

GENDER AND ETHNIC DISPARITIES OF HIV AND SYPHILIS SEROCONVERSIONS IN A 4-YEAR COHORT OF INJECTION DRUG USERS

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Abstract. This study assessed gender and ethnic disparities of HIV and syphilis seroconversions in a cohort of injection drug users (IDUs) in Southwest China. A cohort of HIV-seronegative IDUs was followed up from November 2002 to January 2007. The average seroincidence for HIV and syphilis was 2.2 and 4.2 per 100 person-years (PYs), respectively. Multivariable Poisson regression models indicated that the predictors for incident HIV seroconversion included non-Han minority ethnic groups (RR: 5.2; 95%CI: 1.9-14.4) and injecting drugs ≥ 7 times/week in the past 3 months (RR: 3.6; 95%CI: 1.4-9.8). The predictors for incident syphilis seroconversion included female (RR: 4.1; 95%CI: 1.8-9.3) and being married or cohabiting (RR: 2.7; 95%CI: 1.2-5.9). These findings suggested that HIV continues to spread among IDUs, especially among Yi and other minority ethnic groups, and frequent risky injections might be the major driver of the epidemic. Female IDUs are disproportionately affected by syphilis. Further research is needed to better understand the ethnicity disparity for HIV and gender disparity for syphilis.

Keywords: HIV, syphilis, cohort study, incidence, injection drug users, China

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INTRODUCTION

China continuously faces the dual challenge of drug use and HIV/AIDS (Drucker *et al*, 2011). HIV-1 transmission has increased either through heterosexual or homosexual contacts (Wu *et al*, 2004; Jia *et al*, 2008b; Lu *et al*, 2008; State Council AIDS Working Committee Office and UN Theme Group on HIV/AIDS in China, 2008; Ruan *et al*, 2009). Injection drug

users (IDU) still account for about one-third of the estimated 740,000 persons living with HIV/AIDS in China. The number of drug users continues to increase, and the HIV epidemic continues to expand despite the scaling-up of the harm reduction programs (China CDC, 2009).

A conservative estimate of HIV prevalence among IDUs is 12.6% (Bao and Liu, 2009). The HIV infection rates among IDUs in Xinjiang, Guangxi, and Sichuan Provinces are 41.3%, 17.0%, and 15.1%, respectively; whereas, HIV infection rates among IDUs in Xinjiang and Yunnan provinces may as high as 52.5% (Bao and Liu, 2009). In certain areas of Southwest China, IDU-driven HIV epidemics result in nearly 1.5% HIV prevalence among the general population (Liangshan Prefecture CDC, 2009).

Risky drug injection and unprotected sex practices remain prevalent among IDUs in many parts of China. Cross sectional studies have consistently indicated high prevalence rates of HIV and other sexually transmitted diseases (STDs) among IDUs in Southwest and Northwest China (Jia *et al*, 2007; Sun *et al*, 2007; China CDC, 2008; Jia *et al*, 2008a). Limited cohort studies have indicated high rates of seroconversions, but these rates vary geographically (Ruan *et al*, 2004, 2005; Wei *et al*, 2006; Zhang *et al*, 2007). The government scaled up the intervention efforts among IDUs in the past years across the nation; however, so far, insufficient data are available on the ethnic and gender distributions of the incidence rates of HIV and syphilis in these IDU-driven epidemics. It will provide insightful information in guiding effective better-targeted prevention, care, and treatment programs if we carefully compare these rates and analyze predictors by gender and ethnicity. This study aim was to investigate the

ethnic and gender disparities of and the predictors for seroconversion of HIV and syphilis in a cohort of IDUs in southwest China.

MATERIALS AND METHODS

Study setting

Xichang City, a county-level city in Liangshan Prefecture of Sichuan Province, China, is located along one of the major drug trafficking routes to Northwest, South, and Central China from the "Golden Triangle," one of the world's largest illicit heroin production and distribution centers. The specific HIV subtypes first seen in Dehong, Yunnan spread to IDUs along these drug trafficking routes, including Xichang. The city hosts a population of more than 600,000 with a majority of the Han ethnic group and about 10% of the Yi ethnic group. Xichang City has about 100,000 migrant people each year, and nearly 2,500 local residents are registered drug users. The HIV epidemic in Xichang City has become one of the worst in Southwest China, with 1,153 cumulative reported cases of HIV/AIDS reported by the end of 2009 (Sichuan Provincial CDC, 2009).

Study design and participants

A cohort baseline screening survey was conducted in November 2002. Participants were recruited through community-based outreach with a snowball-sample technique. Eligibility criteria for the cohort study participants at baseline included HIV-seronegative, ≥ 18 years old, had injected drugs during the previous three months, and willing to provide informed consent. Participants were asked to return to the clinic for follow-up evaluations every six months. Eligible participants were followed up for 48 months, from November 2002 to January 2007. The study

protocol and cohort retention strategy were described in detail elsewhere (Ruan *et al*, 2005; Wei *et al*, 2006).

Ethical considerations

The study protocol was approved by the Institutional Review Board (IRB) of the Chinese Center for AIDS/STD Control and Prevention (CDC) (Ref N° KX040202022; 2004 Apr 16). The completion of written informed consent is described elsewhere (Ruan *et al*, 2005; Wei *et al*, 2006). All participants were informed of the purpose of the research and voluntary condition of their participation. All participants were informed of the opportunity to withdraw at any stage of the study. Each participant was assigned a unique identifier code to keep all collected data confidential.

The data collected were stored with password protection in the local CDC in a locked office of a secured building to ensure the security and confidentiality of collected data. The data will be subsequently destroyed based on the completion of the research project. All subjects were informed of their results and provided with follow-up advice/care.

Data collection

Trained health professionals conducted structured questionnaire-based interviews to collect data on demographics, behavioral information concerning drug injection practices, and characteristics of sexual behavior with primary and casual sexual partners. Unprotected sex was defined as 'not always using condoms with primary or non-primary casual sexual partners in the one month before the visit.' This questionnaire, which had been previously tested in China, was modified mainly based on another international cohort study: the HIV Prevention Trials Network Preparedness Study (HPTN 033) (Wei *et al*, 2006; Zhang *et al*, 2007).

Laboratory tests

Blood samples were collected from all subjects for HIV and syphilis tests. HIV infection status was determined by an enzyme immunoassay (EIA) (Beijing Wantai Biological Pharmacy Enterprise, Beijing, China) and an HIV-1/2 Western Blot confirmation (HIV Blot 2.2 WB™; MP Biomedicals Asia Pacific, Singapore). Syphilis infection was determined with an EIA (Beijing Jinhao Biological Production, Beijing, China) and confirmed with a passive particle agglutination test for detection of antibodies to *Treponema pallidum* (Serodia®-TPPA; Fujirebio, Tokyo, Japan).

Data analysis

Data analyses were performed with the Statistical Analysis System (SAS 9.1 for Windows®; Cary, NC: SAS Institute). HIV and syphilis incidence density rates were calculated based on Poisson distribution, with 100 person-years (PYs) of follow-up as the denominator. Dates of seroconversion were estimated using the midpoint between the previous negative and the first positive antibody test result. Univariate Poisson regression models were used to assess the effect of both fixed covariates (for example, socio-demographic characteristics) and time-dependent covariates (for example, frequency of IDU and sexual behaviors). Variables that were significantly ($p < 0.05$) associated with time to seroconversion in the univariate analyses were considered for inclusion in multivariate Poisson regression models. All tests of significance were two-sided, with a p -value at < 0.05 indicating that an association was statistically significant.

RESULTS

Characteristics of participants at baseline

The baseline characteristics of participants are described in Table 1. The

prevalence rates at baseline were 11.3% (43/379) for HIV and 15.3% (58/379) for syphilis. The HIV prevalence rate was 12.1% (38/313) for males and 7.6% for females (5/66) ($p=0.3$); and 8.2% (20/243) for the Han majority ethnic group and 16.9% (23/136) for the Yi and other ethnic minority groups ($p=0.01$). Syphilis prevalence was significantly lower for males (12.5%, 39/313) than that for females (28.8%, 19/66) ($p<0.001$), and 10.7% (26/243) for the Han ethnic group and 23.5% (32/136) for the Yi and other ethnic minority groups ($p=0.001$). Of the 333 IDUs who were HIV seronegative and eligible to enroll in the cohort, 288 were syphilis negative.

Altogether, 333 HIV-negative subjects were included in the analysis; 81.7% were male, and 33.6% belonged to Yi and other minority ethnic groups. A little over two-fifths (44.1%) of the males and approximately one-fourth (23.0%) of the females received a primary school or lower-level education; 25.3% of Han subjects, and 69.6% of Yi and other minority subjects received a primary school or lower level education. The proportion of males and females who were unemployed was 52.2% and 75.4%, respectively; 36.4% of males and 39.3% of females were married or cohabiting with partners; 34.9% of males and 26.2% of females owned a house. The mean annual income was USD1,686 for males and USD2,597 for females (Table 1).

Of the 333 subjects, less than three-quarters who used heroin in the previous 3 months did so ≥ 7 times-per-week; with similar rates for both genders and different ethnic groups. More than three-quarters who injected drugs within the previous 3 months did so ≥ 7 times-per-week, with similar rates for both genders and different ethnic groups.

The prevalence of needle and/or sy-

ringe sharing was high; with similar rates among both genders, but it was significantly higher between Yi and other minority ethnic groups (55.4%) compared with the Han majority ethnic group (32.6%).

However, females reported a significantly higher rate of unprotected sex with a primary sex partner in the previous month (42.6%) compared with males (27.2%). Similarly, females also reported a significant higher rate of unprotected sex with a non-primary sex partner in the previous month (37.7%) than males did (16.5%). However, the prevalence for the unprotected sex with both primary and non-primary sex partners did not differ between Han and non-Han ethnic groups.

Of all subjects, 23.2% of males were giving money for sex in the previous six months; whereas, none of the females were. A small number of males (1.8%), and just over half of females (57.4%) had received money for sex in the previous 6 months. Females reported a significantly higher rate of having new sex partners in the previous 6 months (52.5%) than the males did (23.5%). There was no homosexual behavior reported among subjects.

Retention rates of the 4-year cohort

The follow-up rates were 75.7% (252/333) in Year 1, 70.3% (234/333) in Year 2, 68.8% (229/333) in Year 3, and 59.2% (197/333) in Year 4. Multivariate logistic regression model showed that factors that significantly contributed to 4-year cohort retention included appearing at the 6-month follow-up visit (OR: 4.01; 95% CI: 2.35-6.84; $p<0.0001$), and junior high school or lower level of education (OR: 2.11; 95% CI: 1.31-3.40; $p=0.0020$).

Of the 136 subjects lost to follow-up at the 48-month visit, one-third had died (33.1%, 45/136); while two-thirds of these deaths (68.9%, 31/45) were attributed to a

Table 1
 Characteristics of subjects at baseline in Xichang City of Southwest China.

Factors	Total n (%)	Ethnicity			Gender		
		Han n (%)	Non-Han n (%)	p-value	Male n (%)	Female n (%)	p-value
Age (mean ± SD, years)	28±5	29±5	26±5	<0.01	28±5	28±4	0.26
Sex							
Male	272 (81.7)	176 (79.6)	96 (85.7)		272 (100)	0	
Female	61 (18.3)	45 (20.4)	16 (14.3)	0.18	0	61 (100)	-
Ethnicity							
Han	221 (66.4)	221 (100)	0		176 (64.7)	45 (73.8)	
Non-Han minority	112 (33.6)	0	112 (100)	-	96 (35.3)	16 (26.2)	0.18
Education (years)							
≤ 6	134 (40.2)	56 (25.3)	78 (69.6)		120 (44.1)	14 (23.0)	
> 6	199 (59.8)	165 (74.7)	34 (30.4)	<0.01	152 (55.9)	47 (77.0)	<0.01
Currently employed							
No	188 (56.5)	134 (60.6)	54 (48.2)		142 (52.2)	46 (75.4)	
Yes	145 (43.5)	87 (39.4)	58 (51.8)	0.03	130 (47.8)	15 (24.6)	<0.01
Marital status							
Married or cohabiting	123 (36.9)	73 (33.0)	50 (44.6)		99 (36.4)	24 (39.3)	
Others	210 (63.1)	148 (67.0)	62 (55.4)	0.04	173 (63.6)	37 (60.7)	0.67
Owning a house or apartment							
No	222 (66.7)	160 (72.4)	62 (55.4)		177 (65.1)	45 (73.8)	
Yes	111 (33.3)	61 (27.6)	50 (44.6)	<0.01	95 (34.9)	16 (26.2)	0.19
Annual income (mean±SD, USD)	1,853±2,617	1,868±2,710	1,823±2,435	0.88	1,686±2,157	2,597±4,024	0.02
Frequency of heroin use in P3M							
< 7 times per week	74 (22.2)	51 (23.1)	23 (20.5)		62 (22.8)	12 (19.7)	
≥ 7 times per week	259 (77.8)	170 (76.9)	89 (79.5)	0.6	210 (77.2)	49 (80.3)	0.60
Frequency of injected drugs in P3M							
< 7 times per week	72 (21.6)	50 (22.6)	22 (19.6)		58 (21.3)	14 (23.0)	
≥ 7 times per week	261 (78.4)	171 (77.4)	90 (80.4)	0.53	214 (78.7)	47 (77.0)	0.78
Shared needles and syringes in P3M							
No	199 (59.8)	149 (67.4)	50 (44.6)		161 (59.2)	38 (62.3)	
Yes	134 (40.2)	72 (32.6)	62 (55.4)	<0.01	111 (40.8)	23 (37.7)	0.66
Unprotected sex with a primary sex partner in P1M							
No	233 (67.0)	148 (67.0)	85 (75.9)		198 (72.8)	35 (57.4)	
Yes	100 (30.0)	73 (33.0)	27 (24.1)	0.09	74 (27.2)	26 (42.6)	0.02
Unprotected sex with non-primary sex partners in P1M							
No	265 (79.6)	176 (79.6)	89 (79.5)		227 (83.5)	38 (62.3)	
Yes	68 (20.4)	45 (20.4)	23 (20.5)	0.97	45 (16.5)	23 (37.7)	<0.01
Paid money for sex in P6M							
No	270 (81.1)	179 (81)	91 (81.2)		209 (76.8)	61 (100.0)	
Yes	63 (18.9)	42 (19)	21 (18.8)	0.96	63 (23.2)	0 (0.0)	<0.01
Exchanged sex for money in P6M							
No	293 (88.0)	192 (86.9)	101 (90.2)		267 (98.2)	26 (42.6)	
Yes	40 (12.0)	29 (13.1)	11 (9.8)	0.38	5 (1.8)	35 (57.4)	<0.01
Had new sex partners in P6M							
No	237 (71.2)	155 (70.1)	82 (73.2)		208 (76.5)	29 (47.5)	
Yes	96 (28.8)	66 (29.9)	30 (26.8)	0.56	64 (23.5)	32 (52.5)	<0.01

Han, Han majority ethnic group; Non-Han, Yi and other minority ethnic groups; P1M, past 1 month; P3M, past 3 months; P6M, past 6 months.

Table 2
Predictors for HIV seroconversions among injection drug users in Southwest China.

Factors	Seroconversions (<i>n</i>)	Person- years (PYs)	Incidence rate (/100 PYs)	Crude RR (95%CI)	Adjusted RR (95%CI)
Total	16	729.1	2.2		
Age (per 1 year)				1.1(0.9-1.2)	
Sex					
Male	13	587.4	2.2	1.0	
Female	3	141.7	2.1	1.0 (0.3-3.4)	
Ethnicity					
Han majority	6	541.4	1.1	1.0	1.0
Yi and others	10	187.7	5.3	4.8 (1.8-13.2) ^a	5.2 (1.9-14.4) ^a
Education (years)					
≤ 6	10	218.1	4.6	1.0	
> 6	6	511.0	1.2	0.3 (0.1-0.7) ^a	
Currently employed					
No	6	438.3	1.4	1.0	
Yes	10	290.8	3.4	2.5 (0.9-6.9)	
Married or cohabiting					
No	7	491.5	1.4	1.0	
Yes	9	237.6	3.8	2.7 (1.0-7.1) ^a	
Owned a house or apartment					
No	9	491.8	1.8	1.0	
Yes	7	237.3	3.0	1.6 (0.6-4.3)	
Annual income (per USD100)				1.0 (1.0-1.0)	
Frequency of heroin use in the previous 3 months					
< 7 times per week	9	579.7	1.6	1.0	
≥ 7 times per week	7	149.4	4.7	3.0 (1.1-8.1) ^b	
Frequency of injected drugs in the previous 3 months					
< 7 times per week	9	587.7	1.5	1.0	1.0
≥ 7 times per week	7	141.4	5.0	3.2 (1.2-8.7) ^b	3.6 (1.4-9.8) ^a
Shared needles/syringes in the previous 3 months					
No	11	666.8	1.7	1.0	
Yes	5	62.3	8.0	4.9 (1.7-14.0) ^a	
Had unprotected sex with a primary sex partner in the previous 30 days					
No	11	528.5	2.1	1.0	
Yes	5	200.6	2.5	1.2 (0.4-3.5)	
Had unprotected sex with non-primary sex partners in the previous 30 days					
No	14	554.3	2.5	1.0	
Yes	2	174.8	1.1	0.5 (0.1-2.0)	
Paid money for sex or exchanging sex for money in the previous 6 months					
No	15	452.8	3.3	1.0	
Yes	1	276.3	0.4	0.1 (0.01-0.8) ^b	
Had new sex partners in the previous 6 months					
No	12	501.7	2.4	1.0	
Yes	4	227.4	1.8	0.7 (0.2-2.3)	

^a $p < 0.01$; ^b $p < 0.05$; PYs, incidence per 100 person-years; RR, risk ratio; CI, confidence interval.

Table 3
Predictors for syphilis seroconversions among injection drug users in Southwest China.

Factors	No. of seroconversions (n)	Person-years (PYs)	Incidence rate (/100 PYs)	Crude RR (95%CI)	Adjusted RR (95%CI)
Total	24	577.8	4.2		
Age (per 1 year)				1.0 (0.9-1.1)	
Sex					
Male	15	502.0	3.0	1.0	1.0
Female	9	75.8	11.9	4.0 (1.7-9.1) ^a	4.1 (1.8, 9.3) ^a
Ethnicity					
Han	18	447.0	4.0	1.0	
Yi and others	6	130.8	4.6	1.1 (0.5-2.9)	
Education (years)					
≤ 6	6	165.5	3.6	1.0	
> 6	18	412.3	4.4	1.2 (0.5-3.0)	
Currently employed					
No	16	350.9	4.6	1.0	
Yes	8	226.9	3.5	0.8 (0.3-1.8)	
Married or cohabiting					
No	11	396.0	2.8	1.0	1.0
Yes	13	181.8	7.2	2.6 (1.2-5.7) ^b	2.7 (1.2-5.9) ^b
Owned a house or apartment					
No	15	400.3	3.8	1.0	
Yes	9	177.5	5.1	1.4 (0.6-3.1)	
Annual income (per 100 USD)				1.0 (1.0-1.0)	
Frequency of heroin use in the previous 3 months					
< 7 times per week	17	444.8	3.8	1.0	
≥ 7 times per week	7	133.0	5.3	1.4 (0.6-3.3)	
Frequency of injected drugs in the previous 3 months					
< 7 times per week	17	452.9	3.8	1.0	
≥ 7 times per week	7	124.9	5.6	1.5 (0.6-3.6)	
Had unprotected sex with a primary sex partner in the previous 30 days					
No	19	407.3	4.7	1.0	
Yes	5	170.5	2.9	0.6 (0.2-1.7)	
Had unprotected sex with non-primary sex partners in the previous 30 days					
No	21	470.8	4.5	1.0	
Yes	3	107.0	2.8	0.6 (0.2-2.1)	
Paid money for sex or exchanging sex for money in the previous 6 months					
No	17	397.1	4.3	1.0	
Yes	7	180.7	3.9	0.9 (0.4-2.2)	
Had new sex partners in the previous 6 months					
No	18	429.6	4.2	1.0	
Yes	6	148.2	4.1	1.0 (0.4-2.4)	

^a $p < 0.01$; ^b $p < 0.05$; PYs, incidence per 100 person-years; RR, risk ratio; CI, confidence interval.

heroin overdose. Other causes resulting in the loss to follow-up included moving out of the study area (24.3%, 33/136), incorrect contact information (14.7%, 20/136), internment in jail or detoxification centers (8.1%, 11/136), and unknown reasons (19.8%, 27/136).

Seroconversions, subtypes of HIV-1, and its drug resistance

Sixteen HIV seroconversions were observed among 729.1 person-years of observation. The average incidence of HIV was 2.2 per 100 PYs (95%CI: 1.1-3.3) during four years of follow-up; the incidences were similar for males (2.2 per 100 PYs) and females (2.1 per 100 PYs), but, it was significantly higher among Yi and other ethnic groups (5.3 per 100 PYs) compared with the Han majority (1.1 per 100 PYs).

Analysis of HIV-1 sequence from the Env and Gag regions of the virus envelope indicated that HIV-1 strains among the seroconverters were CRF_07BC subtypes. No HIV-drug resistance was found among HIV seroconversions.

Syphilis seroconversions

Twenty-four syphilis seroconversions were observed among 288 subjects with negative syphilis at the baseline. The average incidence for syphilis was 4.2 per 100 PYs (95%CI: 2.5-5.8) during four years of follow-up. The seroincidence was significantly higher for females (11.9 per 100 PYs) than for males (3.0 per 100 PYs), but it did not differ between the Han (4.0 per 100 PYs) and Yi/other ethnic groups (4.6 per 100 PYs).

Predictors for HIV seroconversions

In the final Poisson regression model, non-Han ethnic minority ethnic groups (RR: 5.2; 95%CI: 1.9-14.4) and injected drugs in the previous three months at ≥ 7 times/week (RR: 3.6; 95%CI: 1.4-9.8)

were significantly associated with HIV seroconversion (Table 2).

Predictors for syphilis seroconversions

In the final Poisson regression model, the predictors for syphilis seroconversion included females (RR: 4.1; 95%CI: 1.8-9.3) and being married or cohabiting (RR: 2.7; 95%CI: 1.2-5.9) (Table 3).

DISCUSSION

Unacceptably high seroincidence for HIV and syphilis were found among IDUs in this 4-year cohort study. HIV disproportionately affected Yi and other minority ethnic groups, with nearly five times higher HIV seroincidence than that in the Han ethnic group. HIV seroincidence for recent higher frequency injectors was three times higher than that among lower frequency injectors. These findings suggested that HIV continues to rapidly spread among IDUs, particularly minority IDUs (Ruan *et al*, 2005; Liu *et al*, 2009). Frequent risky injection is still the major driver of the HIV epidemic.

HIV seroincidence was similar between females and males. This may be explained by the similarity of the high-risk drug-use behaviors between both genders, for example, recent use, injection, frequency of injection, and needle and/or syringe sharing. It seems that significant difference of high-risk sexual behaviors between both genders does not lead to a significant gender difference in HIV incidence during this four-year follow-up.

However, this study suggested that the female IDUs are disproportionately affected by syphilis, with four times higher seroincidence than that among males, which is consistent with data that female IDUs reported higher rates of unprotected sex with both primary and non-primary

sex partners, as well as having sex for money and having new sex partners. These results are consistent with other reports (Lau *et al*, 2005), which may explain why female IDUs were disproportionately affected by syphilis. These findings underscore the needs for further research to understand why the gender difference was not found for HIV but was for syphilis.

Female IDUs report higher rates of unprotected sex and are more likely to exchange sex for drugs or money thus putting themselves at greater risk of acquiring STDs (Ruan *et al*, 2006; Celenano *et al*, 2008). Our previous report also showed that drug use increased the risk for female sex workers for syphilis in the same community (Ruan *et al*, 2006). The annual reported incidence (per 100,000) of syphilis in China increased from 0.02 in 1985, to 0.23 in 1990, and rapidly rose to 6.43 in 2000 and 24.78 in 2009 (China CDC, 2007). The ulcerative STDs, for example, syphilis, are of particular concern as they have been found to increase the likelihood of HIV seroconversion by two-to-five times (Fleming and Wasserheit, 1999; Rottingen *et al*, 2001).

High seroincidence of syphilis also indicated common unprotected sexual practices among female IDUs. Syphilis is mainly transmitted by sexual contact or through a mother-to-child route. In many countries, HIV has been initially spread among drug users, and then sexual transmission of HIV has become a dominant route. It supports the growing concern about HIV sexual transmission from infected IDUs to their sexual partners and the general population in China. Therefore, the integrated intervention programs addressing high-risk drug use and HIV/other STDs are needed targeting IDU population, especially female IDUs.

This study did not show a difference in unprotected sex behaviors between ethnic groups, but it suggested that non-Han minority ethnic groups have a significantly higher prevalence of needle/syringe sharing and lower levels of education than that among the Han ethnic group, which could be the major reasons to explain ethnic disparities for HIV seroconversions but not for syphilis. Other reports show that ethnic minorities are more engaged in drug trade and drug use (Yin *et al*, 2007). In addition, a lower socioeconomic status in the minority ethnic groups, for example, lower incomes and higher rates of unemployment than the Han ethnic group have been documented (Ruan *et al*, 2004).

Data suggest that the increased HIV spread among the Yi ethnic group is driven by the higher prevalence of unprotected casual heterosexual sex (Liu *et al*, 2009). Synthesized modeling data showed that the high frequency of unprotected casual sex acts among Yi adolescents and adults could make the general populations more vulnerable in this part of China. Despite adjusting for needle sharing, individuals from ethnic minority groups remain more likely to have HIV seroconversion. This may indicate that ethnic minority may be a surrogate for unmeasured risks.

Thus far, IDU has remained the leading route for HIV transmission, and HIV continues to spread rapidly among IDUs in Xichang (Sichuan Provincial CDC, 2009). This study found that the rate of needle sharing has still remained at high levels among this group (40% overall, 32.6% for the Han ethnic group, and 55.4% for non-Han minority ethnic groups), although it is significantly lower than surveillance synthesized data (52.3%) in Liangshan Prefecture (Lu *et al*, 2008).

Mathematical modeling shows that the spread of HIV among IDUs will not be reduced unless needle sharing is reduced to $\leq 30\%$ (Liu *et al*, 2009). A higher rate of needle sharing and high seroconversion rate found in this study suggested that HIV could continue to spread among IDUs, especially among minority ethnic groups.

This study indicated a decreasing trend in HIV incidence from the first year (4.1 per 100 PYs, 95% CI: 1.6-6.5) to the fourth year of the study (1.8 per 100 PYs, 95% CI: 0-4.3), despite the overlapping of the confidence intervals. The mathematical model projected an even higher HIV incidence (7.0%) among IDUs in Liangshan Prefecture; it is similar to the BED-incidence of 8.3% (95% CI: 5.3-11.2%) estimated from a community-based survey of 1,098 IDUs (Liu *et al*, 2009). These estimates are significantly higher than this present cohort estimates. Although both modeling and cross sectional survey are conducted in entire Liangshan Prefecture, the cohort subjects are recruited in Xichang City, one of county-level cities and a hardest hit area by HIV in Liangshan Prefecture.

Many factors could contribute to the decreasing trend of HIV seroincidence. The Chinese Government, and the China-UK AIDS Prevention and Care Project supported harm reduction programs, for example, needle exchange, condom promotion, and methadone maintenance therapy (MMT) have been scaled up in the past years with a focus on highly affected areas. The impact of MMT in Xichang has displayed a significant reduction in frequency of risky drug use and sexual behaviors among MMT clients (Pang *et al*, 2007).

If minority subjects and those with

more risky drug-use behavior were more likely to drop out of the study, the incidence rates would likely be underestimated and show a decreasing trend. The semiannual assessments of HIV/syphilis with repeated testing and consulting and long-term retention strategy might have positive "intervention" impacts on behavior change. Being retained for four years in the study, subjects may improve or modify their high-risk behaviors, the Hawthorne effect, which is an improved performance solely due to the subject's knowledge that he or she is being studied (McCarney *et al*, 2007; Fox *et al*, 2008).

This is the first study in China to evaluate the retention rate of a four-year cohort of IDUs. The retention of this cohort study reached at 59.4% during four-year follow-up. IDUs are difficult to retain in a cohort and hard to reach through routine intervention programs because IDU behaviors are considered socially unacceptable and pressure against IDU could be anticipated. The main reasons for loss of retention in the study cohort included death or overdose-related death; and changing cell phone numbers, mail addresses, or the addresses of online communication. It urgently needs to provide targeted interventions in reducing unnatural mortality among IDUs. Although it is generally believed that IDUs are difficult to retain in a cohort study, we found a relatively high retention rate in Chinese IDUs (Ruan *et al*, 2004; Yin *et al*, 2007).

The molecular epidemiological data of HIV-1 strains in the seroconverters confirm other reports that the HIV virus found in Sichuan Province is similar to those identified in Thailand, Myanmar, and the Yunnan Province of China (Beyrer *et al*, 2000). This finding supports that Xichang in Sichuan Province is located

along one of the major drug trafficking routes to Northwest and South China from the "Golden Triangle" (Jia *et al*, 2007, 2008b). HIV drug resistance among HIV seroconversions was not found in this study; however, other reports found 3.8% of resistance among the antiretroviral-naive HIV/AIDS patients in China. HIV drug resistance monitoring among this group should not be ignored.

The findings of this study suggest that HIV continues to spread among IDUs, especially among Yi and other minority ethnic groups, and frequent risky injections might be the major driver of the epidemic. Female IDUs are disproportionately affected by syphilis. Further research is needed to better understand the ethnicity disparity for HIV and gender disparity for syphilis.

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