

The Changing Trends of HIV/AIDS in An Ethnic Minority Region of China: Modeling the Epidemic in Liangshan Prefecture, Sichuan Province*

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Abstract

Objective This study was to investigate the HIV current situation in Liangshan prefecture, in order to predict prevalence and transmission trends.

Methods Region-specific population, behavior, serosurveillance, and policy/program data (from 1995 to 2010) were gathered from various local and national organizations and applied to the Asian Epidemic Model (AEM) and used to derive estimates of future HIV prevalence, epidemic trends, and outcomes of intervention strategies.

Results The AEM projections for 2020 included increased number of people living with HIV (PLHIV; to 136 617), increased HIV prevalence (2.51%), and 8037 deaths from acquired immunodeficiency syndrome (AIDS) in this region. However, the overall HIV incidence rate (per 10 000) was projected to decline from 27 in 2015 to 22 in 2020, largely due to a predicted decrease in HIV infection rate (per 10 000) from 658 in 2013 to 621 in 2020 among intravenous drug users. In contrast, the cases of HIV infection per 10 000 was projected to increase from 420 in 2010 to 503 in 2020 among men who have sex with men, and from 8 in 2010 to 15 in 2020 among the general population. The predominant risk factor for HIV transmission over the next decade in Liangshan was casual sex. Community-based outreach strategies to reduce injected drug use and casual sex, and to promote condom use, were predicted as effective interventions to decrease HIV transmission.

Conclusion Implementation of a comprehensive public health program, with targeting to the region-specific at-risk populations, will help to mitigate HIV/AIDS spread in Liangshan.

Key words: HIV/AIDS; Asian epidemic model; High-risk population; Liangshan Prefecture

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INTRODUCTION

The overall prevalence of human immunodeficiency virus (HIV)/autoimmune deficiency syndrome (AIDS) remains low in

China (0.058% at the end of 2011); however, geographic distribution of the overall 780 000 people living with HIV (PLHIV, including 154 000 AIDS cases) has revealed regions of especially high prevalence^[1]. Among the five provinces that account for ~60% of

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the PLHIV cases, four, including Sichuan Province, feature populations composed primarily of ethnic minority groups^[2]. This HIV/AIDS-affected population composition is further highlighted by the fact that ethnic minorities account for more than 30% of the reported total HIV/AIDS cases in China although they represent less than 9% of the nation's population^[3].

Sichuan Province reported its first case of AIDS in 1991, and by 2002 HIV cases had been diagnosed in all 21 cities/prefectures^[4]. By the end of 2010, Sichuan had the fourth highest number of cumulative reported HIV/AIDS cases in the country, with 38 365 PLHIV cases, 7669 of which had progressed to AIDS. Moreover, the majority (56.2%) of these PLHIV cases occurred in a prefecture of the province with the largest proportion of the Yi ethnic minority group, Liangshan Yi Autonomous Prefecture^[2,4].

Since sentinel surveillance was established in Liangshan Prefecture in 1995^[4], the cases of HIV/AIDS have reached epidemic proportions in several counties^[5-7]. Epidemiologic analyses at the end of 2010 determined that the primary route of HIV transmission in Liangshan Prefecture is intravenous drug use (IDU, accounting for 67.2% of cumulative reported cases), with sexual contact being the second most common route (17.6%)^[8]. This trend was also reflected in the 6060 new HIV infections reported in 2010, with 59.5% contracted through IDU and 26.3% through sexual contact^[9]. Meanwhile, a higher frequency of casual heterosexual relationships has been reported among the Yi people^[10-11], representing an increase in the impact of risk for HIV transmission via sexual contact. Indeed, there is already an increased prevalence of HIV among men who have sex with men (MSM)^[12].

The Asian Epidemic Model (AEM) was devised to evaluate trends in risk behaviors among important Asian sub-populations to determine the HIV transmission probabilities necessary to fit observed epidemiological patterns revealed by surveillance data^[13]. Previously, AEM results have provided useful guidance for designing targeted HIV prevention and control strategies^[14-17]. In particular, the results from our 2007 AEM study played an important role in guiding HIV/AIDS prevention and control in Liangshan Prefecture, which resulted in increased condom usage and syringe exchange and helped to mitigate the increasing trend in HIV prevalence among intravenous drug users (IDUs) and female sex workers (FSWs) and their clients^[9].

The aim of this study was to investigate the

current situation in 17 counties of Liangshan Prefecture, in order to update the prediction of future trends in HIV prevalence and transmission. These updated data will facilitate modifications in the current HIV intervention strategies and HIV policies that will meet the most recent needs of the Prefecture's population and particular groups.

MATERIALS AND METHODS

AEM

The Asian Epidemic Model (AEM), developed by Dr. Tim Brown and Dr. Wiwat Peerapatanapokin in 2004, is based on a semi-empirical process which replicates the key processes driving HIV transmission in Asia^[2]. Using trends in risk behaviors among important Asian sub-populations as inputs, the model determines the HIV transmission probabilities necessary to fit observed epidemiological patterns revealed by surveillance data. Although we can get richer results from the AEM, it has limitations to be wider used due to needs more parameters. By implementation of many HIV prevention and control project, Liangshan health section has formed the systematic HIV detect and monitor system. At present, the existing data can be used by AEM.

Data Sources

Data collected in Liangshan Province from 1995 to 2010 was obtained for analysis as follows: (a) Population data, including demographic information (i.e., annual ratio of males and females aged ≥ 15 years, and fertility rate) obtained from the Liangshan Statistical Yearbook, population size obtained from the Liangshan Prefecture Census Bureau, estimated size of high-risk populations obtained from the Chinese Center for Disease Control and Prevention; (b) Behavioral data, including proportion of condom use, injection practice, needle sharing, sexual behavior among IDUs and sex workers were obtained from four behavioral surveillance sites; (c) HIV prevalence data, surveillance and epidemiological survey data were obtained from 12 sentinel surveillance sites, and comprehensive surveillance data for ten defined groups (i.e., FSWs, IDUs, migrant workers, urban residents, community members of a cohort of >15 year-olds under routine monitoring, rural residents, adolescents in school, pregnant women, male patients attending sexually transmitted disease (STD) clinic, and MSM) from the HIV surveillance systems of 17 counties were

obtained from Liangshan Prefecture Center for Disease Control and Prevention (CDC); (d) Reports and publications of HIV-related policies and public health/outreach projects were obtained from local organizations (i.e., government, health-related sector, project management offices, and public security departments).

The accumulated data were checked, screened, sorted, and classified based on the standardized Information System for Reportable Diseases of AIDS Cases database (National Center for AIDS/STD Control and Prevention (NCAIDS/STD), Chinese CDC and Sichuan Province CDC). Experts were consulted to ensure that only high quality data were captured, and missing data were supplemented by referring to previous data or interpolation.

Model Fitting

Based on the epidemiological pattern in China, data for eight different populations (stratified according to HIV status) were selected for application to the AEM: IDUs, FSWs, injecting sex workers (ISWs), clients of FSWs, MSM, male sex workers (MSWs), low-risk males, and low-risk females. As individuals often move from one population group to another, population dynamics were considered. The data were entered into the AEM, and modeling was carried out as previously described^[2,13,18]. Briefly, the AEM calculates annual numbers of PLHIV, new AIDS cases, and HIV-related deaths based on an overall consideration of new infections and the natural history of HIV infection and AIDS^[13], which allows for prediction of future HIV prevalence and transmission trends, as well as estimations of effects of different interventions on HIV prevalence. In addition, the AEM was able to predict HIV prevalence in children <15 years old, even though data was not collected for this age group, by evaluating the HIV prevalence in women of childbearing age along with fertility rates.

RESULTS

Predictions of Future HIV Prevalence

The reported number of PLHIV in 2010 was 54 385 (new infections: 8920; AIDS: 7045), which represented a prevalence of 1.14%. When the intervention effects were fixed at their present levels in the AEM, HIV prevalence was predicted to rapidly increase over the next decade. Specifically, PLHIV number was predicted to rise to 103 344 (new

infections: 13 841; AIDS: 15 249) by 2015 and to 136 617 (new infections: 12 016; AIDS: 21 405) by 2020, representing a >2-fold rise in prevalence (to 2.51% in 2020). In conjunction with the growing numbers of PLHIV, AIDS deaths were also predicted to increase annually (reaching 8037 in 2020). While the cumulative number of HIV infections was predicted to rise (to 203 879 in 2020; Figure 1), the incidence rate (per 10 000) was predicted to decline from 27 in 2015 to 22 in 2020.

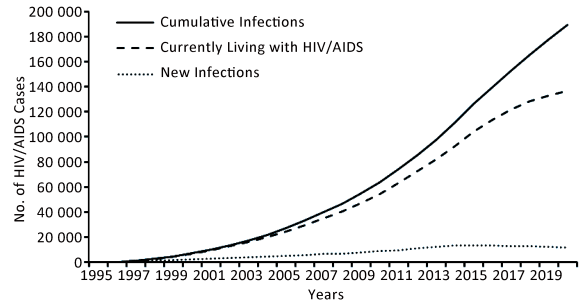


Figure 1. Estimated (1995-2010) and projected (2011-2020) numbers of new and cumulative infections and PLHIV cases in Liangshan Yi Autonomous Prefecture, Sichuan Province, China.

Predicted HIV Prevalence Changes by Gender and Age Group

In 2010, males represented over 70% of the estimated PLHIV in Liangshan Prefecture. When the intervention effects were fixed at their present levels in the AEM, the proportion of female HIV infections was predicted to increase (to 39.53% by 2020). HIV prevalence in children aged less than 15 years old was also predicted to increase (to 0.19% by 2020), so that this age group will represent 2.37% of the PLHIV. Interestingly, while the proportion of current HIV infections among adults aged 50 years and above was predicted to increase (from 1.51% in 2010 to 1.78% in 2020), the proportion among the 15-49 year-old age group was predicted to decline (from 96.62% in 2010 to 95.85% in 2020) (Figure 2).

Predicted Trends in HIV Transmission

Sexual transmission is predicted to replace IDU as the primary route of HIV transmission, with 54.68% of new infections in 2013 predicted to be transmitted via sexual contact, rising to 72.90% by 2020. The majority of new infections in 2020 are attributed to non-commercial sex. The major routes of transmission will include unsafe sex (24.65%),

male-to-male sexual contact (22.05%), husband-to-wife transmission (13.51%), wife-to-husband transmission (12.00%) and transmission via sex workers (5.19%). In addition, 4.55% of new HIV infections in 2020 are attributed to mother-to-child transmission, and 18.04% due to needle sharing (Figure 3).

Predicted HIV Incidence and Prevalence in High-risk Groups

IDUs accounted for 48.57% (26 414/54 385) of all PLHIV cases in 2010. The AEM predicted IDU as the major transmission route up to 2013 (52.31%), after which its contribution will wane (falling to 39.13% by 2020). Accordingly, the increasing trend in average annual growth rate of HIV prevalence among IDUs seen in 1995 to 2010 (2.00%) was predicted to decline

in the next decade (to 0.46%). While the HIV prevalence in IDUs was predicted to increase (from 32.95% in 2010 to 37.53% in 2020) (Figure 4), the incidence rate (per 10 000 IDUs) was predicted to decline after peaking in 2013 (from 658 to 621 in 2020). Although sexual transmission was predicted as the major transmission route from 2013 onwards, comparison of numbers of new HIV infections among the high-risk groups showed that the IDUs remained the group with the largest amount (3137 in 2020).

The estimated number of HIV-infected MSM was 2500 in 2010. When the intervention effects were fixed at their present levels in the AEM, this number was predicted to rise sharply by 2020 (to 12 300), with the HIV prevalence among MSM exceeding that among IDUs as early as 2013. Moreover, MSM were predicted to have the highest HIV prevalence among all the high-risk groups by 2020, when 9.96% of new HIV infections among individuals' ≥15 years old will be contracted via male-to-male sex (Figure 4). Finally, the incidence rate (per 10 000 MSM) was predicted to increase from 420 in 2010 to 503 in 2020.

When the 2010 rates of condom use were fixed at their present levels in the AEM, the HIV prevalence was projected to increase for FSWs (including ISWs; from 2.85% to 4.70% in 2020) and for their clients (from 1.87% to and 3.09% in 2020). In addition to the 2020 projected higher estimated number of HIV-infected FSWs (to 532) and clients (to 3 846) (Figure 4), the incidence rate (per 10 000 FSWs and clients, respectively) was predicted to increase (to 198 and 51, respectively).

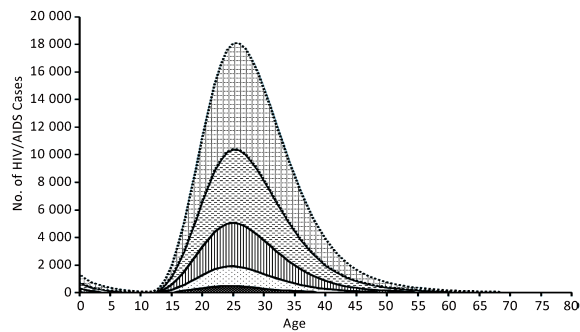


Figure 2. Estimated (2000-2010) and projected (2011-2020) numbers of PLHIV cases by age.

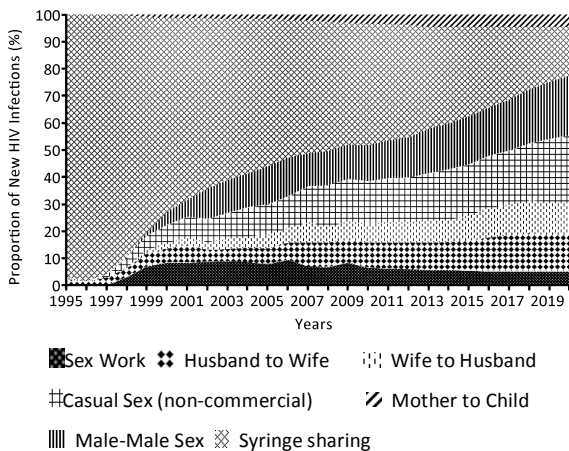


Figure 3. Estimated (1995-2010) and projected (2011-2020) proportions of new HIV infections acquired via specific transmissions routes.

Predicted Incidence and Prevalence of HIV in the General Population

When the intervention effects were fixed at their present levels in the AEM, the HIV prevalence of the general population was predicted to increase by 2020 (from 0.77% to 1.27%) (Figure 4). The number of new HIV infections was predicted to increase by 1.77-fold, with incidence rates (per 10 000 population) increasing from 5 to increase to 10. Finally, the proportion of new HIV cases coming from the general population was predicted to increase (from 33.65% to 47.04% in 2020).

Predicted Effects of Different Levels of Uptake of Comprehensive Interventions on HIV Prevalence in Different Population Groups

The dynamics of HIV prevalence was predicted for the following scenarios, with baseline figures being taken from the data collected for 2010:

(a) With the rate of condom use among IDUs during the last sex contact at 18.7%, a 60% increase in new syringe use and a 28.3% prevalence of unsafe needle sharing, HIV prevalence is predicted to

increase gradually among IDUs. If the prevalence of unsafe needle sharing drops to 20%, however, the prevalence is predicted to decline dramatically (Figure 5A).

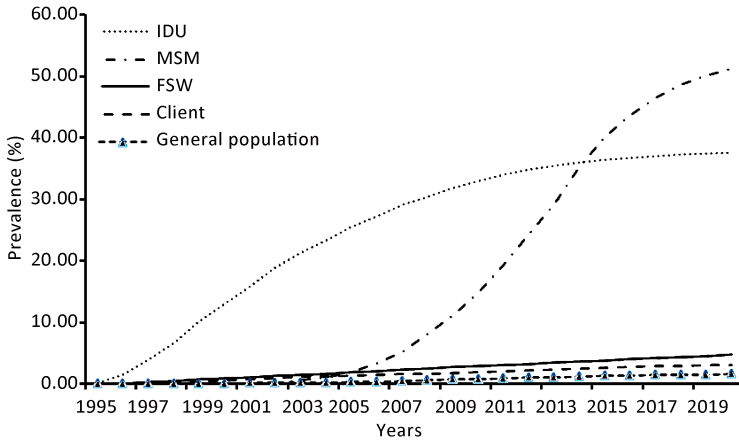


Figure 4. Estimated (1995-2010) and projected (2011-2020) prevalence of HIV in high-risk groups.

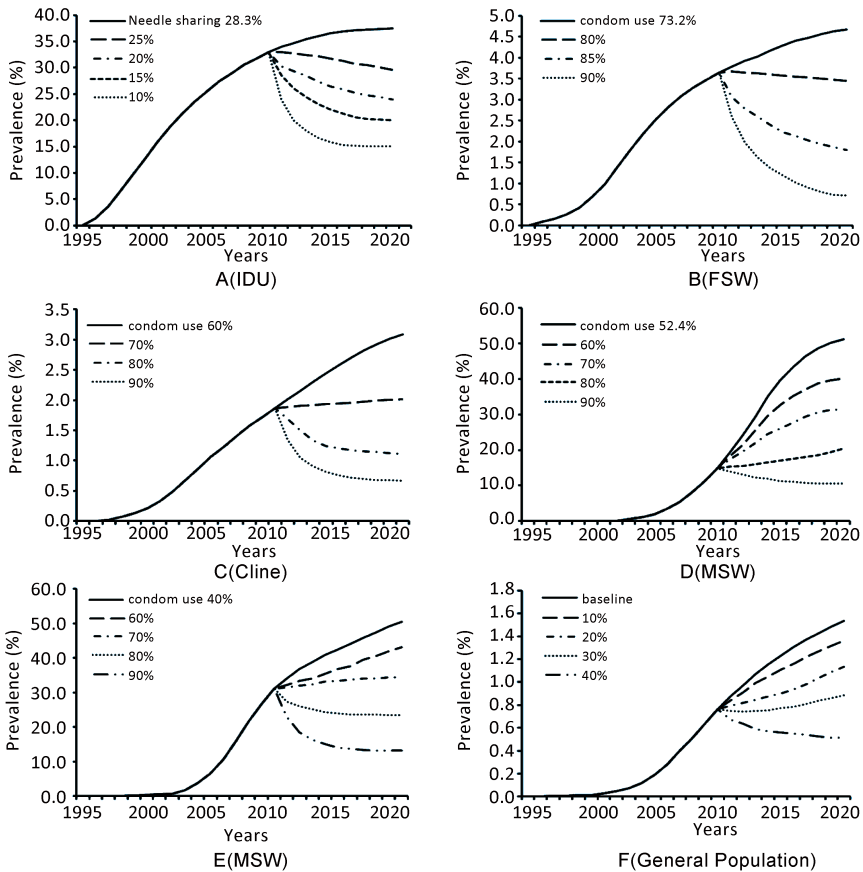


Figure 5. Predicted for intervention scenarios impact on HIV prevalence (2011-2020) in the particular risk groups and general population. (A) Intravenous drug users: (B) Female sex workers: (C) Clients of female sex workers: (D) Male-to-male sex: (E) Male sex workers: (F) General population.

(b) With 73.2% condom use, the model predicts a continuing rise in HIV prevalence among FSWs and their clients. However, if condom use rises to 80%, this trend of rising HIV prevalence is reversed (Figure 5B, C).

(c) The current prevalence of condom use (at 52.4%) among MSM/MSWs is not predicted to lower the prevalence of HIV. HIV prevalence in both groups is predicted to decline only if condom use reaches 90% among MSM (Figure 5D) and 80% among MSW (Figure 5E).

(d) If unsafe sex is practiced by 26% of males and 7% of females among the general population, and condoms are used in 5% of sexual contacts outside of marriage and 1% of sexual contacts within marriage, HIV prevalence is predicted to rise rapidly. However, if the adoption of safe sexual practices increased by 40%, this would result in a downward trend of HIV prevalence (Figure 5F).

DISCUSSION

This updated analysis of the current HIV/AIDS situation in Liangshan Prefecture highlighted the on-going public health challenge faced by both the general population and high-risk groups. Moreover, the AEM projections generated an alarming estimate of the epidemic expanding to even greater proportions over the next decade. Thus, the question emerges, what can be done to eliminate (or at least curb) this expansion? Several local organizations, including governmental and health-related (CDC), in conjunction with international and domestic organizations [i.e., the "Four Frees and One Care" policy (2003), the China-MSD HIV/AIDS Partnership (2005), the Global Fund Round 4 (2007), and the China Red Ribbon Foundation (2010)], have devised and implemented comprehensive prevention, treatment, and patient care strategies targeted to the Liangshan Prefecture. For example, pilot projects targeting middle school children in the three counties with the highest HIV incidences (XI Chang, BU Tuo, and ZHAO Jue^[7]) were launched in 2008, and then expanded to all counties in the prefecture in 2009^[19].

Nonetheless, the AEM projections from this study indicated that the current comprehensive intervention strategies, which include promotion of condom use, HIV counseling and testing, peer education and syringe exchange, are insufficiently effective, since the incidence rate is predicted to continue to increase until 2015. Indeed, the

incidence rate is predicted to decline after 2015, but this was related to changes involving the IDUs high-risk group, which currently represents a majority of HIV/AIDS cases. Unfortunately, the decrease of cases in this particular group is counterbalanced by increased incidences in all other high-risk groups. Thus, by 2020 it is predicted that there will be over 130 000 PLHIV and a prevalence of 2.51%, representing a remarkable increase of the prediction of a previous AEM study (which indicated 1.5% prevalence in 2020)^[2]. Given that the estimated prevalence in 2010 had already exceeded the national average in 2009 by nearly 20-fold^[20], these new findings are a cause for serious concern.

Six years after the first outbreak of HIV infection among IDUs was reported in China in 1989^[21], the first cases of HIV infection were confirmed among IDUs in Liangshan Prefecture^[22]. Syringe sharing is the largest cause of new HIV infections in Liangshan Prefecture, with 67.22% of cumulative HIV/AIDS cases being attributed to IDU by the end of 2010, and 59.49% of new reported cases being infected by unsafe injection practices in 2010. Thus, it is possible that IDU was the primary source of all subsequent HIV transmissions in Liangshan Prefecture. Since 1995, attempts to control the HIV epidemic in Liangshan Prefecture have focused on IDUs. Certainly, these efforts have achieved appreciable success, as evidenced by an observable change in behavior among IDUs (decreased needle sharing and increased needle exchange). Compared to the rates reported in 2007, unsafe syringe sharing dropped to 28.3% and new syringe use increased to 60.0% in 2010^[2]. In addition, the rate of condom use among IDUs in the last sexual contact had increased to 18.7% in 2010 from 12.3% in 2007^[2]. In the current AEM, these behavioral changes among IDUs led to the predicted decrease in growth of HIV prevalence (from 32.95% in 2010 to only 37.53% in 2020), which is slightly lower than the prevalence predicted in the previous study (38.3% in 2020)^[2]. However, the current AEM suggested that if new syringe use could be further increased to 80.0% then HIV incidence (and prevalence) would decline dramatically in IDUs. Several options exist to achieve this level of change in behavior, including strategies involving the counter-narcotics operations, methadone maintenance treatment programs, and clean syringe-exchange projects.

Since 2007, sex has been the major route of HIV transmission in China, accounting for 75% of new infections in 2009^[23]. Moreover, of the 780 000

PLHIV in China, 17.4% were reported to have contracted HIV through homosexual practices^[1] and MSM have emerged as the most at-risk group^[24]. In the current AEM, sexual transmission was predicted to become the primary route of HIV transmission in Liangshan Prefecture by 2013. The HIV prevalence among MSM was predicted to exceed that of IDUs by 2013 and to continue to increase through 2020, when MSM would be the risk group with the highest HIV prevalence. This prediction is far lower than the 78.6% prevalence that was predicted by the very limited data available for MSM in our previous study^[2]. While we believe that the current prediction is more reliable, data on MSM are still very limited, being available only from Xichang county and from monitoring that was started in 2008. The limited data on MSM restrict accurate prediction of MSM population size, which may lead to bias (under-prediction). Despite global reports that HIV prevention efforts have successfully led to widespread adoption of safer sexual practices among MSM^[25-28], the fact is that there is also evidence of increased high-risk sexual behaviors counterbalances the possible benefit to HIV transmission and HIV prevalence among MSM^[29-31]. In China, a number of factors have been identified that contribute to the growing HIV prevalence among MSM, including lack of support for developers of intervention programs targeting MSM due to on-going social stigma and the illegal status of sex between males, low coverage for the few interventions that have targeted MSM, and low condom usage among MSM^[32-34].

Despite commercial sex being illegal in China, it is widely practiced, and there is a high HIV prevalence among FSWs and their clients in Liangshan Prefecture. Local governmental and health sector organizations have made substantial efforts to control the HIV spread in this particular high-risk group; by the end of 2010, sentinel surveillance was set up in all counties in Liangshan Prefecture to monitor the epidemic in this group. However, as in MSM, stigma and discrimination against FSWs have impeded the efficacy of interventions^[23]. The related difficulties in reaching this particular group have also possibly created bias in analyses, producing unreliable estimates of their rates of HIV. Nonetheless, the coverage of comprehensive interventions aimed at FSWs has increased since 2008 (from 29.35% to 41.41% in 2010)^[21]. The positive effects of these interventions have included reported increases in condom usage (29.1% in

2003^[2], 56.8% in 2007^[2], and 73.2% in 2010). However, in the current AEM, HIV prevalence among FSWs and their clients is predicted to continue to increase, and increase in condom usage to 80.0% was required to decrease the prevalence prediction. The current prevalence figures (with current condom usage rates) are higher than those of our previous predictions for 2020 (3.9% in FSWs, and 1.5% in their clients)^[2]; we believe the previous findings may have been underestimated because the FSWs data was available from only five sites at that time^[2].

The past five years has seen an alarming shift in the route of HIV transmission from high-risk groups to the general population in China, and this trend has also been observed in the Liangshan Prefecture^[35]. The current AEM predicted an increase in prevalence and incidence among the general population of Liangshan Prefecture by 2020. Previous studies have implicated unprotected casual heterosexual sex as a primary factor for the increasing HIV prevalence among members of the Yi ethnic group in the general population of Liangshan Prefecture^[5,10]. The reported high frequency of casual sex among Yi adolescents and adults, coupled with low condom usage, puts the general population at higher risk for HIV transmission.

The current AEM study has highlighted the fact that many challenges still exist to curbing the spread of the HIV epidemic in Liangshan Prefecture, despite the extensive efforts undertaken by the government and the health sector over the past 16 years. First, the original prevention and treatment coverage targets for 2010 proved difficult to meet. Indeed, several areas are still unable to establish and adequately provide services to their targeted groups. Second, the persistent practice of unsafe casual sex among the Yi people in the age range of 15-35 years old as only promoted the spread of HIV and the challenge of mitigating future rates. Third, in recent years, the Jiazhi, a cultural Yi group that maintains social order within the Yi community^[10], have overtaken the illicit drug trade^[4] and drug abuse, including of intravenous drugs, has become rampant^[4,9]. Fourth, stigma and discrimination against PLHIV among health care personnel still exists^[10]. Fifth, poverty and lack of professional staff also affect the future trends of the HIV/AIDS epidemic. Eleven counties of Liangshan Prefecture have been listed as national poverty-stricken counties in need of aid. In some rural areas, the physical infrastructure for health care exists but staff lack the necessary skills and resources to treat

HIV-infected patients^[35-36].

There are several limitations to the current AEM study that must be considered when interpreting its findings. AEM is a semi-empirical process model, based on the existing characteristics of the HIV epidemic in Asia. For this study, parameters were chosen so as to fit the publicly available prevalence data for Liangshan Prefecture as accurately as possible, but some deviations from the actual HIV epidemic situation may exist. The need for high quality data and the complex input process also limits the widespread usage of the AEM^[2]. Finally, the current AEM predictions were based on data from HIV surveillance systems, in which behavioral data is self-reported. Thus, information bias may exist. When cases are newly diagnosed, there may be a tendency to conceal the true route of infection because of stigma.

In conclusion, the current AEM study provides evidence that under the current coverage of effective interventions to prevent the HIV epidemic in Liangshan Prefecture, the epidemic may become more serious among specific at-risk groups and expand into the general population. Understanding the trend of HIV among high-risk groups could inform future intervention strategies aimed at preventing the further spread of HIV in Liangshan Prefecture. A comprehensive and effective prevention intervention program to reduce intravenous drug use, promote condom use, and reduce casual sex is urgently needed. The current successes in curtailing the HIV epidemic among IDUs need to be expanded to the groups of MSM^[32] and FSWs and their clients. Efforts among the general population are also very important, with the strengthening of all sectors among it being necessary to ensure that good policy is translated into reasonable understanding and sustained practice.

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REFERENCES

1. Ministry of Health, People's Republic of China, Joint United Nations Program on HIV/AIDS, World Health Organization. 2011 estimates for the HIV/AIDS epidemic in China [cited 2012 April 23]; Available from: URL: <http://www.chinaids.org.cn/n1971/n2151/n777994.files/n777993.pdf>.
2. Liu L, Luan R, Yang W, et al. Projecting Dynamic Trends for HIV/AIDS in a Highly Endemic Area of China: Estimation Models for Liangshan Prefecture, Sichuan Province. *Current HIV Research*, 2009; 7, 390-7.
3. Joint United Nations Programme on HIV/AIDS. Join the fight against AIDS in China [cited 2012 August 29]; Available from: URL: http://data.unaids.org/Topics/Partnership-Menus/PDF/chinacover_en.pdf.
4. Sichuan University School of Public Health. Comprehensive assessment report for HIV/AIDS control and prevention in Sichuan Province (2006-2010). Chengdu: Sichuan University 2012. (In Chinese)
5. Liangshan Prefecture CDC. Report of HIV/AIDS Epidemiological Survey in 14 Counties of Liangshan Prefecture, Sichuan Province 2009. (In Chinese)
6. Zhou WR, Sun X. Liangshan Prefecture in 2010 and Control Status of the AIDS Epidemic. *Asia-Pacific Traditional Medicine*, 2011; 7, 190-2. (In Chinese)
7. Wang L, Qing QQ, Ding ZW, et al. Current case reporting of HIV/AIDS epidemic in 2010 in China. *Chinese J AIDS & STD*, 2011; 17, 275-8. (In Chinese)
8. Sichuan University. Report of HIV/AIDS Comprehensive Surveillance in Liangshan Prefecture 2011. Chengdu, 2012. (In Chinese)
9. Sichuan University. Report of HIV/AIDS comprehensive assessment in Liangshan Prefecture, Sichuan Province (1995-2010), Chengdu; 2011. (In Chinese)
10. Yang Y, Luan RS, Liu P, et al. Casual sex and concurrent sexual partnerships among young people from an Yi community with a high prevalence of HIV in China. *Asian Journal of Andrology* 2012; 14, 758-65.
11. Yang Y, Luan RS, Liu P, et al. Casual Sex Among 89 Young Men from 8 Yi Villages in China. *Journal of Reproduction & Contraception*, 2011; 22(4), 247-53.
12. Liangshan Prefecture CDC. Surveillance report of HIV/AIDS in Liangshan Yi Autonomous Prefecture 1990-2011; 2012. (In Chinese)
13. Brown T, Peerapatanapokin W. The Asian Epidemic Model: a process model for exploring HIV policy and programme alternative in Asia. *Sex Transm Infect* 2004; 80(Suppl 1), i19-i24.
14. Thai Working Group on HIV/AIDS Projection. Projections for HIV/AIDS in Thailand: 2000-2020: Bangkok: Department of Communicable Disease Control, Ministry of Public Health 2001.
15. Phalla T, Leng HB, Mills S, et al. HIV and STD epidemiology, risk behaviors, and prevention and care response in Cambodia. *AIDS*, 1998; 12(Suppl B), S11-8.
16. Cambodia Working Group on HIV/AIDS Projection. Projections for HIV/AIDS in Cambodia: 2000-2010: Phnom Penh: Family Health International Cambodia 2002.
17. Duan S, Guo HY, Pang L, et al. Analysis of the epidemiologic patterns of HIV transmission in Dehong prefecture Yunnan province. *Chin J Prev Med (Chin)*, 2008; 42, 866-9.
18. Cohen J. The Asian epidemic model's provocative curves. *Science*, 2004; 304, 1934.
19. Sichuan University. Report of HIV/AIDS comprehensive assessment in Liangshan Prefecture, Sichuan Province (1995-2010), Chengdu; 2011. (In Chinese)
20. Ministry of Health, People's Republic of China, Joint United Nations Program on HIV/AIDS, World Health Organization. 2009 estimates for the HIV/AIDS epidemic in China [cited 2010 June 18]; Available from: URL: <http://www.moh.gov.cn/publicfiles/business/htmlfiles/mohjbyfkj/s3586/201009/488>

- 58.htm.
21. Jia YJ, Sun JP, Fan L, et al. Estimates of HIV prevalence in a highly endemic area of China: Dehong Prefecture, Yunnan Province. *Int J Epidemiol*, 2008; 37, 287-96.
 22. Sichuan University. Report of HIV/AIDS Comprehensive Surveillance among Four Groups of China-MAP Project in Liangshan Prefecture 2008. Chengdu, 2008. (In Chinese)
 23. Rou KM, Sullivan SG, Liu P, et al. Scaling up prevention programmes to reduce the sexual transmission of HIV in China. *International Journal of Epidemiology*, 2010; 39(suppl 2), ii38-ii46.
 24. UNAIDS. AIDS epidemic update: December 2009. Geneva: UNAIDS; 2009.
 25. Merson MH, O'Malley J, Serwadda D, et al. The history and challenge of HIV prevention. *Lancet*, 2008; 372, 475-88.
 26. Lau JT, Lin C, Hao C, et al. Public health challenges of the emerging HIV epidemic among men who have sex with men in China. *Public Health*, 2011; 125, 260-5.
 27. Mastro TD, Cohen MS. Honing the test-and-treat HIV strategy. *Science*, 2010; 328, 976.
 28. Sullivan PS, Hamouda O, Delpech V, et al. Preemergence of the HIV epidemic among men who have sex with men in North America, western Europe, and Australia. *Ann Epidemiol*, 2009; 19, 423-31.
 29. Elford J. Changing patterns of sexual behavior in the era of highly active antiretroviral therapy. *Curr Opin Infect Dis*, 2006; 19, 26-32.
 30. Bozicevic I, Voncina L, Zigrovic L, et al. HIV epidemics among men who have sex with men in central and eastern Europe. *Sex Transm Infect*, 2009; 85, 336-42.
 31. Smith AD, Tapsoba P, Peshu N, et al. Men who have sex with men and HIV/AIDS in sub-Saharan Africa. *Lancet*, 2009; 374, 416-22.
 32. UNAIDS. China to tackle HIV incidence amongst MSM [cited 2009 January 16]; Available from: URL: <http://www.unaids.org/en/Resources/PressCentre/Featurestories/2009/January/20090116MSMAsia/>.
 33. Zhou F, Gao L, Li S, et al. Willingness to accept HIV pre-exposure prophylaxis among Chinese men who have sex with men. *PLoS ONE*, 2012; 7, e32329.
 34. Chen GZ, Li Y, Zhang BC, et al. Psychological characteristics in high-risk MSM in China. *BMC Public Health*, 2012; 12, 58.
 35. Shao Y, Jia Z. Challenges and opportunities for HIV/AIDS control in China. *The Lancet*, 2012; 379, 804.
 36. Yip R. Opportunity for effective prevention of AIDS in China. In: Kaufman J, Kleinman A, Saich T, eds. *AIDS and social policy in China*. Cambridge: Harvard University Asia Center, 2006; 177-89.