Recruitment Procedures." "... *Sexpulse* were sent two automated email reminders, and were then contacted by telephone. At each follow-up, reminder e-mails were sent asking participants to return to the website to complete follow-up surveys." in Methods-- Experimental Conditions. "The primary weakness of a null control is the potential for participant awareness that they did not receive the intervention." in Discussion Comment: No blinding information was reported. It is impossible to blind the participants from the interventions they received. However, the study was completed online from the beginning to the end, it is unlikely for the participants to know which arm they were in unless they got the chance to communicate with each other; it is also unlikely that personnel would have direct contact with participants prior to and during intervention implementation. So the outcomes are not likely to

		be influenced by lack of blinding.
Blinding of outcome assessment (detection bias)	Low	No blinding information was reported. However, the study was completed online from the beginning to the end. All the outcomes were subjective and self-reported via the study website. So the outcomes are not likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	High	Quote: "Retention over the 12-month study ranged between 76% and 99%" in Results. Comment: According to figure 1 in the manuscript, the attrition rate differed in the intervention and control groups at each time point; and the attrition rate was higher in the intervention group than in the control at each time point. There is no information reported about the reasons why the imbalances occur.
Selective reporting (reporting bias)	Low	The study protocol is not available but it is clear that the published reported included all expected outcomes pre-specified in the measures in the Methods
Other bias	Low	Quote: "Except for a 6.3% larger proportion of white men and modest differences in the distributions of age and educational attainment, randomization procedures appear to have balanced background characteristics across treatment conditions." Comment: Although there are modest differences in some baseline characteristics, the outcomes might not be biased as age, race and income were adjusted for in the analyses of the intervention effect.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Adam 2011	Not a rigorously designed quasi-experimental study; merely 2 separate cross-sectional surveys for pre-test and post-test.
Blas 2009	A dissertation which contained nearly the same information as an included published paper.
Bowen 2008	Comparison of individual module effects within a complete intervention package and the effects of intervention order, not the intervention efficacy.
Chiasson 2006	Conference abstract was published in full journal article
Chiasson 2010	Not an intervention study but a review of HIV prevention in the information era
Daniel 2008	A conference abstract. It was the same study with an included paper, trying to assess the long-term efficacy of the intervention.
Hightow-Weidman 2011	Not an intervention effectiveness study, but a description of a behavioral theory-based intervention via the Internet
Klausner 2004	Not a RCT, just a programmatic intervention
Kok 2006	Just a description of an interventin without efficacy results
Rhodes 2011	Not a rigorously designed quasi-experimental study; merely 2 separate cross-sectional surveys for pre-test and post-test.
Smolenski 2010	A conference abstract. It was the same study with an included paper, performing a sub-group analysis of the eligible MSM (categorized into three risk levels) to see why no long-term efficacy was observed in the original study.

Characteristics of studies awaiting classification [ordered by study ID]

Catalani 2011

Methods	A pre-post intervention study conducted in India to compare two culturally sensitive videos about individual-level stigma among vulnerable groups. Interventions were delivered through mobile tablets and phones in hard-to-reach communities to improving HIV counseling and testing
Participants	200 men who have sex with men and sex workers in rural and urban sites in Southern India
Interventions	Video 1: a short feature film produced by media professionals during 1-year Video 2: a short digital story produced by newly trained health worker staff during 2-months Interventions were delivered through a network of mobile tablets and phones
Outcomes	HIV counseling and testing
Notes	Focus groups were also performed and analyzed with modified grounded theory on Atlas.ti

Davidovich 2004

Methods	A RCT conducted online, examining cognitive effects directly after the intervention (posttest) and behavioral effects at a 6-months follow-up via e-mail.
Participants	1013 single men who have sex with men with an average age of 33 years old
Interventions	An online tailored intervention to increase knowledge, correct beliefs and increase sense of vulnerability regarding sexual risks in relationships and increase motivation and skills to engage in safer sex, according to according to knowledge, faulty beliefs, and skills
Outcomes	Attitudes towards sexual agreements; intention, attitudes and perceived control regarding condom use
Notes	High lost-to-follow-up (63%) in both intervention and control arm

De Wit 2008

Methods	A theory-driven online intervention was tested using RCT. Participants were randomly assigned to one of three arms: 2 intervention arms and 1 control arm. Impact of advice and delivery format was measured immediately (T1) and six months later (T2), using men's self-reported sexual control, willingness to engage in risk-taking, and UAIC as indicators of effect.
Participants	331 MSM engaging in sex with casual partners
Interventions	Participants in the 2 invention groups received similar advice to promote their vigilance and control over situations related to unpremeditated risk-taking, such as when being drunk/high or strongly aroused, either through an e-card format (read at leisure) or through an interactive e-animation (3 min. duration). The reference group did not receive any prevention advice.
Outcomes	The e-card was generally not effective. The e-animation increased men's intention to exert vigilance and control over tempting situations at T1 ($p<0.05$), increased effective vigilance and control behaviors at T2 ($p=0.001$), and reduced willingness to engage in risk-taking at T1 ($p<0.01$) and T2 ($p=0.000$). Six months after the intervention the e-animation had reduced UAIC by 23% (adjusted OR=.770, p=0.001).
Notes	

Harterink 2006

Methods	Participants registered with e-mail address through Chatboy-the most popular Dutch gay chat site- were randomized to the intervention group or control group. Virtual agents guided participants through the intervention, giving personalized feedback. Follow-up was at three months.
Participants	5617 men who have sex with men with an average age of 33 years old
Interventions	The theory-based interactive intervention "GAY CRUISE", developed using the Intervention Mapping protocol, was tailored to age and sexual experience and focusing on psychosocial determinants.
Outcomes	Condom use with casual sex partners; the level of having unprotected anal intercourse with casual partners
Notes	Response rate at follow-up was 39% in the intervention and 44% in the control group.

Characteristics of ongoing studies [ordered by study ID]

Fernandez 2011

Study Name	Motiv82Change: an HIV Prevention Study for Young Latino Men
Methods	A total of 120 participants will be enrolled in a pilot test of a culturally and developmentally tailored motivational enhancement intervention (MEI) to reduce risky sex (unprotected anal sex and multiple partners) among young Hispanic men who have sex with men (YHMSM) to be delivered face-to-face (FtF) and through the Internet using a real-time implementation approach. A tailored MEI for two delivery modalities, and a health education control (HEALTH) comparable in time and number of sessions. The study also test the MEI's acceptability and feasibility, obtain effect size estimates of the intervention's strength to reduce risky sex, and determine if it is ready for efficacy testing.
Participants	- Male; - Self-identify as Hispanic/Latino; 18 - 29 years of age; - Live in South Florida; - Have had at least 1 episode of unprotected anal sex with a man in the last 6 months; - Have had at least 2 male sex partners in the last 6 months; - HIV negative or not known to be HIV positive; and - Have not previously participated in this study.
Interventions	Interventions - Motive82Change FtF This arm of the MEI will be delivered FtF using a real-time, dynamic implementation approach. - Motive82Change -Internet This arm of the MEI will be delivered via the Internet FtF using a real-time, dynamic implementation approach. Controls - No Intervention: delayed Delayed treatment control - Active Control: Motiv8 2Change Careers Comparable in number of sessions and duration to the experimental arms, but focused on resume development and interviewing skills. Contains ethically mandated information regarding HIV prevention
Outcomes	Reduction in number of unprotected anal sex acts and/or number of sex partners in the last 3 months
Starting date	August 2010
Contact information	Dr.M.Isabel Fernandez, Nova Southeastern University, Florida, USA
Notes	Data collection completed in June 2012.

Hosek 2011

Study Name	Project Power: An HIV Risk Reduction Intervention for Black Men Who Have Sex With Men and Women (BMSM/W)
Methods	A RCT to compare preliminary efficacy of POWER (intervention) with HEALTH (control) for reducing HIV acquisition and transmission. About 200 BMSM/W will be recruited for each arm using chain referral method. Participants will complete an assessment battery delivered via ACASI at baseline, immediate post intervention and at 3-month post intervention. They will also complete acceptability/feasibility assessments after the intervention.
Participants	- Self-identified as Black or African descent 18-60 years old - Resident of Chicago MSA - Sexually active with men and women - First-time participant of this study - Not self-identified as transgendered
Interventions	Intervention: PROJECT POWER A three session intervention to help BMSM/W lead healthier lives, make informed sexual choices and reduce their chances of getting or giving HIV to their sex partners. Interventions are designed to be delivered via the Internet in real time by a trained health educator. Each session will last between 1 and 2 hours. Control: Power Health A one session intervention designed to help BMSM/W improve their general health. It focuses on health issues (including HIV) that affect Black men. The program consists of 1 session delivered via the Internet in real time by a trained health educator and last approximately 2 hours
Outcomes	Unprotected sex (either vaginal or anal sex); number of either male or female sex partners
Starting date	July 2011
Contact information	Dr. Sybil Hosek, John H. Stroger Hospital of Cook county, Chicago, USA Dr. M.Isabel Fernandez, Nova Southeastern University, Florida, USA
Notes	This study is currently recruiting participants.

Lelutiu-Weinberger 2011

Study Name	An Innovative HIV Prevention Intervention Using Social Networking Technology
Methods	40 high-risk young men who have sex with men (YMSM, ages 18-29 and Facebook users) will be enrolled in a pilot intervention with one single group assignment. The intervention will span 4 weeks and contain 8 bi-weekly 30 minute Motivational Interviewing (MI) chat-window sessions consisting of a sequential progression of intervention approaches tailored to each participant's readiness to change their drug use and high risk sexual behavior. Pre-post intervention behavioral risk assessments, as well as individual interviews with all 40 intervention participants will be evaluated regarding the feasibility and acceptability of the intervention's structure, and process. Findings will inform revision of the intervention in preparation for a subsequent RCT.
Participants	- At least 5 days of drug use (of 1 or more of the following drugs: cocaine, methamphetamine (MA), or ecstasy (MDMA) in the prior three months; - High-risk sexual behavior (1 or more acts of unprotected insertive or receptive anal sex with a male partner of unknown or HIV+ serostatus), in the prior three months; - Biologically male; 18 to 29 years of age; - HIV negative; - Have reliable Internet access; - Facebook use at least four times per week; - Being able to write in English given that intervention participation involves writing; - New York City residency. - Not simultaneously enrolled in other drug or HIV related intervention or research
Interventions	Motivational Interviewing Eight 30-minute sessions utilizing Motivational Interviewing will be delivered over chat window to reduce substance use and sexual risk in a group of high risk YMSM. Participants' intervention experience will be evaluated at the end of their eight sessions and post-assessment.
Outcomes	Feasibility and acceptability of intervention delivery
Starting date	August 2010
Contact information	Dr. Corina T Lelutiu-Weinberger, Hunter College, CUNY, New York, USA
Notes	Data collection completed in June 2012.

Mustanski 2009

Study Name	Internet-based HIV/STI Prevention for Young MSM Receiving HIV Testing (KIU)
Methods	A total of 80 participants will be enrolled by invitation in this RCT to compare two different versions of an online HIV/STI intervention for young MSM (YMSM).
Participants	18-24 years of age - Self-identify as a biological male - Understand and read English - Have tested HIV negative at an approved clinic within 6 weeks - Report at least one (male) sex partners in the past three months, and unprotected anal sex with at least one male sex partner in the past three months. - HIV negative or unknown status at the time of recruitment - Not simultaneously enrolled in other HIV prevention program - Have access to the Internet or an email address
Interventions	<u>Intervention</u>: Keep It Up! Online HIV Intervention Prevention Website tailored to YMSM. Website is tailored to be more engaging, motivational, culturally tailored includes videos and games. <u>Control</u>: Information only Medically fact based HIV information delivered online.
Outcomes	HIV knowledge, Decisional Balance, condom errors, safer sex self-efficacy, intentions
Starting date	Aug 2009
Contact information	Dr. Brian Mustanski, University of Illinois at Chicago, Chicago, USA
Notes	The study is estimated to complete data collection in Jan 2010. But the current status is "This study is enrolling invited participants only."

Appendix 1. Search strategy in PubMed

Search	Most Recent Queries
#12	Search #9 AND #10 Limits: Publication Date from 1980/01/01 to 2011/12/01
#11	Search #9 AND #10
#10	Search (randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR placebo [tiab] OR drug therapy [sh] OR randomly [tiab] OR trial [tiab] OR groups [tiab]) NOT (animals [mh] NOT humans [mh])
#9	Search #2 AND #3 AND #8
#8	Search #4 OR #5 OR #6 OR #7
#7	Search "money boy"
#6	Search (homosexual[tiab] OR gay[tiab] OR bisexual[tiab] OR sex worker[tiab]) AND (men[tiab] OR man[tiab] OR male[tiab] OR males[tiab])
#5	Search "men who have sex with men" OR MSM[tiab]
#4	Search homosexuality,male[mh]
#3	Search internet[mh] OR internet[tiab] OR website[tiab] OR websites[tiab] OR web[tiab] OR cyber[tiab] OR online[tiab]
#2	Search HIV Infections[MeSH] OR HIV[MeSH] OR hiv[tw] OR hiv-1*[tw] OR hiv-2*[tw] OR hiv1[tw] OR hiv2[tw] OR hiv infect*[tw] OR human immunodeficiency virus[tw] OR human immunedeficiency virus[tw] OR human immuno-deficiency virus[tw] OR human immune-deficiency virus[tw] OR ((human immun*) AND (deficiency virus[tw])) OR acquired immunodeficiency syndrome[tw] OR acquired immunedeficiency syndrome[tw] OR acquired immuno-deficiency syndrome[tw] OR acquired immune-deficiency syndrome[tw] OR ((acquired immun*) AND (deficiency syndrome[tw])) OR "sexually transmitted diseases, viral"[MESH:NoExp]

Appendix 2. Clinicaltrials.gov search strategy

hiv AND ("men who have sex with men" OR homosexual OR "sex worker") AND (internet OR website OR cyber OR online) | Interventional Studies | received from 01/01/1980 to 12/01/2011

Conclusions

In this dissertation work, I analyzed data from two cross-sectional surveys collected in 2009 and 2010 among MSM in Chongqing City located in southwestern China. The major findings from the results and implications for future research are summarized here:

1. Demographic and behavioral characteristics of MSM in Chongqing City were similar to those within the existing MSM literature in China. Most MSM in Chongqing were young (≤30 years old), of Han ethnicity, never married, and living in the downtown area by themselves. Most MSM surveyed already had a college degree and were local citizens, i.e., were not migrants with legal residency outside of Chongqing. College students were also well represented in local MSM community accessed through RDS methods of sampling. About two-thirds self-identified as homosexual/gay. Most MSM had engaged in their first homosexual activity at an early age (≤25 years old). Over half of MSM had never had sex with a woman and most had had multiple lifetime male sexual partners.

2. The proportion of MSM taking HIV tests is low in Chongqing City, only 58% in our sample, despite public health efforts and some improvement in testing coverage over time. A higher educational level, insertive roles in anal sex, and more frequent use of condoms were factors correlated positively with HIV testing history. Major perceived barriers for taking an HIV test included fear of knowing positive results, fear of discrimination if testing HIV-positive, unwillingness to go to an HIV clinic, concern about meeting acquaintances at testing venues, and not knowing where to get tested. Major reasons for failing to get HIV tested were an absence of perceived HIV risk, not knowing where to get tested, fear of having a positive result, concern about the reporting of a positive result to the government, and having no free time to take a test. Education about HIV/AIDS knowledge and the benefits of early therapy, and mental and

psychological support from family and friends, health providers, and the whole society are essential to motivate MSM for HIV testing. High quality pre- and post-test counseling and non-judgmental staff attitudes can help reduce fear and concerns and can facilitate the linkage to care.

3. HIV and syphilis prevalence is higher among MSM in Chongqing City than reported among MSM elsewhere in China. The strongest predictors for HIV seropositivity were lower education and higher sexual risk taking. Syphilis infection was also associated with an increased likelihood of HIV infection. Non-student, non-college graduate MSM are a top priority for appropriate education and counseling, given their risk profiles and HIV/syphilis infection prevalence. Physical, psychological, and mental support are needed for all MSM who often feel alienated from mainstream institutions. Biological and behavioral combination prevention strategies are needed urgently to address the Chinese HIV epidemic.

4. College students comprised a sub-group in Chongqing MSM community and were at high risk for both HIV and syphilis acquisition. Although these youths had lower HIV prevalence than college graduates and non-student non-college graduate MSM, they engaged in similar risky sexual behaviors (e.g., number of lifetime male sexual partners) as others during their relatively short periods of homosexual experience. More research among this sub-type population is necessary for better understanding their physical, mental and psychological needs in terms of HIV prevention. Targeted interventions and care should be provided as per scientific evidence for impact.

5. Finally, a systematic review and meta-analysis suggested that Internet-based behavioral interventions were effective in promoting risk-reduction behaviors and, possibly, reducing HIV infections. It was not possible to make conclusive statements about efficacy from the existing evidence because of significant variations in the interventions and inconsistent

effectiveness. More rigorously designed and implemented behavioral interventions with application of theory-based approaches are needed in developing countries. Sub-population analyses (e.g., by age period, ethnicity/race, or HIV infection status) are necessary to better understand the applicability and efficacy of Internet-based interventions. Development, implementation, reporting, and evaluation of future Internet-based behavioral interventions should follow existing guidelines to enable future systematic reviews to draw a valid pooled effect estimate.

There are several areas of strength in my work. First, the RDS method constructed a sampling frame during the sampling process that distinguishes itself favorably from traditional non-probability methods such as snowball sampling (Heckathorn, 2002; Heckathorn, et al., 2001). The final sample composition is independent of the initial, purposefully selected seeds after 5 to 6 waves of recruitment (Heckathorn, 1997, 2002). The recruitment biases can be assessed by calculation of selection probability and adjusted for in the analysis (Heckathorn, 2002; Volz & Heckathorn, 2008). Second, an innovative HIV Risk Score was created to capture multi-dimensions of risky anal sexual activities including partner type, sex acts and condom use frequency. The score was developed based on the concepts that HIV acquisition risk for MSM is dependent on the multiplicative risks of type of partner, type of sexual act, and condom use frequency, plus the additive risks of each single act in a certain time period. We extrapolated the overall HIV acquisition risk for each individual from calculating the risks for one's last three sexual activities in the past 6 months. Third, my study represents the first time in China that MSM student vs. non-student risk and prevalence are compared. Fourth, my systematic review and meta-analysis of Internet-based behavioral interventions in the MSM population to prevent HIV infections is the first such published assessment.

Limitations are also noted in my research. First, RDS has its own methodological

limitations. The RDS method might not succeed in recruiting a representative sample of the

whole MSM population in Chongqing. Theoretically, the RDS method should generate unbiased

estimates (Heckathorn, 2002; Volz & Heckathorn, 2008). In practice, any violations of the

assumptions under which the RDS is applied could end up failing to obtain an unbiased sample

(Heckathorn, 2007; Volz & Heckathorn, 2008). In this project, most of the assumptions required

by RDS were met. However, personal network sizes could not be accurately reported. In addition,

well-educated MSM may have been oversampled with our respondent driving sampling, as the

study sample included a significant proportion of college students who may be more likely to

bring their fellow students to take a test. As we did not know the accurate characteristics and the

size of the MSM population, we could not verify whether the sample included all MSM networks

(Goel & Salganik, 2010). Moreover, both univariable and multivariable analyses in this study

were conducted by applying RDSAT-generated weights to dependent variables only (e.g., HIV

infection) as much of the comparable literature has done (Liu, et al., 2011; Wei, Ruan, et al.,

2011; Xu, et al., 2010). However, such an application is still under development and requires

further validation. There are also inherent limitations of this approach. Some have argued that

RDS produce a narrow confidence interval due to its construction of confidence intervals as if

random sampling had been applied (Salganik, 2006). Others found out RDS was more efficient

in recruiting PWID than other populations (Malekinejad, et al., 2008). A second limitation is that

condom use was measured within a timeframe of the last six months while testing experience

was a lifetime measurement in our study. It is possible that those who used condoms more often

may have gotten information about safe sex in their prior testing and counseling experience and

thus increased their condom use. A third limitation is that our HIV Risk Score might lead to an

underestimation of the actual risk of HIV acquisition due to lack of several important biological factors such as partners' viral load. In order to get more accurate estimation, mathematical models could be applied to include as many risk-related parameters as possible, taking into consideration potential interactions and correlations between multiple co-factors. A fourth limitation is that self-reported information about prior behaviors such as HIV testing and condom use may be subject to recall bias. Interviews on sensitive information that challenge social norms such as sexual behaviors are often subject to underreporting (information bias) due to stigma. However, our use of the CASI approach should have reduced this bias, but would not eliminate it. A fifth limitation is that cross-sectional research designs lack the ability to assess temporal relationships of putative predictors for condom use. Finally, I could not draw robust conclusions for Internet-based risk reduction programs from the body of the evidence available for the systematic review.

In conclusion, the HIV epidemic among MSM in Chongqing, China, is a major and a growing concern. My thesis work provides key data to help public health officials and community-based organizations and activists improve and target their prevention, testing, and care programs for maximum impact. My systematic review should prove helpful to investigators and public health professionals and activists in the field, given the opportunities for education presented by the Internet. I close my dissertation with thanks to all the participants who gave their time and shared their histories with the investigative team.

References

Abdul-Quader, A. S., Heckathorn, D. D., McKnight, C., Bramson, H., Nemeth, C., Sabin, K., . . . Des Jarlais, D. C. (2006). Effectiveness of respondent-driven sampling for recruiting drug users in New York City: findings from a pilot study. *J Urban Health, 83*(3), 459-476. doi: 10.1007/s11524-006-9052-7

Abdul-Quader, A. S., Heckathorn, D. D., Sabin, K., & Saidel, T. (2006). Implementation and analysis of respondent driven sampling: lessons learned from the field. *J Urban Health, 83*(6 Suppl), i1-5. doi: 10.1007/s11524-006-9108-8

Abu-Raddad, L. J., Hilmi, N., Mumtaz, G., Benkirane, M., Akala, F. A., Riedner, G., . . . Wilson, D. (2010). Epidemiology of HIV infection in the Middle East and North Africa. *AIDS, 24 Suppl 2*, S5-23. doi: 10.1097/01.aids.0000386729.56683.33

Adam, B. D., Murray, J., Ross, S., Oliver, J., Lincoln, S. G., & Rynard, V. (2011). hivstigma.com, an innovative web-supported stigma reduction intervention for gay and bisexual men. *Health Educ Res, 26*(5), 795-807. doi: 10.1093/her/cyq078

Adam, P. C., de Wit, J. B., Toskin, I., Mathers, B. M., Nashkhoev, M., Zablotska, I., . . . Rugg, D. (2009). Estimating levels of HIV testing, HIV prevention coverage, HIV knowledge, and condom use among men who have sex with men (MSM) in low-income and middle-income countries. *J Acquir Immune Defic Syndr, 52 Suppl 2*, S143-151. doi: 10.1097/QAI.0b013e3181baf111

Albarracin, D., Gillette, J. C., Earl, A. N., Glasman, L. R., Durantini, M. R., & Ho, M. H. (2005). A test of major assumptions about behavior change: a comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychol Bull, 131*(6), 856-897. doi: 10.1037/0033-2909.131.6.856

Altman, D. G. (1996). Better reporting of randomised controlled trials: the CONSORT statement. *BMJ, 313*(7057), 570-571. doi: dx.doi.org/10.1136/bmj.313.7057.570

Baggaley, R. F., White, R. G., & Boily, M. C. (2010). HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. *Int J Epidemiol, 39*(4), 1048-1063. doi: 10.1093/ije/dyq057

Barak, A., Klein, B., & Proudfoot, J. G. (2009). Defining internet-supported therapeutic interventions. *Ann Behav Med, 38*(1), 4-17. doi: 10.1007/s12160-009-9130-7

Bartholow, B. N., Buchbinder, S., Celum, C., Goli, V., Koblin, B., Para, M., . . . Team, V. V. S. (2005). HIV sexual risk behavior over 36 months of follow-up in the world's first HIV vaccine efficacy trial. *J Acquir Immune Defic Syndr, 39*(1), 90-101.

Beadnell, B., Morrison, D. M., Wilsdon, A., Wells, E. A., Murowchick, E., Hoppe, M., . . . Nahom, D. (2005). Condom use, frequency of sex, and number of partners: multidimensional characterization of adolescent sexual risk-taking. *J Sex Res, 42*(3), 192-202. doi: 10.1080/00224490509552274

Benn, P., Fisher, M., & Kulasegaram, R. (2011). UK guideline for the use of post-exposure prophylaxis for HIV following sexual exposure (2011). *Int J STD AIDS, 22*(12), 695-708. doi: 10.1258/ijsa.2011.171011

Bennett, G. G., & Glasgow, R. E. (2009). The delivery of public health interventions via the Internet: actualizing their potential. *Annu Rev Public Health, 30*, 273-292. doi: 10.1146/annurev.publhealth.031308.100235

Berg, R. (2009). The effectiveness of behavioural and psychosocial HIV/STI prevention interventions for MSM in Europe: A systematic review. *Euro Surveill, 14*(48).

Beyrer, C., Baral, S. D., van Griensven, F., Goodreau, S. M., Chariyalertsak, S., Wirtz, A. L., & Brookmeyer, R. (2012). Global epidemiology of HIV infection in men who have sex with men. *Lancet, 380*(9839), 367-377. doi: 10.1016/S0140-6736(12)60821-6

Beyrer, C., Baral, S. D., Walker, D., Wirtz, A. L., Johns, B., & Sifakis, F. (2010). The expanding epidemics of HIV type 1 among men who have sex with men in low- and middle-income countries: diversity and consistency. *Epidemiol Rev, 32*(1), 137-151. doi: 10.1093/epirev/mxq011

Beyrer, C., Wirtz, A. L., Walker, D., Johns, B., Sifakis, F., & Baral, S. D. (2011). The Global HIV Epidemics among Men Who Have Sex with Men.   Retrieved from http://siteresources.worldbank.org/INTHIVAIDS/Resources/375798-1103037153392/MSMReport.pdf doi:10.1596/978-0-8213-8726-9

Blas, M. M. (2009). *Effect of an online video-based intervention to increase HIV testing in gay-identified and non-gay-identified men who have sex with men in Peru.* (Doctoral Dissertation). Retrieved from http://search.proquest.com.proxy.library.vanderbilt.edu/docview/622052117?accountid=14816. PsycINFO database. (AAI3328373)

Blas, M. M., Alva, I. E., Cabello, R., Carcamo, C., & Kurth, A. E. (2011). Risk behaviors and reasons for not getting tested for HIV among men who have sex with men: an online survey in Peru. *PLoS One, 6*(11), e27334. doi: 10.1371/journal.pone.0027334

Blas, M. M., Alva, I. E., Carcamo, C. P., Cabello, R., Goodreau, S. M., Kimball, A. M., & Kurth, A. E. (2010). Effect of an online video-based intervention to increase HIV testing in men who have sex with men in Peru. *PLoS One, 5*(5), e10448. doi: 10.1371/journal.pone.0010448

Blaya, J. A., Fraser, H. S., & Holt, B. (2010). E-health technologies show promise in developing countries. *Health Aff (Millwood), 29*(2), 244-251. doi: 10.1377/hlthaff.2009.0894

Boily, M. C., Baggaley, R. F., Wang, L., Masse, B., White, R. G., Hayes, R. J., & Alary, M. (2009). Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis, 9*(2), 118-129. doi: 10.1016/S1473-3099(09)70021-0

Boutron, I., Guittet, L., Estellat, C., Moher, D., Hrobjartsson, A., & Ravaud, P. (2007). Reporting methods of blinding in randomized trials assessing nonpharmacological treatments. *PLoS Med, 4*(2), e61. doi: 10.1371/journal.pmed.0040061

Boutron, I., Tubach, F., Giraudeau, B., & Ravaud, P. (2004). Blinding was judged more difficult to achieve and maintain in nonpharmacologic than pharmacologic trials. *J Clin Epidemiol, 57*(6), 543-550. doi: 10.1016/j.jclinepi.2003.12.010

Bowen, A. M., Horvath, K., & Williams, M. L. (2007). A randomized control trial of Internet-delivered HIV prevention targeting rural MSM. *Health Educ Res, 22*(1), 120-127. doi: 10.1093/her/cyl057

Bowen, A. M., Williams, M. L., Daniel, C. M., & Clayton, S. (2008). Internet based HIV prevention research targeting rural MSM: feasibility, acceptability, and preliminary efficacy. *J Behav Med, 31*(6), 463-477. doi: 10.1007/s10865-008-9171-6

Bridge, J., Lazarus, J. V., & Atun, R. (2010). HIV epidemics and prevention responses in Asia and Eastern Europe: lessons to be learned? *AIDS, 24 Suppl 3*, S86-94. doi: 10.1097/01.aids.0000390094.91176.d8

Brown, J. L., & Diclemente, R. J. (2011). Secondary HIV prevention: novel intervention approaches to impact populations most at risk. *Curr HIV/AIDS Rep, 8*(4), 269-276. doi: 10.1007/s11904-011-0092-6

Bull, S. S., Lloyd, L., Rietmeijer, C., & McFarlane, M. (2004). Recruitment and retention of an online sample for an HIV prevention intervention targeting men who have sex with men: the Smart Sex Quest Project. *AIDS Care, 16*(8), 931-943. doi: 10.1080/09540120412331292507

Bull, S. S., & McFarlane, M. (2000). Soliciting sex on the Internet: what are the risks for sexually transmitted diseases and HIV? *Sex Transm Dis, 27*(9), 545-550.

Bull, S. S., McFarlane, M., Lloyd, L., & Rietmeijer, C. (2004). The process of seeking sex partners online and implications for STD/HIV prevention. *AIDS Care, 16*(8), 1012-1020. doi: 10.1080/09540120412331292426

Bull, S. S., Vallejos, D., Levine, D., & Ortiz, C. (2008). Improving recruitment and retention for an online randomized controlled trial: experience from the Youthnet study. *AIDS Care, 20*(8), 887-893. doi: 10.1080/09540120701771697

Caceres, C. F. (2002). HIV among gay and other men who have sex with men in Latin America and the Caribbean: a hidden epidemic? *AIDS, 16 Suppl 3*, S23-33.

Campbell-Kelly, M., Aspray, W., Ensmenger, N., & Yost, J. R. (2013). *Computer: A History of the Information Machine* (3rd ed.). Boulder, CO: Westview Press.

Carpenter, K. M., Stoner, S. A., Mikko, A. N., Dhanak, L. P., & Parsons, J. T. (2010). Efficacy of a web-based intervention to reduce sexual risk in men who have sex with men. *AIDS Behav, 14*(3), 549-557. doi: 10.1007/s10461-009-9578-2

Catalani, C., & Castaneda, D. (July, 2011). *Development and comparative assessment of media to reduce stigma and enhance access to HIV testing and counseling for vulnerable populations in India*. Paper presented at the 6th IAS Conference on HIV Pathogenesis and Treatment, Rome, Italy. Abstract retrieved from http://www.iasociety.org/Default.aspx?pageId=11&abstractId=200742106

Centers for Disease Control and Prevention. (2012). HIV Transmission Risk. Retrieved from http://www.cdc.gov/hiv/law/pdf/HIVtranmsmision.pdf

Centers for Disease Control and Prevention (CDC). (1981). Pneumocystis pneumonia-Los Angeles. *MMWR Morb Mortal Wkly Rep, 30*(21), 250-252.

Centers for Disease Control and Prevention (CDC). (2012). HIV among Gay and Bisexual Men. Retrieved June 1, 2012, from http://www.cdc.gov/hiv/topics/msm/index.htm

Chen, M. Y., Bilardi, J. E., Lee, D., Cummings, R., Bush, M., & Fairley, C. K. (2010). Australian men who have sex with men prefer rapid oral HIV testing over conventional blood testing for HIV. *Int J STD AIDS, 21*(6), 428-430. doi: 10.1258/ijsa.2010.009552

Chiasson, M. A., Parsons, J. T., Tesoriero, J. M., Carballo-Dieguez, A., Hirshfield, S., & Remien, R. H. (2006). HIV behavioral research online. *J Urban Health, 83*(1), 73-85. doi: 10.1007/s11524-005-9008-3

Chiasson, M. A., Shaw, F. S., Humberstone, M., & Hirshfield, S. (August, 2006). *A Successful Online Behavioral Intervention For Men Who Have Sex With Men (MSM)*. Paper presented at the 16th International AIDS Conference, Toronto, Canada. Abstract retrieved from http://www.iasociety.org/Default.aspx?pageId=11&abstractId=2192707

Chiasson, M. A., Shaw, F. S., Humberstone, M., Hirshfield, S., & Hartel, D. (2009). Increased HIV disclosure three months after an online video intervention for men who have sex with men (MSM). *AIDS Care, 21*(9), 1081-1089. doi: 10.1080/09540120902730013

Choi, K. H., Liu, H., Guo, Y., Han, L., Mandel, J. S., & Rutherford, G. W. (2003). Emerging HIV-1 epidemic in China in men who have sex with men. *Lancet, 361*(9375), 2125-2126. doi: 10.1016/S0140-6736(03)13690-2

Chongqing Municipal Goverment. (2007a, June 12 2007). About Chongqing-Advantages. Retrieved July 15, 2011, from http://en.cq.gov.cn/AboutChongqing/1916.htm

Chongqing Municipal Goverment. (2007b, June 12 2007). About Chongqing-Demographic. Retrieved July 15, 2011, from http://en.cq.gov.cn/AboutChongqing/1916.htm

Chow, E. P., Wilson, D. P., Zhang, J., Jing, J., & Zhang, L. (2011). Human immunodeficiency virus prevalence is increasing among men who have sex with men in China: findings from a review and meta-analysis. *Sex Transm Dis, 38*(9), 845-857. doi: 10.1097/OLQ.0b013e31821a4f43

Chow, E. P., Wilson, D. P., & Zhang, L. (2011a). HIV and syphilis co-infection increasing among men who have sex with men in China: a systematic review and meta-analysis. *PLoS One, 6*(8), e22768. doi: 10.1371/journal.pone.0022768

Chow, E. P., Wilson, D. P., & Zhang, L. (2011b). What is the potential for bisexual men in China to act as a bridge of HIV transmission to the female population? Behavioral evidence from a systematic review and meta-analysis. *BMC Infect Dis, 11*(1), 242.

Chow, E. P., Wilson, D. P., & Zhang, L. (2012a). Patterns of condom use among men who have sex with men in China: a systematic review and meta-analysis. *AIDS Behav, 16*(3), 653-663. doi: 10.1007/s10461-011-9935-9

Chow, E. P., Wilson, D. P., & Zhang, L. (2012b). The rate of HIV testing is increasing among men who have sex with men in China. *HIV Med, 13*(5), 255-263. doi: 10.1111/j.1468-1293.2011.00974.x

Cochrane Review Group on HIV/AIDS. (2012, 6/5/2012). Sample data abstraction form: RCTs. *More resources for authors.* Retrieved June 15, 2012, from http://hiv.cochrane.org/sites/hiv.cochrane.org/files/uploads/Data%20extraction%20form_RCTs.docx

Cong, L., Ono-Kihara, M., Xu, G., Ma, Q., Pan, X., Zhang, D., . . . Kihara, M. (2008). The characterisation of sexual behaviour in Chinese male university students who have sex with other men: a cross-sectional study. *BMC Public Health, 8*, 250. doi: 10.1186/1471-2458-8-250

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., Petticrew, M., & Medical Research Council Guidance. (2008). Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ, 337*, a1655. doi: 10.1136/bmj.a1655

Crosby, R. A. (1998). Condom use as a dependent variable: Measurement issues relevant to HIV prevention programs. *AIDS Education and Prevention, 10*(6), 548-557.

Daniel, C. M., Bowen, A., Williams, M., Clayton, S., & Ross, L. (2008). Assessment of long-term efficacy of an internet delivered HIV risk reduction intervention for rural MSM. *Annals of Behavioral Medicine, 35*, S105-S105.

Davidovich, U., de Wit, J., & Stroebe, W. (July, 2004). *The effect of an Internet intervention for promoting safe sex between steady male partners - results and methodological implications of a longitudinal randomized controlled trial online*. Paper presented at the XV International AIDS Conference, Bangkok, Thailand. Abstract retrieved from http://www.iasociety.org/Default.aspx?pageId=12&abstractId=2174766

De Cock, K. M., Jaffe, H. W., & Curran, J. W. (2012). The evolving epidemiology of HIV/AIDS. *AIDS, 26*(10), 1205-1213. doi: 10.1097/QAD.0b013e328354622a

De Wit, J., & Adam, P. (August, 2008). *Reducing Non-Premeditated Risk-Taking In MSM: A New Intervention Protocol To Increase Vigilance And Control Tested For Efficacy In A Prospective RTC*. Paper presented at the XVII International AIDS Conference, Mexico City, Mexico. Abstract retrieved from http://www.iasociety.org/Default.aspx?pageId=11&abstractId=200720851

DiClemente, R. J., Crosby, R. A., & Kegler, M. C. (2002). *Emerging Theories in Health Promotion Practice and Research : Strategies for Improving Public Health* (1st ed.). San Francisco, USA: Jossey-Bass.

Dosekun, O., & Fox, J. (2010). An overview of the relative risks of different sexual behaviours on HIV transmission. *Curr Opin HIV AIDS, 5*(4), 291-297. doi: 10.1097/COH.0b013e32833a88a3

Dougan, S., Evans, B. G., & Elford, J. (2007). Sexually transmitted infections in Western Europe among HIV-positive men who have sex with men. *Sex Transm Dis, 34*(10), 783-790. doi: 10.1097/01.olq.0000260919.34598.5b

Eysenbach, G., & Consort-Ehealth Group. (2011). CONSORT-EHEALTH: improving and standardizing evaluation reports of Web-based and mobile health interventions. *J Med Internet Res, 13*(4), e126. doi: 10.2196/jmir.1923

Feng, L., Ding, X., Lu, R., Liu, J., Sy, A., Ouyang, L., . . . Zhao, J. (2009). High HIV prevalence detected in 2006 and 2007 among men who have sex with men in China's largest municipality: an alarming epidemic in Chongqing, China. *J Acquir Immune Defic Syndr, 52*(1), 79-85. doi: 10.1097/QAI.0b013e3181a4f53e

Feng, L. G., Ding, X. B., Lu, R. R., Pan, C. B., Yi, H. R., Liu, H. H., . . . Xu, J. (2008). [HIV prevalence and its associated factors among men who have sex with men in Chongqing]. *Zhonghua Yu Fang Yi Xue Za Zhi, 42*(12), 870-874.

Feng, Y., Wu, Z., Detels, R., Qin, G., Liu, L., Wang, X., . . . Zhang, L. (2010). HIV/STD prevalence among men who have sex with men in Chengdu, China and associated risk factors for HIV infection. *J Acquir Immune Defic Syndr, 53 Suppl 1*, S74-80. doi: 10.1097/QAI.0b013e3181c7dd16

Finlayson, T. J., Le, B., Smith, A., Bowles, K., Cribbin, M., Miles, I., . . . Prevention. (2011). HIV risk, prevention, and testing behaviors among men who have sex with men--National HIV Behavioral Surveillance System, 21 U.S. cities, United States, 2008. *MMWR Surveill Summ, 60*(14), 1-34.

Fisher, J. D., & Fisher, W. A. (2002). The Information-Motivation-Behavioral Skills Model. In R. J. DiClemente, R. A. Crosby & M. C. Kegler (Eds.), *Emerging Theories in Health Promotion Practice and Research : Strategies for Improving Public Health* (1st ed., pp. 40-70). San Francisco, USA: Jossey-Bass.

Fox, J., White, P. J., Weber, J., Garnett, G. P., Ward, H., & Fidler, S. (2011). Quantifying sexual exposure to HIV within an HIV-serodiscordant relationship: development of an algorithm. *AIDS, 25*(8), 1065-1082. doi: 10.1097/QAD.0b013e328344fe4a

Freedman, E., & Mindel, A. (2004). Epidemiology of herpes and HIV co-infection. *J HIV Ther, 9*(1), 4-8.

Friedberg, J. P., Lipsitz, S. R., & Natarajan, S. (2010). Challenges and recommendations for blinding in behavioral interventions illustrated using a case study of a behavioral intervention to lower blood pressure. *Patient Educ Couns, 78*(1), 5-11. doi: 10.1016/j.pec.2009.04.009

Gao, L., Zhang, L., & Jin, Q. (2009). Meta-analysis: prevalence of HIV infection and syphilis among MSM in China. *Sex Transm Infect, 85*(5), 354-358. doi: 10.1136/sti.2008.034702

Gao, L., Zhou, F., Li, X., Yang, Y., Ruan, Y., & Jin, Q. (2010). Anal HPV infection in HIV-positive men who have sex with men from China. *PLoS One, 5*(12), e15256. doi: 10.1371/journal.pone.0015256

Girardi, E., Scognamiglio, P., Sciarrone, M. R., Loffredo, M., Gnesivo, C., Noto, P., . . . Geas, G. (2011). High HIV prevalence in male patients with acute hepatitis A in the Rome metropolitan area, Italy 2002-2008. *J Hepatol, 54*(6), 1102-1106. doi: 10.1016/j.jhep.2010.09.024

Glasgow, R. E., Nelson, C. C., Kearney, K. A., Reid, R., Ritzwoller, D. P., Strecher, V. J., . . . Wildenhaus, K. (2007). Reach, engagement, and retention in an Internet-based weight loss program in a multi-site randomized controlled trial. *J Med Internet Res, 9*(2), e11. doi: 10.2196/jmir.9.2.e11

Goel, S., & Salganik, M. J. (2010). Assessing respondent-driven sampling. *Proc Natl Acad Sci U S A, 107*(15), 6743-6747. doi: 10.1073/pnas.1000261107

Golden, M. R., Stekler, J., Hughes, J. P., & Wood, R. W. (2008). HIV serosorting in men who have sex with men: is it safe? *J Acquir Immune Defic Syndr, 49*(2), 212-218. doi: 10.1097/QAI.0b013e31818455e8

Gu, J., Lau, J. T., & Tsui, H. (2011). Psychological factors in association with uptake of voluntary counselling and testing for HIV among men who have sex with men in Hong Kong. *Public Health, 125*(5), 275-282. doi: 10.1016/j.puhe.2011.01.010

Guo, Y., Li, X., & Stanton, B. (2011). HIV-related behavioral studies of men who have sex with men in China: a systematic review and recommendations for future research. *AIDS Behav, 15*(3), 521-534. doi: 10.1007/s10461-010-9808-7

Harlow, L. L., Rose, J. S., Morokoff, P. J., Quina, K., Mayer, K., Mitchell, K., & Schnoll, R. (1998). Women HIV sexual risk takers: related behaviors, interpersonal issues, and attitudes. *Womens Health, 4*(4), 407-439.

Harris, A. D., Bradham, D. D., Baumgarten, M., Zuckerman, I. H., Fink, J. C., & Perencevich, E. N. (2004). The use and interpretation of quasi-experimental studies in infectious diseases. *Clin Infect Dis, 38*(11), 1586-1591. doi: 10.1086/420936

Harterink, P., Hospers, H., Vriens, P., Kok, G., & De Zwart, O. (August, 2006). *A Theory-Based, Tailored, Interactive Intervention Directed At MSM Who Meet Sexual Partners Through Internet Chat Sites: Effective For Msm Who Practice Uai With Casual Partners*. Paper presented at the XVI International AIDS Conference, Toronto, Canada. Abstract retrieved from www.iasociety.org/Default.aspx?pageId=11&abstractId=2193197

Heckathorn, D. D. (1997). Respondent-Driven Sampling: A New Approach to the Study of Hidden Populations. *Social Problems, 44*(2), 174-199. doi: 10.1525/sp.1997.44.2.03x0221m

Heckathorn, D. D. (2002). Respondent-Driven Sampling II: Deriving Valid Population Estimates from Chain-Referral Samples of Hidden Populations. *Social Problems, 49*(1), 11-34. doi: 10.1525/sp.2002.49.1.11

Heckathorn, D. D. (2007). EXTENSIONS OF RESPONDENT-DRIVEN SAMPLING: ANALYZING CONTINUOUS VARIABLES AND CONTROLLING FOR DIFFERENTIAL RECRUITMENT. *Sociological Methodology, 37*, 151-208. doi: 10.1111/j.1467-9531.2007.00188.x

Heckathorn, D. D. (2011). Snowball Versus Respondent-Driven Sampling. *Sociol Methodol, 41*(1), 355-366. doi: 10.1111/j.1467-9531.2011.01244.x

Heckathorn, D. D., Broadhead, R. S., & Sergeyev, B. (2001). A methodology for reducing respondent duplication and impersonation in samples of hidden populations. *Journal of Drug Issues, 31*(2), 543-564.

Higa, D. H., Crepaz, N., Marshall, K. J., Kay, L., Vosburgh, H. W., Spikes, P., . . . Purcell, D. W. (2013). A systematic review to identify challenges of demonstrating efficacy of HIV behavioral interventions for gay, bisexual, and other men who have sex with men (MSM). *AIDS Behav, 17*(4), 1231-1244. doi: 10.1007/s10461-013-0418-z

Higgins, J. P. T., Altman, D. G., & Sterne, J. A. C. (2011). Chapter 8: Assessing risk of bias in included studies. In J. P. T. Higgins & S. Green (Eds.), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]: The Cochrane Collaboration. Retrieved from www.cochrane-handbook.org.

Higgins, J. P. T., & Deeks, J. J. (2011). Chapter 7: Selecting studies and collecting data. In J. P. T. Higgins & S. Green (Eds.), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]: The Cochrane Collaboration. Retrieved from www.cochrane-handbook.org.

Hong, F. C., Zhou, H., Cai, Y. M., Pan, P., Feng, T. J., Liu, X. L., & Chen, X. S. (2009). Prevalence of syphilis and HIV infections among men who have sex with men from different settings in Shenzhen, China: implications for HIV/STD surveillance. *Sex Transm Infect, 85*(1), 42-44. doi: 10.1136/sti.2008.031682

Hong, Y., & Li, X. (2009). HIV/AIDS behavioral interventions in China: a literature review and recommendation for future research. *AIDS Behav, 13*(3), 603-613. doi: 10.1007/s10461-008-9483-0

Horvath, K. J., Nygaard, K., Danilenko, G. P., Goknur, S., Oakes, J. M., & Rosser, B. R. (2012). Strategies to retain participants in a long-term HIV prevention randomized controlled trial: lessons from the MINTS-II study. *AIDS Behav, 16*(2), 469-479. doi: 10.1007/s10461-011-9957-3

Hospers, H. J., Kok, G., Harterink, P., & de Zwart, O. (2005). A new meeting place: chatting on the Internet, e-dating and sexual risk behaviour among Dutch men who have sex with men. *AIDS, 19*(10), 1097-1101.

Hrobjartsson, A., & Boutron, I. (2011). Blinding in randomized clinical trials: imposed impartiality. *Clin Pharmacol Ther, 90*(5), 732-736. doi: 10.1038/clpt.2011.207

Huan, X., Hao, C., Yan, H., Guan, W., Xu, X., Yang, H., . . . Lau, J. T. (2013). High Prevalence of HIV and Syphilis Among Men Who Have Sex With Men Recruited by Respondent-Driven Sampling in a City in Eastern China. *Asia Pac J Public Health*. doi: 10.1177/1010539513480230

Hunter College. (2011). An Innovative HIV Prevention Intervention Using Social Networking Technology (Identifer NCT01381653). Available from National Library of Medicine (US) ClinicalTrial.gov Retrieved Jan 10 2013 http://ClinicalTrials.gov/show/NCT01381653

Hutton, H. E., Wilson, L. M., Apelberg, B. J., Tang, E. A., Odelola, O., Bass, E. B., & Chander, G. (2011). A systematic review of randomized controlled trials: Web-based interventions for smoking cessation among adolescents, college students, and adults. *Nicotine Tob Res, 13*(4), 227-238. doi: 10.1093/ntr/ntq252

ICT Applications and Cybersecurity Division, Policies and Strategies Department, & ITU Telecommunication Development Sector. (2008). Implementing e-Health in Developing

Countries: Guidance and Principles   Retrieved from http://www.itu.int/ITU-D/cyb/app/docs/e-Health_prefinal_15092008.PDF

Jiang, Y., Qiu, M., Zhang, G., Xing, W., Xiao, Y., Pan, P., . . . Su, X. (2010). Quality assurance in the HIV/AIDS laboratory network of China. *Int J Epidemiol, 39 Suppl 2*, ii72-78. doi: 10.1093/ije/dyq224

Johnson, W. D., Diaz, R. M., Flanders, W. D., Goodman, M., Hill, A. N., Holtgrave, D., . . . McClellan, W. M. (2008). Behavioral interventions to reduce risk for sexual transmission of HIV among men who have sex with men. *Cochrane Database Syst Rev*(3), CD001230. doi: 10.1002/14651858.CD001230.pub2

Johnson, W. D., Jr. (2009). *HIV prevention research for men who have sex with men: Meta-analysis, intraclass correlation, and transformation between count and dichotomous outcomes.* (Doctoral Dissertation). Retrieved from http://search.proquest.com.proxy.library.vanderbilt.edu/docview/755207408?accountid=14816 PsycInfo database. (AAI3378444)

Johnston, L. G., & Sabin, K. (2010). Sampling hard-to-reach populations with respondent driven sampling. *Methodological Innovations Online, 5*(2), 38-48.

Kang, W. (2009). *Obsession: male same-sex relations in China, 1900-1950 (Queer Asia)* (1st ed.). Hong Kong: Hong Kong University Press.

Kerani, R. P., Fleming, M., DeYoung, B., & Golden, M. R. (2011). A randomized, controlled trial of inSPOT and patient-delivered partner therapy for gonorrhea and chlamydial infection among men who have sex with men. *Sex Transm Dis, 38*(10), 941-946. doi: 10.1097/OLQ.0b013e318223fcbc

Kim, A. Y., Onofrey, S., & Church, D. R. (2013). An Epidemiologic Update on Hepatitis C Infection in Persons Living With or at Risk of HIV Infection. *J Infect Dis, 207 Suppl 1*, S1-6. doi: 10.1093/infdis/jis927

Klausner, J. D., Levine, D. K., & Kent, C. K. (2004). Internet-based site-specific interventions for syphilis prevention among gay and bisexual men. *AIDS Care, 16*(8), 964-970. doi: 10.1080/09540120412331292471

Klausner, J. D., Wolf, W., Fischer-Ponce, L., Zolt, I., & Katz, M. H. (2000). Tracing a syphilis outbreak through cyberspace. *JAMA, 284*(4), 447-449.

Kok, G., Harterink, P., Vriens, P., Zwart, O., & Hospers, H. J. (2006). The gay cruise: Developing a theory- and evidence-based Internet HIV-prevention intervention. *Sexuality Research and Social Policy, 3*(2), 52-67. doi: 10.1525/srsp.2006.3.2.52

Kong, T. S. K. (2010). *Chinese male homosexualities: memba, tongzhi and golden boy* (1st ed.). New York: Routledge.

Kuhns, L. M., Vazquez, R., & Ramirez-Valles, J. (2008). Researching special populations: retention of Latino gay and bisexual men and transgender persons in longitudinal health research. *Health Educ Res, 23*(5), 814-825. doi: 10.1093/her/cym066

Kurth, A. E., Celum, C., Baeten, J. M., Vermund, S. H., & Wasserheit, J. N. (2011). Combination HIV prevention: significance, challenges, and opportunities. *Curr HIV/AIDS Rep, 8*(1), 62-72. doi: 10.1007/s11904-010-0063-3

Lahuerta, M., Sabido, M., Giardina, F., Hernandez, G., Palacios, J. F., Ortiz, R., . . . UALE project. (2011). Comparison of users of an HIV/syphilis screening community-based mobile van and traditional voluntary counselling and testing sites in Guatemala. *Sex Transm Infect, 87*(2), 136-140. doi: 10.1136/sti.2010.043067

Lau, J. T., Choi, K. C., Tsui, H. Y., & Su, X. (2007). Associations between stigmatization toward HIV-related vulnerable groups and similar attitudes toward people living with HIV/AIDS: branches of the same tree? *AIDS Care, 19*(10), 1230-1240. doi: 10.1080/09540120701402848

Lau, J. T., Lau, M., Cheung, A., & Tsui, H. Y. (2008). A randomized controlled study to evaluate the efficacy of an Internet-based intervention in reducing HIV risk behaviors among men who have sex with men in Hong Kong. *AIDS Care, 20*(7), 820-828. doi: 10.1080/09540120701694048

Lau, J. T., Lin, C., Hao, C., Wu, X., & Gu, J. (2011). Public health challenges of the emerging HIV epidemic among men who have sex with men in China. *Public Health, 125*(5), 260-265. doi: 10.1016/j.puhe.2011.01.007

Lau, P. W., Lau, E. Y., Wong del, P., & Ransdell, L. (2011). A systematic review of information and communication technology-based interventions for promoting physical activity behavior change in children and adolescents. *J Med Internet Res, 13*(3), e48. doi: 10.2196/jmir.1533

Lefebvre, C., Manheimer, E., & Glanville, J. (2011). Chapter 6: Searching for studies. In J. P. T. Higgins & S. Green (Eds.), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]: The Cochrane Collaboration. Retrieved from www.cochrane-handbook.org.

Lewis, T., Synowiec, C., Lagomarsino, G., & Schweitzer, J. (2012). E-health in low- and middle-income countries: findings from the Center for Health Market Innovations. *Bull World Health Organ, 90*(5), 332-340. doi: 10.2471/BLT.11.099820

Li, C. M., Jia, Y. J., Ding, X. B., Liu, J. B., & Xiao, Y. (2009). [HIV infections and heterosexual behaviors among men who have sex with men in Chongqing municipality, China]. *Zhonghua Liu Xing Bing Xue Za Zhi, 30*(9), 882-886.

Li, H. M., Peng, R. R., Li, J., Yin, Y. P., Wang, B., Cohen, M. S., & Chen, X. S. (2011). HIV incidence among men who have sex with men in China: a meta-analysis of published studies. *PLoS One, 6*(8), e23431. doi: 10.1371/journal.pone.0023431

Li, Y., Detels, R., Lin, P., Fu, X., Deng, Z., Liu, Y., . . . Wu, Z. (2010). Prevalence of HIV and STIs and associated risk factors among female sex workers in Guangdong Province, China. *J Acquir Immune Defic Syndr, 53 Suppl 1*, S48-53. doi: 10.1097/QAI.0b013e3181c7d72f

Lieber, E., Chin, D., Li, L., Rotheram-Borus, M. J., Detels, R., Wu, Z., . . . National Institute of Mental Health (NIMH) Collaborative HIV Prevention Trial Group. (2009). Sociocultural contexts and communication about sex in China: informing HIV/STD prevention programs. *AIDS Educ Prev, 21*(5), 415-429. doi: 10.1521/aeap.2009.21.5.415

Liu, H., Liu, H., Cai, Y., Rhodes, A. G., & Hong, F. (2009). Money boys, HIV risks, and the associations between norms and safer sex: a respondent-driven sampling study in Shenzhen, China. *AIDS Behav, 13*(4), 652-662. doi: 10.1007/s10461-008-9475-0

Liu, H., Yang, H., Li, X., Wang, N., Liu, H., Wang, B., . . . Stanton, B. (2006). Men who have sex with men and human immunodeficiency virus/sexually transmitted disease control in China. *Sex Transm Dis, 33*(2), 68-76. doi: 10.1097/01.olq.0000187266.29927.11

Liu, J., Qu, B., Guo, H. Q., & Sun, G. (2011). Factors that influence risky sexual behaviors among men who have sex with men in Liaoning province, China: a structural equation model. *AIDS Patient Care STDS, 25*(7), 423-429. doi: 10.1089/apc.2010.0333

Liu, L., Luan, R., Yang, W., Zhang, L., Zhang, J., Nan, L., . . . Jia, Y. (2009). Projecting dynamic trends for HIV/AIDS in a highly endemic area of China: estimation models for Liangshan Prefecture, Sichuan Province. *Curr HIV Res, 7*(4), 390-397. doi: 10.2174/157016209788680642

Lorenc, T., Marrero-Guillamon, I., Aggleton, P., Cooper, C., Llewellyn, A., Lehmann, A., & Lindsay, C. (2011). Promoting the uptake of HIV testing among men who have sex with men: systematic review of effectiveness and cost-effectiveness. *Sex Transm Infect, 87*(4), 272-278. doi: 10.1136/sti.2010.048280

Lorimer, K., Kidd, L., Lawrence, M., McPherson, K., Cayless, S., & Cornish, F. (2013). Systematic review of reviews of behavioural HIV prevention interventions among men who have sex with men. *AIDS Care, 25*(2), 133-150. doi: 10.1080/09540121.2012.699672

Luo, H. B., Mei, J. Y., Song, L. J., Lu, R., Lu, J. Y., Fu, L. R., . . . Lu, L. (2012). [A comprehensive surveillance on HIV among 1,237 men who have sex with men in thirteen cities of Yunnan]. *Zhonghua Liu Xing Bing Xue Za Zhi, 33*(7), 706-709.

Lyons, A., Pitts, M., Grierson, J., Smith, A., McNally, S., & Couch, M. (2012). Sexual Behavior and HIV Testing Among Bisexual Men: A Nationwide Comparison of Australian Bisexual-Identifying and Gay-Identifying Men. *AIDS Behav*. doi: 10.1007/s10461-012-0148-7

Ma, X., Zhang, Q., He, X., Sun, W., Yue, H., Chen, S., . . . McFarland, W. (2007). Trends in prevalence of HIV, syphilis, hepatitis C, hepatitis B, and sexual risk behavior among men who have sex with men. Results of 3 consecutive respondent-driven sampling surveys in Beijing, 2004 through 2006. *J Acquir Immune Defic Syndr, 45*(5), 581-587. doi: 10.1097/QAI.0b013e31811eadbc

Magnani, R., Sabin, K., Saidel, T., & Heckathorn, D. (2005). Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS, 19 Suppl 2*, S67-72.

Mahfoud, Z., Afifi, R., Ramia, S., El Khoury, D., Kassak, K., El Barbir, F., . . . DeJong, J. (2010). HIV/AIDS among female sex workers, injecting drug users and men who have sex with men in Lebanon: results of the first biobehavioral surveys. *AIDS, 24 Suppl 2*, S45-54. doi: 10.1097/01.aids.0000386733.02425.98

Malekinejad, M., Johnston, L. G., Kendall, C., Kerr, L. R., Rifkin, M. R., & Rutherford, G. W. (2008). Using respondent-driven sampling methodology for HIV biological and behavioral surveillance in international settings: a systematic review. *AIDS Behav, 12*(4 Suppl), S105-130. doi: 10.1007/s10461-008-9421-1

Malta, M., Magnanini, M. M., Mello, M. B., Pascom, A. R., Linhares, Y., & Bastos, F. I. (2010). HIV prevalence among female sex workers, drug users and men who have sex with men in Brazil: a systematic review and meta-analysis. *BMC Public Health, 10*, 317. doi: 10.1186/1471-2458-10-317

Mathieu, E., McGeechan, K., Barratt, A., & Herbert, R. (2013). Internet-based randomized controlled trials: a systematic review. *J Am Med Inform Assoc, 20*(3), 568-576. doi: 10.1136/amiajnl-2012-001175

Mayer, K. H. (2011). Sexually transmitted diseases in men who have sex with men. *Clin Infect Dis, 53 Suppl 3*, S79-83. doi: 10.1093/cid/cir696

Mayer, K. H., Bekker, L. G., Stall, R., Grulich, A. E., Colfax, G., & Lama, J. R. (2012). Comprehensive clinical care for men who have sex with men: an integrated approach. *Lancet, 380*(9839), 378-387. doi: 10.1016/S0140-6736(12)60835-6

McCreesh, N., Frost, S. D., Seeley, J., Katongole, J., Tarsh, M. N., Ndunguse, R., . . . White, R. G. (2012). Evaluation of Respondent-driven Sampling. *Epidemiology, 23*(1), 138-147. doi: 10.1097/EDE.0b013e31823ac17c

McFarlane, M., Bull, S. S., & Rietmeijer, C. A. (2000). The Internet as a newly emerging risk environment for sexually transmitted diseases. *JAMA, 284*(4), 443-446. doi: doi:10.1001/jama.284.4.443

McIntyre, J. A. (2010). The need for HIV prevention interventions for men who have sex with men in Africa. *Sex Transm Infect, 86*(2), 82-83. doi: 10.1136/sti.2009.041640

Mills, E., Cooper, C., Anema, A., & Guyatt, G. (2008). Male circumcision for the prevention of heterosexually acquired HIV infection: a meta-analysis of randomized trials involving 11,050 men. *HIV Med, 9*(6), 332-335. doi: 10.1111/j.1468-1293.2008.00596.x

Ministry of Health of the People's Republic of China. (2010). China 2010 UNGASS Country Progress Report. Retrieved from http://data.unaids.org/pub/Report/2010/china_2010_country_progress_report_en.pdf

Ministry of Health of the People's Republic of China. (2012). 2012 China AIDS Response Progress Report. Retrieved from http://www.unaids.org/en/dataanalysis/monitoringcountryprogress/progressreports/2012countries/ce_CN_Narrative_Report%5B1%5D.pdf

Ministry of Health of the People's Republic of China, Joint United Nations Programme on HIV/AIDS, & World Health Organization. (2010). 2009 Estimates for the HIV/AIDS Epidemic in China. Retrieved from http://www.unaids.org.cn/download/2009%20China%20Estimation%20Report-En.pdf

Modjarrad, K., & Vermund, S. H. (2010). Effect of treating co-infections on HIV-1 viral load: a systematic review. *Lancet Infect Dis, 10*(7), 455-463. doi: 10.1016/S1473-3099(10)70093-1

Morris, S. R., & Little, S. J. (2011). MSM: resurgent epidemics. *Curr Opin HIV AIDS, 6*(4), 326-332. doi: 10.1097/COH.0b013e3283476c29

Muessig, K. E., & Cohen, M. S. (2013). China, HIV, and Syphilis Among Men Who Have Sex With Men: An Urgent Call to Action. *Clin Infect Dis*. doi: 10.1093/cid/cit213

Murray, E. (2012). Web-Based Interventions for Behavior Change and Self-Management: Potential, Pitfalls, and Progress. *Med 2.0, 1*(2), e3. doi: 10.2196/med20.1741

Myung, S. K., McDonnell, D. D., Kazinets, G., Seo, H. G., & Moskowitz, J. M. (2009). Effects of Web- and computer-based smoking cessation programs: meta-analysis of randomized controlled trials. *Arch Intern Med, 169*(10), 929-937. doi: 10.1001/archinternmed.2009.109

National Cancer Institute, U.S. Department of Health and Human Services, & National Institutes of Health. (2012). Theory at a Glance: A Guide for Health Promotion Practice. Retrieved from http://www.cancer.gov/cancertopics/cancerlibrary/theory.pdf

Netemeyer, R. G., Bearden, W. O., & Sharma, S. (2003). *Scaling Procedures: Issues and Applications* (1st ed.). London, UK: SAGE Publications.

Noar, S. M. (2011). Computer technology-based interventions in HIV prevention: state of the evidence and future directions for research. *AIDS Care, 23*(5), 525-533. doi: 10.1080/09540121.2010.516349

Noar, S. M., Black, H. G., & Pierce, L. B. (2009). Efficacy of computer technology-based HIV prevention interventions: a meta-analysis. *AIDS, 23*(1), 107-115. doi: 10.1097/QAD.0b013e32831c5500

Noar, S. M., Cole, C., & Carlyle, K. (2006). Condom use measurement in 56 studies of sexual risk behavior: review and recommendations. *Arch Sex Behav, 35*(3), 327-345. doi: 10.1007/s10508-006-9028-4

Nova Southeastern University. (2011a). Motiv82Change: an HIV Prevention Study for Young Latino Men (Identifier NCT00877695). Available from Nationa Library of Medicine (US) ClinicalTrial.gov Retrieved Jan 10 2013 http://ClinicalTrials.gov/show/NCT00877695

Nova Southeastern University. (2011b). Project Power: An HIV Risk Reduction Intervention for Black Men Who Have Sex With Men and Women (BMSM/W) (Identifier NCT01376895). Available from National Library of Medicine (US) ClinicalTrials.gov Retrieved Jan 10 2013 http://ClinicalTrials.gov/show/NCT01376895

Oswalt, S. B., & Wyatt, T. J. (2013). Sexual Health Behaviors and Sexual Orientation in a U.S. National Sample of College Students. *Arch Sex Behav*. doi: 10.1007/s10508-012-0066-9

Ouyang, L., Feng, L. G., Ding, X. B., Zhao, J. K., Xu, J., Han, M., & Zhou, C. (2009). [A respondent-driven sampling survey on HIV and risk factors among men who have sex with men in Chongqing]. *Zhonghua Liu Xing Bing Xue Za Zhi, 30*(10), 1001-1004.

Padian, N. S., Buve, A., Balkus, J., Serwadda, D., & Cates, W., Jr. (2008). Biomedical interventions to prevent HIV infection: evidence, challenges, and way forward. *Lancet, 372*(9638), 585-599. doi: 10.1016/S0140-6736(08)60885-5

Pequegnat, W., Rosser, B. R., Bowen, A. M., Bull, S. S., DiClemente, R. J., Bockting, W. O., . . . Zimmerman, R. (2007). Conducting Internet-based HIV/STD prevention survey research: considerations in design and evaluation. *AIDS Behav, 11*(4), 505-521. doi: 10.1007/s10461-006-9172-9

Peterman, T. A., Drotman, D. P., & Curran, J. W. (1985). Epidemiology of the acquired immunodeficiency syndrome (AIDS). *Epidemiol Rev, 7*, 1-21.

Proudfoot, J., Klein, B., Barak, A., Carlbring, P., Cuijpers, P., Lange, A., . . . Andersson, G. (2011). Establishing guidelines for executing and reporting internet intervention research. *Cognitive Behaviour Therapy, 40*(2), 82-97. doi: 10.1080/16506073.2011.573807

Reisner, S. L., Mimiaga, M. J., Bland, S., Skeer, M., Cranston, K., Isenberg, D., . . . Mayer, K. H. (2010). Problematic alcohol use and HIV risk among Black men who have sex with men in Massachusetts. *AIDS Care, 22*(5), 577-587. doi: 10.1080/09540120903311482

Reynolds, H. W., Luseno, W. K., & Speizer, I. S. (2012). The measurement of condom use in four countries in East and southern Africa. *AIDS Behav, 16*(4), 1044-1053. doi: 10.1007/s10461-012-0146-9

Rhodes, S. D., Vissman, A. T., Stowers, J., Miller, C., McCoy, T. P., Hergenrather, K. C., . . . Eng, E. (2011). A CBPR partnership increases HIV testing among men who have sex with men (MSM): outcome findings from a pilot test of the CyBER/testing internet intervention. *Health Educ Behav, 38*(3), 311-320. doi: 10.1177/1090198110379572

Rietmeijer, C. A., & McFarlane, M. (2009). Web 2.0 and beyond: risks for sexually transmitted infections and opportunities for prevention. *Curr Opin Infect Dis, 22*(1), 67-71. doi: 10.1097/QCO.0b013e328320a871

Ritterband, L. M., & Tate, D. F. (2009). The science of internet interventions. Introduction. *Ann Behav Med, 38*(1), 1-3. doi: 10.1007/s12160-009-9132-5

Ritterband, L. M., Thorndike, F. P., Cox, D. J., Kovatchev, B. P., & Gonder-Frederick, L. A. (2009). A behavior change model for internet interventions. *Ann Behav Med, 38*(1), 18-27. doi: 10.1007/s12160-009-9133-4

Rosser, B. R., Oakes, J. M., Konstan, J., Hooper, S., Horvath, K. J., Danilenko, G. P., . . . Smolenski, D. J. (2010). Reducing HIV risk behavior of men who have sex with men through persuasive computing: results of the Men's INTernet Study-II. *AIDS, 24*(13), 2099-2107. doi: 10.1097/QAD.0b013e32833c4ac7

Ruan, S., Yang, H., Zhu, Y., Ma, Y., Li, J., Zhao, J., . . . Raymond, H. F. (2008). HIV prevalence and correlates of unprotected anal intercourse among men who have sex with men, Jinan, China. *AIDS Behav, 12*(3), 469-475. doi: 10.1007/s10461-008-9361-9

Ruan, S., Yang, H., Zhu, Y., Wang, M., Ma, Y., Zhao, J., . . . Raymond, H. F. (2009). Rising HIV prevalence among married and unmarried among men who have sex with men: Jinan, China. *AIDS Behav, 13*(4), 671-676. doi: 10.1007/s10461-009-9567-5

Ruan, Y., Li, D., Li, X., Qian, H. Z., Shi, W., Zhang, X., . . . Shao, Y. (2007). Relationship between syphilis and HIV infections among men who have sex with men in Beijing, China. *Sex Transm Dis, 34*(8), 592-597. doi: 10.1097/01.olq.0000253336.64324.ef

Ruan, Y., Luo, F., Jia, Y., Li, X., Li, Q., Liang, H., . . . Shao, Y. (2009). Risk factors for syphilis and prevalence of HIV, hepatitis B and C among men who have sex with men in Beijing, China: implications for HIV prevention. *AIDS Behav, 13*(4), 663-670. doi: 10.1007/s10461-008-9503-0

Salganik, M. J. (2006). Variance estimation, design effects, and sample size calculations for respondent-driven sampling. *J Urban Health, 83*(6 Suppl), i98-112. doi: 10.1007/s11524-006-9106-x

Schroder, K. E., Carey, M. P., & Vanable, P. A. (2003). Methodological challenges in research on sexual risk behavior: II. Accuracy of self-reports. *Ann Behav Med, 26*(2), 104-123.

Schulz, K. F., Altman, D. G., Moher, D., & Group, C. (2010). CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *PLoS Med, 7*(3), e1000251. doi: 10.1371/journal.pmed.1000251

Schünemann, H. J., Oxman, A. D., Higgins, J. P. T., Vist, G. E., Glasziou, P., & Guyatt, G. H. (2011). Chapter 11: Presenting results and 'summary of findings' tables. In J. P. T. Higgins & S. Green (Eds.), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]: The Cochrane Collaboration. Retrieved from www.cochrane-handbook.org.

Sheeran, P., & Abraham, C. (1994). Measurement of condom use in 72 studies of HIV-preventive behaviour: A critical review. *Patient Education and Counseling, 24*(3), 199-216. doi: dx.doi.org/10.1016/0738-3991(94)90065-5

Smith, A. D., Tapsoba, P., Peshu, N., Sanders, E. J., & Jaffe, H. W. (2009). Men who have sex with men and HIV/AIDS in sub-Saharan Africa. *Lancet, 374*(9687), 416-422. doi: 10.1016/S0140-6736(09)61118-1

Smolenski, D., Wilkerson, J. M., & Rosser, B. R. S. (July, 2010a). *Mechanisms of change in an online randomized-controlled trial for HIV-negative and HIV-positive men who have sex with men*. Paper presented at the XVIII International AIDS Conference, Vienna, Austria. Abstract retrieved from http://www.iasociety.org/Default.aspx?pageId=11&abstractId=200738241

Smolenski, D., Wilkerson, J. M., & Rosser, B. R. S. (July, 2010b). *Unobserved heterogeneity in the effect of a randomized-controlled prevention trial among men who have sex with men*. Paper presented at the XVIII International AIDS Conference, Vienna, Austria. Abstract retrieved from www.iasociety.org/Default.aspx?pageId=12&abstractId=200738252

Song, Y., Li, X., Zhang, L., Fang, X., Lin, X., Liu, Y., & Stanton, B. (2011). HIV-testing behavior among young migrant men who have sex with men (MSM) in Beijing, China. *AIDS Care, 23*(2), 179-186. doi: 10.1080/09540121.2010.487088

State Council AIDS Working Committee Office China. (2012). China Global AIDS Response Progress Report 2012. Retrieved from http://www.unaids.org/en/dataanalysis/monitoringcountryprogress/progressreports/2012countries/ce_CN_Narrative_Report%5B1%5D.pdf

State Council AIDS Working Committee Office UN Theme Group on AIDS in China. (2007). A joint assessment of HIV/AIDS prevention, treatment and care in China.   Retrieved from http://chinaaids.cn/n443289/n443292/appendix/2008111111551.pdf

Sullivan, P. S., Carballo-Dieguez, A., Coates, T., Goodreau, S. M., McGowan, I., Sanders, E. J., . . . Sanchez, J. (2012). Successes and challenges of HIV prevention in men who have sex with men. *Lancet, 380*(9839), 388-399. doi: 10.1016/S0140-6736(12)60955-6

Sullivan, P. S., Hamouda, O., Delpech, V., Geduld, J. E., Prejean, J., Semaille, C., . . . Annecy MSM Epidemiology Study Group. (2009). Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996-2005. *Ann Epidemiol, 19*(6), 423-431. doi: 10.1016/j.annepidem.2009.03.004

Sun, X., Nan, J., & Guo, Q. (1994). AIDS and HIV infection in China. *AIDS, 8 Suppl 2*, S55-59.

Swendeman, D., & Rotheram-Borus, M. J. (2010). Innovation in sexually transmitted disease and HIV prevention: internet and mobile phone delivery vehicles for global diffusion. *Curr Opin Psychiatry, 23*(2), 139-144. doi: 10.1097/YCO.0b013e328336656a

Tao, X., Gai, R., Zhang, N., Zheng, W., Zhang, X., Xu, A., & Li, S. (2010). HIV infection and mental health of "money boys": a pilot study in Shandong Province, China. *Southeast Asian J Trop Med Public Health, 41*(2), 358-368.

The World Bank. (2013). Data-indicators-Health-Population(total). Retrieved 6/1, 2013, from http://data.worldbank.org/indicator/SP.POP.TOTL

Thompson, M. A., Aberg, J. A., Cahn, P., Montaner, J. S., Rizzardini, G., Telenti, A., . . . International AIDS Society-USA. (2010). Antiretroviral treatment of adult HIV infection: 2010 recommendations of the International AIDS Society-USA panel. *JAMA, 304*(3), 321-333. doi: 10.1001/jama.2010.1004

Tucker, J. D., Bu, J., Brown, L. B., Yin, Y. P., Chen, X. S., & Cohen, M. S. (2010). Accelerating worldwide syphilis screening through rapid testing: a systematic review. *Lancet Infect Dis, 10*(6), 381-386. doi: 10.1016/S1473-3099(10)70092-X

Turner, L., Shamseer, L., Altman, D. G., Weeks, L., Peters, J., Kober, T., . . . Moher, D. (2012). Consolidated standards of reporting trials (CONSORT) and the completeness of reporting of randomised controlled trials (RCTs) published in medical journals. *Cochrane Database Syst Rev, 11*, MR000030. doi: 10.1002/14651858.MR000030.pub2

UNAIDS. (2006). Policy Brief: HIV and SEX BETWEEN MEN. Retrieved from www.unaids.org.cn/uploadfiles/20080725150033.pdf

UNAIDS. (2009). UNAIDS Action Framework: Universal Access for Men who have Sex with Men and Transgender People.   Retrieved from http://data.unaids.org/pub/report/2009/jc1720_action_framework_msm_en.pdf

UNAIDS. (2010a). Getting to Zero: 2011-2015 Strategy. Retrieved from http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2010/JC2034_UNAIDS_Strategy_en.pdf

UNAIDS. (2010b). Global report: UNAIDS report on the global AIDS epidemic 2010. Retrieved from http://www.unaids.org/globalreport/documents/20101123_GlobalReport_full_en.pdf

UNAIDS. (2011). UNAIDS World AIDS Day Report 2011. Retrieved from http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/JC2216_WorldAIDSday_report_2011_en.pdf

UNAIDS. (2012). UNAIDS report on the global AIDS epidemic 2012. Retrieved from http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2012/gr2012/20121120_UNAIDS_Global_Report_2012_with_annexes_en.pdf

UNAIDS. (2013). Global report: 2013 UNAIDS Report on the global AIDS epidemic. Retrieved from http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2013/gr2013/UNAIDS_Global_Report_2013_en.pdf

University of Illinois. (2009). Internet-based HIV/STI Prevention for Young MSM Receiving HIV Testing (Identifier NCT00968188). Available from National Library of Medicine (US) ClinicalTrials.gov Retrieved Jan 10 2013 http://ClinicalTrials.gov/show/NCT00968188

van Griensven, F., & de Lind van Wijngaarden, J. W. (2010). A review of the epidemiology of HIV infection and prevention responses among MSM in Asia. *AIDS, 24 Suppl 3*, S30-40. doi: 10.1097/01.aids.0000390087.22565.b4

Vandelanotte, C., Spathonis, K. M., Eakin, E. G., & Owen, N. (2007). Website-delivered physical activity interventions a review of the literature. *Am J Prev Med, 33*(1), 54-64. doi: 10.1016/j.amepre.2007.02.041

Velter, A., Barin, F., Bouyssou, A., Guinard, J., Leon, L., Le Vu, S., . . . Semaille, C. (2013). HIV prevalence and sexual risk behaviors associated with awareness of HIV status among men who have sex with men in Paris, France. *AIDS Behav, 17*(4), 1266-1278. doi: 10.1007/s10461-012-0303-1

Vergidis, P. I., & Falagas, M. E. (2009). Meta-analyses on behavioral interventions to reduce the risk of transmission of HIV. *Infect Dis Clin North Am, 23*(2), 309-314. doi: 10.1016/j.idc.2009.02.001

Vermund, S. H., & Leigh-Brown, A. J. (2012). The HIV Epidemic: High-Income Countries. *Cold Spring Harb Perspect Med, 2*(5), a007195. doi: 10.1101/cshperspect.a007195

Vermund, S. H., Tique, J. A., Cassell, H. M., Pask, M. E., Ciampa, P. J., & Audet, C. M. (2013). Translation of Biomedical Prevention Strategies for HIV: Prospects and Pitfalls. *J Acquir Immune Defic Syndr, 63 Suppl 1*, S12-25. doi: 10.1097/QAI.0b013e31829202a2

Vital Wave Consulting. (2009). mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World. Retrieved from http://www.vitalwaveconsulting.com/pdf/2011/mHealth.pdf

Volz, E., & Heckathorn, D. D. (2008). Probability Based Estimation Theory for Respondent Driven Sampling. *Journal of Official Statistics, 24*(1), 79-97.

Wah-Shan, C. (2001). Homosexuality and the cultural politics of tongzhi in Chinese societies. *J Homosex, 40*(3-4), 27-46. doi: 10.1300/J082v40n03_03

Wang, B., Li, X., Stanton, B., Liu, Y., & Jiang, S. (2013). Socio-demographic and behavioral correlates for HIV and syphilis infections among migrant men who have sex with men in Beijing, China. *AIDS Care, 25*(2), 249-257. doi: 10.1080/09540121.2012.701714

Wang, L., Ding, Z. W., Yan, R. X., Li, D. M., Guo, W., Ding, G. W., . . . Wang, L. (2010). [HIV/AIDS epidemic situation and data analysis among young students from 2006-2009 in China]. *Zhonghua Liu Xing Bing Xue Za Zhi, 31*(9), 1017-1021.

Wang, S., Moss, J. R., & Hiller, J. E. (2011). The cost-effectiveness of HIV voluntary counseling and testing in China. *Asia Pac J Public Health, 23*(4), 620-633. doi: 10.1177/1010539511412576

Webb, T. L., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *J Med Internet Res, 12*(1), e4. doi: 10.2196/jmir.1376

Wei, C., Herrick, A., Raymond, H. F., Anglemyer, A., Gerbase, A., & Noar, S. M. (2011). Social marketing interventions to increase HIV/STI testing uptake among men who have sex with men and male-to-female transgender women. *Cochrane Database Syst Rev*(9), CD009337. doi: 10.1002/14651858.CD009337

Wei, C., Ruan, S., Zhao, J., Yang, H., Zhu, Y., & Raymond, H. F. (2011). Which Chinese men who have sex with men miss out on HIV testing? *Sex Transm Infect, 87*(3), 225-228. doi: 10.1136/sti.2010.047407

White, R. G., Lansky, A., Goel, S., Wilson, D., Hladik, W., Hakim, A., & Frost, S. D. (2012). Respondent driven sampling--where we are and where should we be going? *Sex Transm Infect, 88*(6), 397-399. doi: 10.1136/sextrans-2012-050703

Wiysonge, C. S., Kongnyuy, E. J., Shey, M., Muula, A. S., Navti, O. B., Akl, E. A., & Lo, Y. R. (2011). Male circumcision for prevention of homosexual acquisition of HIV in men. *Cochrane Database Syst Rev*(6), CD007496. doi: 10.1002/14651858.CD007496.pub2

Wolitski, R. J., & Fenton, K. A. (2011). Sexual health, HIV, and sexually transmitted infections among gay, bisexual, and other men who have sex with men in the United States. *AIDS Behav, 15 Suppl 1*, S9-17. doi: 10.1007/s10461-011-9901-6

Wong, F. Y., Huang, Z. J., Wang, W., He, N., Marzzurco, J., Frangos, S., . . . Smith, B. D. (2009). STIs and HIV among men having sex with men in China: a ticking time bomb? *AIDS Educ Prev, 21*(5), 430-446. doi: 10.1521/aeap.2009.21.5.430

Wu, Z., Xu, J., Liu, E., Mao, Y., Xiao, Y., Sun, X., . . . for the National, M. S. M. S. G. (2013). HIV and Syphilis Prevalence Among Men Who Have Sex With Men: A Cross-Sectional Survey of 61 Cities in China. *Clin Infect Dis*. doi: 10.1093/cid/cit210

www.aidsdatahub.org (Producer). (2013, May 1 2013). HIV and AIDS Data Hub for Asia-Pacific Review in slides China. Retrieved from http://www.slideboom.com/presentations/download/315201/China---Overview-in-Slides%3A-All-Indicators

Xiao, Y., Ding, X., Li, C., Liu, J., Sun, J., & Jia, Y. (2009). Prevalence and correlates of HIV and syphilis infections among men who have sex with men in Chongqing Municipality, China. *Sex Transm Dis, 36*(10), 647-656. doi: 10.1097/OLQ.0b013e3181aac23d

Xiao, Y., Sun, J., Li, C., Lu, F., Allen, K. L., Vermund, S. H., & Jia, Y. (2010). Prevalence and correlates of HIV and syphilis infections among men who have sex with men in seven provinces in China with historically low HIV prevalence. *J Acquir Immune Defic Syndr, 53 Suppl 1*, S66-73. doi: 10.1097/QAI.0b013e3181c7db43

Xiridou, M., Geskus, R., de Wit, J., Coutinho, R., & Kretzschmar, M. (2004). Primary HIV infection as source of HIV transmission within steady and casual partnerships among homosexual men. *AIDS, 18*(9), 1311-1320.

Xu, J., Han, D. L., Liu, Z., Ma, X. Y., Wang, L. L., Xu, J., . . . Wu, Z. Y. (2010). [The prevalence of HIV infection and the risk factors among MSM in 4 cities, China]. *Zhonghua Yu Fang Yi Xue Za Zhi, 44*(11), 975-980.

Xu, J. J., Reilly, K. H., Lu, C. M., Ma, N., Zhang, M., Chu, Z. X., . . . Shang, H. (2011). A cross-sectional study of HIV and syphilis infections among male students who have sex with men (MSM) in northeast China: implications for implementing HIV screening and intervention programs. *BMC Public Health, 11*, 287. doi: 10.1186/1471-2458-11-287

Ybarra, M. L., & Bull, S. S. (2007). Current trends in Internet- and cell phone-based HIV prevention and intervention programs. *Curr HIV/AIDS Rep, 4*(4), 201-207.

Yin, L., Qin, G., Qian, H. Z., Zhu, Y., Hu, W., Zhang, L., . . . Shao, Y. (2007). Continued spread of HIV among injecting drug users in southern Sichuan Province, China. *Harm Reduct J, 4*, 6. doi: 10.1186/1477-7517-4-6

Yun, K., Xu, J. J., Reilly, K. H., Zhang, J., Jiang, Y. J., Wang, N., & Shang, H. (2011). Prevalence of bisexual behaviour among bridge population of men who have sex with men in China: a meta-analysis of observational studies. *Sex Transm Infect, 87*(7), 563-570. doi: 10.1136/sextrans-2011-050079

Zhang, B., Liu, D., Li, X., & Hu, T. (2000). A survey of men who have sex with men: mainland China. *Am J Public Health, 90*(12), 1949-1950.

Zhang, D., Bi, P., Lv, F., Zhang, J., & Hiller, J. E. (2007). Changes in HIV prevalence and sexual behavior among men who have sex with men in a northern Chinese city: 2002-2006. *J Infect, 55*(5), 456-463. doi: 10.1016/j.jinf.2007.06.015

Zhang, H., Stanton, B., Li, X., Mao, R., Sun, Z., Kaljee, L., . . . Qu, M. (2004). Perceptions and attitudes regarding sex and condom use among Chinese college students: a qualitative study. *AIDS Behav, 8*(2), 105-117. doi: 10.1023/B:AIBE.0000030242.46843.71

Zhang, K., Li, D., Li, H., & Beck, E. J. (1999). Changing sexual attitudes and behaviour in China: implications for the spread of HIV and other sexually transmitted diseases. *AIDS Care, 11*(5), 581-589. doi: 10.1080/09540129947730

Zhang, L., Ding, X., Lu, R., Feng, L., Li, X., Xiao, Y., . . . Qian, H. Z. (2012). Predictors of HIV and syphilis among men who have sex with men in a Chinese metropolitan city: comparison of risks among students and non-students. *PLoS One, 7*(5), e37211. doi: 10.1371/journal.pone.0037211

Zhang, L., Li, J., Lai, W., Feng, L., Zeng, Y., Liu, L., . . . Jia, Y. (2010). Prevalence and correlates of needle-sharing among new and long-term injection drug users in southwest China. *Subst Use Misuse, 45*(14), 2503-2523. doi: 10.3109/10826084.2010.487234

Zhang, L., Qian, H. Z., Blevins Meridith, L., Yin, L., Ruan, Y., & Vermund Sten, H. (2011). Internet-based behavioral interventions for preventing HIV infection in men who have sex with men (MSM) (Protocol). *Cochrane Database of Systematic Reviews*(12), Art. No.: CD009525. doi: 10.1002/14651858.CD009525

Zhang, L., Xiao, Y., Lu, R., Wu, G., Ding, X., Qian, H. Z., . . . Shao, Y. (2013). Predictors of HIV testing among men who have sex with men in a Large Chinese City. *Sex Transm Dis, 40*(3), 235-240. doi: 10.1097/OLQ.0b013e31827ca6b9

Zhang, Y., Chen, P., Lu, R., Liu, L., Wu, Y., Liu, X., . . . Yi, D. (2012). Prevalence of HIV among men who have sex with men in Chongqing, China, 2006-2009: cross-sectional biological and behavioural surveys. *Sex Transm Infect, 88*(6), 444-450. doi: 10.1136/sextrans-2011-050295

Zheng, J., Wu, Z., Poundstone, K. E., Pang, L., & Rou, K. (2012). HIV, syphilis infection, and risky sexual behaviors among male university students who have sex with men in Beijing, China: a cross-sectional study. *AIDS Educ Prev, 24*(1), 78-88. doi: 10.1521/aeap.2012.24.1.78

Zheng, J. D., Pang, L., Xu, J., Rou, K. M., Xiao, D., & Wu, Z. Y. (2011). [Study on the prevalence of HIV and AIDS-related risky sexual behaviors among male university students who have sex with men in Beijing, China]. *Zhonghua Liu Xing Bing Xue Za Zhi, 32*(4), 337-340.

Zhong, F., Lin, P., Xu, H., Wang, Y., Wang, M., He, Q., . . . Zhao, J. (2011). Possible increase in HIV and syphilis prevalence among men who have sex with men in Guangzhou, China: results from a respondent-driven sampling survey. *AIDS Behav, 15*(5), 1058-1066. doi: 10.1007/s10461-009-9619-x

Zhou, L., Guo, J., Fan, L., Tian, J., & Zhou, B. (2009). Survey of motivation for use of voluntary counseling and testing services for HIV in a high risk area of Shenyang, China. *BMC Health Serv Res, 9*, 23. doi: 10.1186/1472-6963-9-23