HIV TRENDS AND RELATED RISK FACTORS AMONG MEN HAVING SEX WITH MEN IN MAINLAND CHINA: FINDINGS FROM A SYSTEMATIC LITERATURE REVIEW

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Abstract. The purpose of this study was to assess trends in the HIV epidemic and risk factors for HIV infection among men having sex with men (MSM) in mainland China. A literature review was conducted. Data from studies regarding HIV prevalence, syphilis infection and risk behavior, were pooled into three chronological stages. The independent correlates of HIV infection were gathered in order to guide the development of future interventions. HIV prevalences were 2.5% (95%CI 1.8-3.7), 1.8% (95%CI 1.1-2.9) and 3.3% (95%CI 2.0-5.3) before 2004, during 2004 to 2005 and 2006 to 2007, respectively. About two-thirds of MSM had multiple male sex partners during the previous six months (P6M), and more than one third of MSM engaged in unprotected anal intercourse (UAI) during last sex. Only UAI among commercial sex workers declined significantly. More than one quarter of MSM had female partners in P6M and the proportion having multiple female partners declined. The rates of unprotected vaginal sex had a downward trend. The prevalence of injecting drug use was low and remained the same. The number of lifetime male sexual partners and the frequency of anal sex in P6M were independently associated with HIV infection; UAI was correlated to the number of male partners, buying sex from males, being part of a mobile population, prior HIV testing and having a prior sexually transmitted disease (STD). We conclude intervention programs targeting UAI and multiple partners are urgently needed to control the HIV epidemic among MSM in mainland China.

Keywords: HIV/AIDS, men who have sex with men (MSM), risk behavior, meta-analysis, China

INTRODUCTION

China is experiencing a nationwide HIV epidemic. Sexual contact has exceeded injecting drug use, as the predominant transmission route. Sexual contact accounts for the majority of transmissions among newly reported cases during the most recent years. The proportion of cases that are due to sexual transmission has increased by more than 2% since 2005 (Lu *et al*, 2006b; State Council AIDS Working Committee Office and UN Theme Group on AIDS in China, 2007). Of the 45,572 newly reported infections in 2008, 38.0% were contracted through heterosexual

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transmission, 6.8% through homosexual transmission, and 29.2% through intravenous drug use (NCAIDS, 2009).

China's HIV/AIDS epidemic has followed a pattern similar to several Asian countries (Ruxrungtham *et al*, 2004), where the HIV epidemic occurs initially among injecting drug users (IDU), followed by spread among female sex workers (FSW) then sexual transmission. In many Asian countries men having sex with men are a part of the HIV epidemic. This subgroup has been overlooked for several decades in China but is now believed to be at the leading edge of the HIV epidemic due to both biological and social susceptibility (He and Wang, 2005).

Because MSM are difficult to identify, due to social discrimination and traditional taboos against openly discussing homosexuality, there are few surveillance data on the HIV epidemic among MSM in mainland China (Neilands *et al*, 2008). According to pilot epidemiological surveys conducted in numerous cities in China, the reported HIV prevalence among MSM varies from city to city (Gu *et al*, 2004; Cai *et al*, 2005; He *et al*, 2005; Cao *et al*, 2006; Lu *et al*, 2006a; Tang *et al*, 2006; Cao *et al*, 2007; Feng *et al*, 2007; Liu *et al*, 2007; Meng *et al*, 2007; Wang *et al*, 2007a; Zhang *et al*, 2007a; Zhu *et al*, 2007a; Ruan *et al*, 2008). There are indications transmission of HIV is dramatically rising among MSM in a number of cities (Feng *et al*, 2007; Ma *et al*, 2007; Ruan *et al*, 2008).

In order to clearly understand the HIV epidemic a related risk factors among MSM in mainland China, we conducted a systematic review of the existing literature using a chronological framework to organize our findings. First, we present the results by studies. Second, we present the prevalence of HIV, syphilis, self-reported STDs and risk behaviors associated with HIV infection through meta-analysis. Third, we aggregate the independent correlates for HIV, syphilis infections and unprotected anal intercourse (UAI) by studies.

MATERIALS AND METHODS

Study design

A systematic review of the literature was applied to estimate the prevalence of HIV, syphilis and related risk behaviors to reveal the HIV epidemic trend among MSM in mainland, China.

Literature review

Search strategies. We searched electronic databases from PubMed for English publications and the China National Knowledge Infrastructure (CNKI) for Chinese publications for 2000 to 2008 using the terms "China AND (HIV OR AIDS) AND (MSM OR gay OR homosexual)" for PubMed, and the Chinese translations of these same search terms for the CNKI database. Current journals only available in hard copy were searched at the libraries of the Center for Disease Control and Prevention of Guangdong Province (GDCDC) and Sun Yat-sen University on 10 October 2008. Data from the studies included in the systematic review were extracted independently by two researchers (HQ, XY). If an individual manuscript presented ambiguous results or lacked details on methodology we contacted the authors for clarification. In addition to the published peer reviewed manuscripts, we also included reports issued by epidemiologic monitoring authorities, such as the Centers for Disease Control and Prevention (CDC) and the Ministry of Health of China. These reports were included, especially in places where few peer-reviewed publications were available.

Inclusion criteria. Original research was considered for inclusion if the authors reported the prevalence of HIV, syphilis and/or high risk behavior among MSM (including homosexual or gay men, bisexual men, male sex workers who had sold sex with men in the past 12 months and their clients) and if the study was conducted in mainland China. Additional inclusion criteria were that they listed details of sampling techniques, had a sample size over 50, their data collection started on or after 1 January 1999 and the studies were published in either English or Chinese. If the study was published both in Chinese and English, we chose to review the English version. The exclusion criteria were those that only presented self-reported HIV status rather than serologic-tested results. A total of 89 English publications from 2001 to 2008 and 123 Chinese publications from 2000 to 2008 were retrieved. Among them, 11 Chinese papers, also indexed by PubMed, were excluded from our study sample due to duplication. Having been rated by HQ and XY independently for quality assurance, a total of 45 publications met the inclusion and exclusion criteria and were included in the current analysis.

Analysis

Meta-analysis, including sensitivity analysis and pooled estimation of measures of interest, were carried out using Comprehensive Meta-Analysis (V2.0, Biostat, Englewood, NJ).

Random effects models were used for meta-analysis, taking into account the possibility of heterogeneity between studies, which was defined when the I^2 statistic was greater than 50% and fixed effects models were used when it was less than 30% if the I^2 statistic fell between 50% and 30%. A p-value of the Q test less than 0.05 was considered indicative of statistically significant heterogeneity (Higgins and Thompson, 2002; He and Chen, 2006).

To assess the heterogeneity of included studies, a sensitivity analysis was conducted through examining whether an individual study result substantially affected the overall effect size estimation. In this study, two factors possibly contributing to the variability were considered: outliers and representativeness of the samples. The identification of an "outlier" was based on a thorough evaluation and comparison of the study characteristics with all other selected studies (Malta *et al*, 2010). Outliers could be found by comparing the aggregated effect size with estimates obtained after iterations using k-1 findings (k=number of independent samples). If outliers exist, the adjusted overall effect would be estimated by deleting the outliers.

Since MSM are a hidden population, multiple methods were used to sample them. Variability between studies could have also resulted from differences in representativeness of the samples due to improper application of these sampling approaches as well as the inherent bias of sampling. In this study, the included literature was classified into six categories based on sampling methods: convenience samples at MSM venues or on through gay-oriented websites (27 studies, including those which sampled using mixed methods, such as using snow-balling, informants referral and venue based sampling), samples from HIV surveillance (3 studies), samples of care-seekers in hospitals or CDCs (3 studies), samples recruited by RDS (3 studies), samples by snow ball or informant referral (3 studies) and unclear (2 studies). Subgroup analysis is supposed to be the first choice to identify the difference between categories (Song *et al*, 2001); unfortunately, the number of studies in some subgroups were too small

to be analyzed. Thus, we identified the effect of the sampling method similar to the outliers, through deleting related articles and examining the changes of I^2 and the pooled effect.

Egger's regression was used to assess the potential for publication bias ($p<0.05$ was considered indicative of statistically significant publication bias) (Li, 2007).

After heterogeneity was assessed, we present the prevalence of HIV, syphilis, sexually transmitted diseases (STD), sex with male partners during the six months prior to the study (P6M), sex with females both during the participant's lifetime and during the P6M, and drug use experiences through pooled effects estimation. In order to demonstrate prevalence of HIV and syphilis more intuitively, a forest plot was drawn with StatsDirect (Version 2.7.8). To examine trends in the epidemic among MSM, we used stratified analyses and categorized the data into three chronological stages, according to when the original data were collected. These strata are: before 2004, 2004 to 2005, and 2006 to 2007. We defined any lifetime female partners as having sex with females at any time. We measured last unprotected anal intercourse (LUAI), last commercial UAI (LCUAI) during the six months prior to participation in the study, experience of lifetime drug use and drug injecting.

Few studies included multivariable analyses identifying independent correlates of HIV, syphilis infection or UAI among MSM. Most studies did not have common measures of correlates. Thus we present here the studies' original results disaggregated.

RESULTS

A total of 45 publications from 41 studies were included, among which, 8 papers were from 4 studies which were conducted in consecutive years or for the same study. Thus the number of studies conducted before 2004, from 2004 to 2005 and from 2006 to 2007 were 9, 23, and 12, respectively. All studies included in our dataset were conducted between 1999 and 2007 and covered all provinces in mainland China. Sample sizes ranged from 79 to 1,389. All together 17,295 subjects were included in our analysis.

Reported prevalence of HIV, syphilis and related risk behavior among MSM by study

The reported prevalence of HIV infection among MSM was between 0 and 17.7% (Fig 1), and the prevalence of syphilis infection was between 0.7% and 39.9% (Fig 2). Three percent to 43.2% of MSM reported having had at least one STD during the 12 months prior to the study. Some MSM (range: 15.6- 46.3%) reported only one male sexual partner while most MSM (range: 11.6- 91.6%) reported multiple male sexual partners in P6M. Thirteen point eight percent to 71.3% of MSM reported having LUAI, among whom, 12.3% to 61.4% reported having LCUAI. Ten point six percent to 47.5% of MSM had sex with a female in the P6M, up to 63.9% had female partners during their lifetime. A small proportion of MSM (range: 1.7-6.85%) reported a lifetime experience of illicit drug use with 0.15% to 6.1% reporting ever injecting drugs. Table 1 reports the author, location and key outcomes of each study.

Epidemic trend by meta-analysis

Sensitivity analysis showed no significant change for the effect size estimates whether stratifying groups of studies based on one specific sampling method or without stratification, *ie*, 95% CIs of the effect sizes highly overlapped. Changes in I^2 were random in two directions, increas-

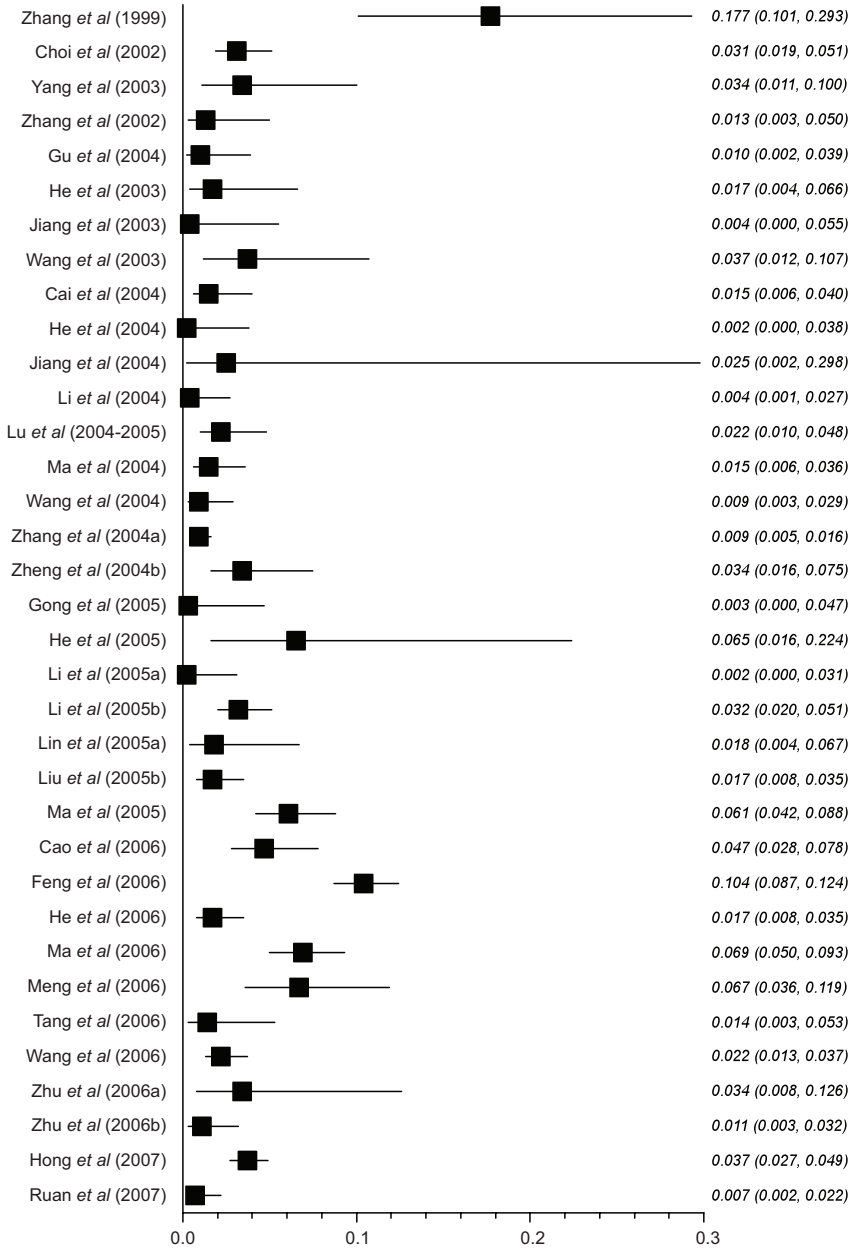

Fig 1–Forrest plots regarding HIV prevalence and corresponding 95% confidence intervals among MSM in China (in parentheses are the years when the data were collected).

ing for some measures of interest but decreasing for others. Therefore, we present the pooled effects during three periods, with the exclusion of one "outlier" (Zhang *et al*, 2001) for pooled HIV prevalence. The exclusion of this study decreased the pooled HIV prevalence before 2004 from 2.8% to 2.5%, and decreased the I^2 from 80.8 to 5.2. The outlier study collected data among MSM from all provinces in China,

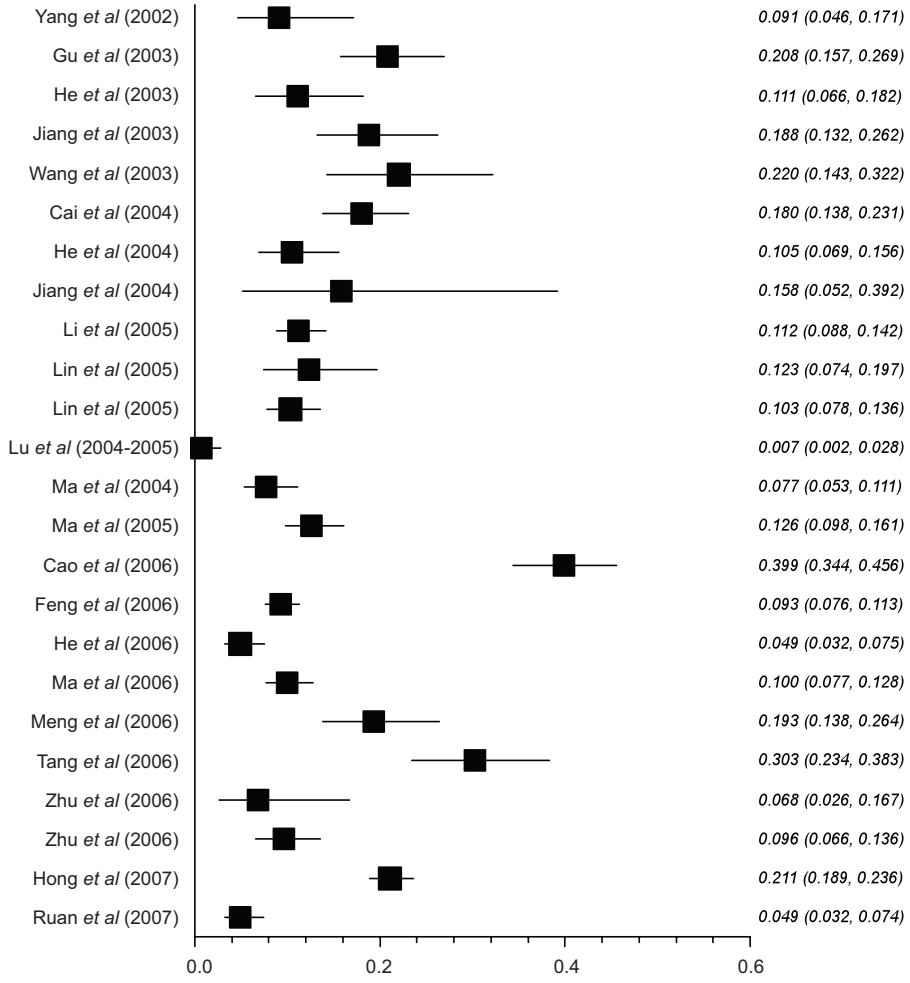

Fig 2–Forrest plots regarding syphilis prevalence and corresponding 95% confidence intervals among MSM in China (in parentheses are the years when the data were collected).

who corresponded with the researchers.

The current meta-analysis suggests a possible increasing trend in HIV prevalence among MSM since 2004. HIV prevalence rose from 1.8% (95%CI 1.1-2.9) to 3.3% (95%CI 2.0-5.3). Repeated measurements in Beijing, Harbin, and Shenzhen showed the same increase. The prevalences of syphilis and previously identified STDs remained the same during this period. The majority of MSM had multiple male partners and about a quarter had only one male partner in the P6M. The prevalence of LUAI increased since 2004 while the prevalence of LCUAI significantly decreased since 2006. The proportion of respondents having multiple female partners in P6M declined significantly since 2004. The proportion reporting unprotected vaginal sex (UVI) at last vaginal sex also declined from 2004 to 2007. Apart from the risky sexual behaviors, few MSM were putting themselves at risk through injection drug use (Table 2).

Table 1
HIV and syphilis prevalence and related risk behaviors among MSM by study in mainland China, 1999-2007.

Author and year published	Study sites and year conducted	Sample size	No. tested	HIV (%)	Syphilis (%)	History of STD (%)	Sex with males (%)				Sex with females				Drug use (%)	
							No. of sex partners		LUAI	LCUAI	No. of sex partners			LUVI	LCUVI	Drug use	Injecting
							1	>1			>0 (%)	1	>1				
Zhang *et al*, 2001	Mainland,1999	729	62	17.74		18.2					29.0*						
Choi *et al*, 2003	Beijing, 2001	482	481	3.12		22.7					63.9*						
Zhang *et al*, 2007	Harbin, 2002	215	154	1.30		32.2		86.5			41.9						6.1
Yang *et al*, 2003	Shenzhen, 2002	88	88	3.41	9.1	43.2											
Wang *et al*, 2007	Chengde, 2003	82	82	3.66	22.0	28.0			29.3		22.0						
Jiang *et al*, 2006	Nanjing, Yangzhou, Changzhou,Wuxi, Suzhou, 2003	144	138	0	18.8	11.1											
Gu *et al*, 2004	Shenyang, 2003	342	202	1.0	20.8		29.8	67.5			36.3	44	80				
Lan *et al*, 2004	Chengdu, Nanchong, 2003	580						62.8	-	52.6	24.0						1.9
He *et al*, 2005	Guangzhou, 2003	121	117	1.71	11.1		46.3	11.6									
Wang *et al*, 2007	Kunming, 2004	222							53.0								
Yang *et al*, 2006	Nanjing, Wuxi, Suzhou, Huai'an, 2004	222				34.0					46.0					6.85	
Ma *et al*, 2007	Beijing, 2004	325	325	1.5	7.7	21.9	28.0	67.8									
Jiang *et al*, 2006b	Weihai, 2004	79	19	0	15.8				63.3								
Li *et al*, 2006	Xi'an, 2004	258	258	0.39							58.1*						
Wang *et al*, 2006; Zhang *et al*, 2007	Harbin, 2004	397	320	0.94		19.0		76.0			24.7	49	49				2.0
He *et al*, 2006	Guangzhou, 2004	201	200	0	10.5	29.9										3.1	0.5
Chu *et al*, 2006	Harbin, 2004	221							71.3								
Zheng *et al*, 2006; Zheng *et al*, 2006	Hefei, 2004	174	174	3.4		10.3			57.6		43.7			46			

Zhang *et al*, 2007	Chongqing, Shenyang, Dalian, Qingdao, Nanjing, Xi'an, 2004	1,389	1,389	0.94		16.8	32.2	72.8	23.6		42.4						
Cai *et al*, 2005	Shenzhen, 2004	273	261	1.53	18.0												
Lu *et al*, 2006	Guiyang, 2004	276	276	2.17	0.7						44.9*						
Wang *et al*, 2007	Kunming, 2005	397							38.6	61.4							
Li *et al*, 2006	Dalian, 2005	247	247	0		11.7				17.8	43.7*						
Chen *et al*, 2007	Hangzhou, 2005	365							29.3		11.5			14			
He *et al*, 2006	Wuhu, 2005	360	31	6.45			26.4	42.8	61.1		12.8						
Hu *et al*, 2006	Nanchang, 2005	200				3.0	34.5	51.5			50.5*	45	19	46			
Li *et al*, 2006	Wuhan, 2005	96				8.3	15.6	61.5	44.0		45.8	31	13	28			
Liu *et al*, 2007	Beijing, 2005	416	416	1.68	10.3						31.7						
Li *et al*, 2008	Beijing, 2005	526	526	3.23	11.2		34.4	65.6			10.6					2.5	
Gong *et al*, 2006	Laiyang, 2005	164	164	0													
Tian and Ji, 2006	Nanchong, 2005	147								32.5	36.1						
Lin *et al*, 2007	Shenzhen, 2005	114	114	1.75	12.3	32.4										4.5	
Ma *et al*, 2007	Beijing, 2005	427	427	6.1	12.7	27.6											
He *et al*, 2008	Guangzhou, 2006	423	409	1.71	4.9	20.8	20.8	33.3	50.4	12.3	26.2			85	28	6.4	2.6
Wang *et al*, 2007; Zhang *et al*, 2007	Harbin, 2006	647	674	2.23		10.2		91.6			25.0*					1.7	0.2
Tang *et al*, 2007	Harbin, 2006	648									23.7	118	36				
Feng *et al*, 2007	Chongqing, 2006	1,000	1,000	10.4	9.3		23.3	50.7	43.6		24.3	179	64	154			6.5
Ma *et al*, 2007	Beijing, 2006	540	540	6.9	10.0	29.6	17.8	81.5									
Wang *et al*, 2007	Kunming, 2006	317							24.1								
Zhu *et al*, 2007	Jinan, 2006	400	282	1.06	9.6						34.8*						
Cao *et al*, 2007	Jiangsu, 2006	296	296	4.73	39.9	18.9											
Tang *et al*, 2006	Wuhan, 2006	145	145	1.38	30.3												
Cai *et al*, 2007	Nanchang, 2006	101					41.6	36.6	13.8		47.5			14			
Zhu *et al*, 2007	Jiaxing, 2006	119	59	3.39	6.8												
Meng *et al*, 2007	Shijiazhuang, 2006	150	150	6.67	19.3												
Ruan *et al*, 2007	Jinan, 2006	656					30.9	55.0	52.5		12.3			51			
Hong *et al*, 2008	Shenzhen, 2007	1,146	1,146	3.67	21.1												
Ruan *et al*, 2008	Jinan, 2007	428	428	0.7	4.9	12.4					32.7					2.3	0.5

LUAI: Last unprotected anal intercourse; LCUAI: last commercial unprotected anal intercourse; LUVI: last unprotected vaginal intercourse; LCUVI: last commercial unprotected vaginal intercourse

* Measurements were not within 6 months

Table 2
Trends for HIV and syphilis prevalence and related behaviors among MSM in mainland China (1999-2007).

Variables	Before 2004	2004-2005	2006-2007
HIV infection			
No. of publications	7	16	11
Pooled No. tested	1,262	5,147	5,129
No. positive	27	92	239
Heterogeneity (I^2, Q, P)	5.2, 6.3, 0.387	73.1, 55.8, <0.001	90.2, 102.1, <0.001
Prevalence (95% CI)	2.5 (1.8-3.7)	1.8 (1.1-2.9)	3.3 (2.0-5.3)
Publication bias (t, p)	2.555, 0.0510	2.487,0.0261	3.475, 0.0070
Syphilis infection			
No. of publications	5	9	10
Pooled No. tested	627	2,564	4,455
No. positive	107	268	652
Heterogeneity (I^2, Q, P)	60.5, 10.1, 0.028	76.0, 33.3, <0.001	96.8, 277.1, <0.001
Prevalence (95% CI)	16.5 (12.2-22.0)	10.7 (8.3-13.9)	13.0 (8.2-20.1)
Publication bias (t, p)	2.321,0.1030	1.434,0.1945	1.262, 0.2425
Previously identified STD			
No. of publications	5	11	5
No. responses	1,647	3,612	2,324
No. reported	349	671	422
Heterogeneity (I^2, Q, P)	89.6, 38.6, <0.001	90.6, 106.4, <0.001	95.1, 81.8, <0.001
Prevalence (95% CI)	21.8 (16.3-28.5)	18.0 (13.9-23.1)	17.5 (11.4-25.8)
Publication bias (t, p)	0.102, 0.9253	0.594, 0.5675	2.278, 0.1071
Male partners in P6M			
Only one partner			
No. of publications	2	5	5
No. responses	463	2,777	2,720
No. reported	148	796	662
Heterogeneity (I^2, Q, P)	—	76.9, 21.7, 0.001	91.4, 46.6, <0.001
Prevalence (95% CI)	33.2 (25.8-41.4)	28.4 (24.7-32.6)	25.6 (20.0-32.2)
Publication bias (t, p)	—	0.425, 0.6929	0.348, 0.7511
Multiple partners			
No. of publications	4	7	6
No. of responses	1,258	3,174	3,367
No. reported	693	2,255	2,079
Heterogeneity (I^2, Q, P)	98.3, 173.6, <0.001	97.8, 278.9, <0.001	98.9, 460.9, <0.001
Prevalence (95% CI)	51.9 (27.1-75.9)	65.5 (51.9-77.0)	61.8 (42.7-77.7)
Publication bias (t, p)	0.045, 0.9685	1.305, 0.2488	0.689, 0.5286
Last UAI			
No. of publications	1	10	5
No. of responses	82	2,970	2,113
No. reported	58	1,029	929
Heterogeneity (I^2, Q, P)	—	97.1, 306.2, <0.001	95.1, 82.0, <0.001
Prevalence (95% CI)	70.7 (60.0-79.5)	44.9 (33.0-57.5)	37.3 (27.8-47.9)
Publication bias (t, p)	—	2.914, 0.0195	1.677, 0.1921
Last commercial UAI			
No. of publications	1	1	1
No. of response	97	40	423
No. of reported	51	13	52
Heterogeneity (I^2, Q, P)	—	—	—
Prevalence (95% CI)	52.6 (42.7-62.3)	32.5 (19.9-48.3)	12.3 (9.5-15.8)
Publication bias (t, p)	—	—	—
Lifetime female partners			
No. of publications	5	14	8
No. of responses	1,701	5,073	4,303

Table 2 (continued).

Variables	Before 2004	2004-2005	2006-2007
No. reported	679	1,643	1,078
Heterogeneity (I^2, Q, P)	97.8, 177.9, <0.001	96.6, 377.3, <0.001	93.7, 110.9, <0.001
Prevalence (95% CI)	36.9 (22.3-54.4)	31.6 (24.6-39.6)	27.0 (21.8-32.9)
Publication bias (t, p)	0.513, 0.6450	1.429, 0.1789	0.758, 0.4773
Female partners in P6M			
No. of publications	4	10	6
No. responsed	1,219	4,092	3,256
No. of reported	371	1,238	777
Heterogeneity (I^2, Q, P)	90.7, 32.4, <0.001	97.2, 325.9, <0.001	94.6, 92.2, <0.001
Prevalence (95% CI)	30.9 (22.4-40.8)	28.0 (19.8-38.1)	26.2 (19.8-33.8)
Publication bias (t, p)	0.079, 0.9442	1.648, 0.1379	0.589, 0.5874
Only one partner			
No. of publications	1	3	2
No. of responses	342	693	1,647
No. reported	44	125	297
Heterogeneity (I^2, Q, P)	—	—	—
Prevalence (95% CI)	12.9 (9.7-16.8)	21.0 (11.8-34.6)	18.0 (16.2-20.0)
Publication bias (t, p)	—	—	—
Multiple partners			
No. of publications	1	3	2
No. of responses	342	693	1,648
No. reported	80	81	100
Heterogeneity (I^2, Q, P)	—	—	—
Prevalence (95% CI)	23.4 (19.2-28.2)	11.8 (9.6-14.4)	6.1 (5.0-7.3)
Publication bias (t, p)	—	—	—
Last UVI			
No. of publications	0	4	4
No. of responses		256	1,551
No. reported		134	304
Heterogeneity (I^2, Q, P)		58.3, 7.2, 0.066	96.5, 85.3, <0.001
Prevalence (95% CI)		51.7 (45.5, 57.9)	29.4 (15.7-48.3)
Publication bias (t, p)		12.929, 0.0059	1.839, 0.2073
Last commercial UVI			
No. of publications	0	0	1
No. of responses			423
No. reported			28
Heterogeneity (I^2, Q, P)			—
Prevalence (95% CI)			6.6 (4.6-9.4)
Publication bias (t, p)			—
Drug use experience			
No. of publications	0	4	3
No. of responses		1,044	1,498
No. reported		39	48
Heterogeneity (I^2, Q, P)		62.3, 8.0, 0.052	88.5, 17.4, <0.001
Prevalence (95% CI)		4.0 (2.3-6.7)	3.0 (1.2-7.2)
Publication bias (t, p)		0.274, 0.8096	3.589, 0.1730
Injecting drug use			
No. of publications	2	2	4
No. of responses	789	582	2,498
No. reported	24	9	79
Heterogeneity (I^2, Q, P)	—	—	91.1, 33.7, <0.001
Prevalence (95% CI)	3.4 (1.1-10.4)	1.4 (0.4-4.9)	1.4 (0.4-4.9)
Publication bias (t, p)	—	—	16.910, 0.0035

All prevalence, rates and I^2 statistics are presented as percentages. When the number of studies was less than 3, publication bias could not be analyzed and quantification of heterogeneity is meaningless, and the related result was reported as "—".

Correlates of HIV, syphilis infection and UAI

In spite of diverse measurements of variables and recall periods, two out of three studies found that HIV infection was associated with the number of lifetime male sex partners, and the others reported HIV infection associated with having anal sex with a male partner in the P6M. One of two studies reported correlations between syphilis infection and the number of lifetime male sex partners. Five out of eight studies reported that UAI was associated with the number of male sex partners, three reported UAI was associated with buying sex from males and immigration, and two found UAI was associate with past HIV testing and history of STDs (Table 3).

DISCUSSION

Our systematic analysis of the existing epidemiologic data strongly suggests HIV has been spreading among MSM in China for some time, as has been suggested in the literature (de Lind van Wijngaarden *et al,* 2009). In addition, we document an increasing HIV prevalence among MSM in mainland China, bearing out earlier speculation by Jones (2007) but a trend not well documented by the literature (Gao *et al,* 2009). The prevalences of both syphilis infection and other STDs are high among this population.

We identified long-standing, highly prevalent risky sexual behaviors among MSM in mainland China. The proportion of MSM who had male partners in the P6M appears stable and the proportion of those having multiple partners was also stable, suggesting having multiple partners was a common risk that puts this population at higher risk for HIV infection (Choi *et al,* 2003; Read *et al,* 2007; Ruan *et al,* 2007a). The increase in prevalence of LUAI after 2004 implies a potentially rapid expanding HIV epidemic if no effective action is taken in a timely manner. Fortunately, the decrease in last commercial UAI, suggests MSM are aware of the risk of participating in the commercial sex industry. The low level of drug use and very low needle/syringe sharing among MSM may help to reduce or prevent bridging of HIV from the IDU population in China.

Although behavioral bisexuality is common among MSM in China, we detected a subtle decline in the proportion who had female partners in the P6M and in their lifetime after 2006, which was also found in Harbin (Zhang *et al,* 2007a). About one in five MSM had only one female partner, which may be spouses or regular female partners. However, recent research suggests a possible association between marriage and risk behavior, making even these low numbers of female partners worrisome in terms of the potential for bridging HIV infections to heterosexual women (Shi *et al,* 2008). In spite of a remarkable decline in the proportion of MSM who have multiple female partners in the P6M, the substantive prevalence of UVI during last sex may bridge HIV between MSM and heterosexual women, a finding also reported in Yunnan (Lau *et al,* 2008).

However, our results showed strong heterogeneity among the studies. Heterogeneity indicates differences in results across studies. There are two sources of heterogeneity: within-study variability and between-study variability. Within-study variability means a difference within a study of estimating the same effect size. It always exists in meta-analysis because of sampling error. Between-study variability means differences among studies in estimating effect size among

Table 3
Independent correlates of HIV and syphilis infection and risky sexual behavior.

Study and year	Sample size	Outcome variable	Factors	OR (95%CI)
Choi *et al*, 2001	481	HIV infection	Age (40-69 *vs* 18-39)	4.48 (1.31-15.33)
			Number of lifetime male sex partners (21 or more *vs* 1-20)	3.00 (1.04-8.61)
Feng *et al*, 2006	1000	HIV infection	Age	1.68 (1.37-2.07)
			Education	0.63 (0.49-0.80)
			AIDS awareness	0.48 (0.30-0.77)
			Anal sex with male in last 6 months	3.18 (1.59-6.37)
Ruan *et al*, 2005	526	HIV	More than 10 lifetime male sex partners	4.3 (1.4-13.6)
			Syphilis seropositive	3.8 (1.3-10.8)
		Syphilis	26 years old or older	2.2 (1.3-3.9)
			More than 10 lifetime male sex partners	1.9 (1.1-3.4)
			Recruited route (web advertisement *vs* peer-referral)	0.5 (0.3-0.8)
He *et al*, 2004	201	Syphilis	Having foreign partner	3.17 (1.03-9.78)
Jiang *et al*, 2003	144	UAI	Men with four or more male sexual partners in the past 3 months	3.34 (1.60-6.99)
Ruan *et al*, 2007	428	UAI	Ever bought sex (men or women)	3.3 (1.6-7.0)
			Ever sold sex (men or women)	2.2 (1.2-4.2)
			Syphilis seropositive	18.7 (2.4-144.2)
			Number of sexual partners past month (per partner)	1.2 (1.0-1.4)
			Immigrant	1.7 (1.1-2.6)
			HIV knowledge (per level)	1.4 (1.0-1.9)
Qu S *et al*, 2002	215	UAI	History of STDs	13.5 (1.75-103.50)
			Past HIV testing	0.29 (0.09-0.88)
Choi *et al*, 2001	482	Insertive UAI in P6M	Did not have Beijing residence card	1.74 (1.13-2.68)
			Number of male sexual partners in the past 6 months (6 or more *vs* 1-5)	1.74 (1.14-2.64)
			No sex with women in the past 6 months	2.02 (1.30-3.15)
			Lifetime history of sexually transmitted diseases	2.87 (1.77-4.65)
			Never been tested for HIV	1.78 (1.03-3.06)
			HIV risk perception (high *vs* low)	1.61 (0.94-2.76)
		Receptive UAI in P6M	Immigrant	1.53 (0.97-2.41)
			Number of male sexual partners in the past 6 months (6 or more *vs* 1-5)	1.73 (1.12-2.67)
			No sex with women in the past 6 months	2.12 (1.34-3.35)
			Never been tested for HIV	1.81 (1.02-3.19)
			Lifetime history of sexually transmitted diseases	1.78 (1.10-2.88)
			Received money from men for sex in the past 6 months	1.55 (0.95-2.52)
			Number of HIV prevention services in the past 2 years (0-4 *vs* 5 or more)	1.84 (1.23-2.77)

Table 3 (continued).

Study and year	Sample size	Outcome variable	Factors	OR (95%CI)
Wang *et al*, 2006	648	Condom use with insertive anal sex in P6M	Usually in Saunas or bathhouses	1.99 (1.29-3.08)
			Attained college or above	1.82 (1.18-2.81)
			Occupation (other *vs* stated occupation)	0.52 (0.33-0.85)
			35-44 years old	
		Condom use with receptive anal sex in P6M	Usually in parks or toilets	0.4 (0.17-0.97)
			Recruited through social network	0.11 (0.06-0.18)
			Occupation (worker *vs* other)	0.63 (0.44-0.91)
			Immigrant	0.62 (0.40-0.96)
Li *et al*, 2005	526	UAI with regular male partners	Monthly income <USD200	1.74 (1.01-2.98)
			Finding male sex partners at bathhouses, public toilets, or parks	2.22 (1.00-4.91)
		UAI with casual male partners	Encountering male sex partners at bathhouses, public toilets, or parks	3.02 (1.76-5.17)
			3 or more male sex partners with receptive anal intercourse	1.8 (1.13-2.86)
			Receiving money for sex with men	0.34 (0.17-0.68)
Li *et al*, 2005	84*	Condom use with last anal sex	Age	0.49 (0.29-0.84)
			Scores of AIDS transmission awareness	0.494 (0.269-0.907)
Zheng *et al*, 2004	174*	Unprotected sex With both male and female in P6M	Age (16-24/ 25-30/ ≥31)	2.73 (1.76-4.24)
			Number of male anal sex partners in 2 months (≥4 *vs* 0~3)	3.62 (1.26-10.40)

*Sampled from gay bar

different populations. In our review, the between-study variability was the main source of heterogeneity, because the studies all varied geographically. Unlike Gao *et al* (2009), we did not find the sampling methods used in the studies contribute significantly the heterogeneity of our review. The considerable mobility of MSM in China implies that the population in different places may substantially overlap (He *et al*, 2009), which guarantees our pooled analysis.

With meta-analysis, assessment of heterogeneity of studies is crucial for choosing a statistical model. When the study results only differ by sampling error, a fixed-effects model can be applied to obtain an average. If the between-study variability accounts for the main cause of variability, a random model should be assumed, which was chosen for our study.

A comprehensive assessment of heterogeneity should include the existence, extent and sources of heterogeneity. The Q test is a classic method to identify the existence of heterogeneity. However, the power of the Q test was questioned by Alexander *et al* (1998) and Hardy and Thompson (1998). Another measurement, the I^2 index, was proposed by Higgins and Thompson (2002) and has been broadly accepted to quantify heterogeneity with

meta-analysis. The I^2 index can be interpreted as the percentage of the total variability in a set of effect sizes due to true heterogeneity. As recommended, we combined the Q test and I^2 index; therefore, we believe we generated more reliable estimates (Higgins and Thompson, 2002 ; He and Chen, 2006).

We acknowledge a number of limitations of our analysis. First, like any systematic review, ours may not have identified all existing literature. Despite the increasing number of studies among MSM in mainland China, the studies are disproportionately centralized in a few economically developed areas. We purposely searched for studies which were conducted in middle sized or small cities to guarantee extensive geographic coverage, however more rural areas may not have been included. Second, the majority of samples were not population based samples employing robust sampling methods, which substantially weakens the quality of the results. Third, we identified many instances of missing data in the original literature which may have introduced uncertainty into our meta-analysis. For example, in a number of studies the time frame used to measure for syphilis infection was unclear. Despite these limitations, the findings of this review point out several important directions for future research. Since the majority of surveys cited in the present study were based on non-probability samples, there needs to be improvement in methodologies employed in future research among MSM. Modified long-chain referral approaches, such as respondent-driven sampling could be one option (Ramirez-Valles *et al*, 2005; He *et al*, 2008).

It is clear from this review the majority of studies among MSM have been conducted in particular geographic areas and over a short time frame. Therefore, more studies are needed from places where surveys have not yet been conducted, such as smaller cities and rural areas. Furthermore, standardization of the methodology for laboratory testing for syphilis and other sexually transmitted infections, and the recall periods for sexual behavior measurements would be helpful. More detailed studies of MSM sexual behavior with female partners are needed to clarify the potential for HIV transmission from MSM to women (Choi *et al*, 2004; He *et al*, 2006b).

Although suggested early on, there are apparently still no studies on interventions among MSM (Choi *et al*, 2002). Therefore, research on interventions should be prioritized.

Considering the increasing rates of HIV infection, the prevalence of risk behavior among MSM identified in this review and the scarcity of focused HIV interventions to date, existing prevention programs should promote routine HIV testing among this population. It is important to develop MSM-specific HIV prevention interventions that focus on risk behaviors, such as the number of sexual partners, UAI and UVI. We hope the findings of this review will not only assist in the development and adaptation of MSM-specific HIV behavioral intervention programs but stimulate additional research addressing the salient HIV prevention needs of high-risk MSM.

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