Original Article

Estimation and Projection of the HIV Epidemic Trend among the Migrant Population in China

MENG XiaoJun[1], WANG Lu[1,#], Susan CHAN[1], Kathleen Heather REILLY[1], PENG ZhiHang[2], GUO Wei[1], DING GuoWei[1], DING ZhengWei[1], and QIN QianQian[1]

1.National Center for AIDS/STD Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing 102206, China; 2. Department of Public Health, Nanjing Medical University, Nanjing 210029, Jiangsu, China

Abstract

Objective The migrant population is a vulnerable group for HIV infection in China. Understanding potential epidemic trends among migrants is critical for developing HIV preventative measures in this population.

Methods The Estimation and Projection Package (EPP) model was used to process prefecture and county-level surveillance data to generate HIV prevalence and epidemic trends for migrant populations in China.

Results The prevalence of HIV among migrants in 2009 was estimated at 0.075% (95% CI: 0.042%, 0.108%) in China. The HIV epidemic among migrants is likely to increase over the next 5 years, with the prevalence expected to reach 0.110% (95% CI: 0.070%, 0.150%) by 2015.

Conclusion Although the 2009 estimates for the HIV/AIDS epidemic in China indicate a slower rate of increase compared with the national HIV/AIDS epidemic, it is estimated to persistently increase among migrants over the next 5 years. Migrants will have a strong impact on the overall future of the HIV epidemic trend in China and evidence-based prevention and monitoring efforts should be expanded for this vulnerable population.

Key words: China; Transients and migrants; Estimation and projection package; HIV/AIDS

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INTRODUCTION

Population mobility is the inevitable result of social development and is important for economic development. Migration, however, has also been associated with several negative outcomes in China, such as increased crime and the spread of infectious disease[1]. Compared with fixed populations, the migrant population is particularly prone to human immunodeficiency virus (HIV) infection[2-3]. Combined with HIV transmission factors such as high-risk sexual behavior and intravenous drug use, migration can lead to an acceleration of HIV transmission because HIV positive migrants may transmit HIV to their spouse or other sexual partners. Since the political and economic reforms of the late 1970s in China, great differences have developed between coastal and inland populations, as well as differences between urban and rural areas due to unbalanced economic development. A large number of rural people have migrated to large cities and those residing inland

[#]Correspondence should be addressed to: WANG Lu. Tel: 86-10-58900958. Fax: 86-10-58900958. E-mail: wanglu64@chinaaids.cn

Biographical note of the first author: MENG XiaoJun, male, born in 1984, MD candidate, majoring in HIV/AIDS epidemiology.

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have migrated to the coast. According to the National 1% Population Sample Survey, in 2005 there were 147.4 million migrants in China and 32.4% of migrants had moved from one province to another. Compared with the fifth National Population Census of 2000, the migrant population increased by 2.96 million and inter-provincial migrants increased by 5.37 million[4]. Statistical data from the National Bureau of Statistics showed that nationally there were 145.3 million migrant workers in 2009 compared with 140.4 million in 2008[5-6]. According to Chinese law all individuals must be registered. As a result of China's unique household registration system, known as the *hukou* system, China has an urban-rural dual structure, meaning that all Chinese are classified with either an urban or rural residence or *hukou*[7]. If one is registered to live in an urban area, they have access to more resources in terms of employment, housing, medical care, pensions, and education[8]. Moreover, different levels of city registration have different levels of social welfare and public services. In China, migrants may experience difficulty in accessing health services, including HIV/AIDS-related medical services, compared with the local resident population[9]. Migrants in China face a serious risk of HIV infection because of lack of health knowledge, as well as limited opportunity to receive HIV awareness education, counseling and testing services. Moreover, migrants may be discriminated against, lack social support, and feel isolated because they are separated from their families, live in sub-standard conditions, and have low social status[10]. Migrants are an important risk group for HIV infection and HIV prevention efforts should focus on this vulnerable group in the future.

At the end of 2009, there were 1 318 sentinel sites collecting data on HIV infections, including 592 national sentinel sites and 726 provincial sentinel sites, covering all of China's 31 provinces (autonomous regions and municipalities). Monitored groups include intravenous drug users (IDUs), female sex workers (FSWs), male STD clinic clients, men that have sex with men (MSM), male clients of FSWs, and migrants. With improvements in China's HIV surveillance system, more cases of HIV have been detected among migrants, but effective HIV prevention programs currently cover less than 1% of the migrant population from rural areas[11]. Previously, because of limited surveillance data, HIV/AIDS research on migrants in China was mostly limited to regional cross-sectional surveys and a small number of cohort studies. These studies can hardly be used to comprehensively analyze HIV infection among Chinese migrants and population mobility makes it harder to predict HIV epidemic trends among this population. Since 2006, the Chinese government has focused on this vulnerable population, to better understand how they are affected by the HIV epidemic. This is the first study to explore the HIV epidemic trend among migrants using the UNAIDS/WHO Estimation and Projection Package (EPP) in order to provide evidence for HIV prevention programs among China's migrant population.

MATERIALS AND METHODS

The Estimation and Projection Package (EPP)

EPP is a common prediction model developed by UNAIDS experts in 2001, replacing the previous *Epimodel* prediction model. The EPP model can be used to draw separate HIV epidemic curves for different sub-populations and to determine the best fitting curve through epidemiological simulation, reflecting a time trend of HIV infection. Combined with different sub-epidemic curves, EPP can produce an epidemic curve reflecting the HIV prevalence of the whole population[12]. The software used in this study is EPP 2009 beta version (UNAIDS, Geneva).

Migrant Definition

A migrant is defined as "any person who lives temporarily or permanently in a country where he or she was not born, and has acquired some significant social ties to this country"[13]. The United Nations Convention on the Rights of Migrants defines a migrant worker as a "person who is to be engaged, is engaged or has been engaged in a remunerated activity in a State of which he or she is not a national"[14]. This study, however, considers "internal migrants" or those Chinese who meet the above definitions with the exception that they have relocated to other regions of China. The majority of migrants included in this study are temporary labor migrants, defined as "people who migrate for a limited period of time to take up employment and send money home"[15].

Sources of Data

Subjects 15 years of age and older were divided into migrant and non-migrant populations. The EPP

model requires data of population size, HIV infection incidence and prevalence, sample size, antiretroviral therapy (ART), and other data relevant to migrants extracted from the current literature in scientific journals.

HIV Prevalence Data Data on HIV prevalence rates among migrants came from national and provincial sentinel surveillance reports, related data in the web-based HIV comprehensive prevention information system, and results of epidemiological investigation about migrant populations conducted in Jilin and Hunan provinces from 2007 to 2008[16-17]. Data on ART also came from the web-based HIV comprehensive prevention information system.

Population Size Data The size of the general population at 15 years of age and older came from the 2009 China statistical yearbook. The size of the migrant population came from the National Bureau of Statistics Rural Division monitoring report.

Model Fitting

Data were entered into the EPP model, focusing on separate fitting for migrants under the appropriate parameters. Parameters were adjusted to obtain the best-fit curve according to the average HIV prevalence based on 2009 sentinel surveillance data[18-19].

Ethics Approval

This study received ethics approval from the institutional review board of the National Center for AIDS/STDs Control and Prevention, China CDC.

RESULTS

Demographic Characteristics of Migrants

Among 14 109 monitored migrants, 71.3% were male and 28.7% were female. Their average age was 34.1 years old and 93.0% of migrants were 15 to 49 years old. The majority of migrants (71.8%) were married, 23.6% were unmarried, 3.6% were cohabitating, and 1.0% were divorced or widowed. A small proportion (1.9%) were illiterate, 18.3% had only completed primary school, 50.6% had completed junior high school, 21.5% had completed senior high school, and 7.7% had at least completed junior college.

Sexual Behavioral Characteristics of Migrants

Table 1 summarizes the sexual behavior reported by migrants. Among 10 638 migrants who were married or cohabitating, 6.8% used a condom every time when having sex with their partner in the preceding year while 20.6% used a condom in their last sexual act. Only 9.7% (*n*=975) of male migrants said that they had purchased sex from a female sex worker in the preceding year, 42.8% of whom used a condom every time and 59.5% reported using a condom in their last commercial sexual act. Among male migrants, 32 (0.3%) reported having anal sex with another man in the last year, 9.4% (*n*=3) of whom reported using a condom every time while 25.0% (*n*=8) used a condom in their last anal sexual act. Among both male and female migrants, 7.0% (*n*=986) reported having had a non-commercial/non-regular casual partner in the last year, 31.7% of whom reported using a condom every time while 56.3% using a condom in their last sexual act.

Table 1. Condom Use in Different Sexual Behavior among the Migrant Population

Sexual Behavior	Monitored Migrants (*n*)	Condom Use (*n*)	Proportion(%)
Sexual Behavior with Spouse or Partner			
Always Used Condom in Last Year	10 638	725	6.8
Last Sexual Act	10 638	2196	20.6
Sexual Behavior of Male Migrants with CSW			
Always Used Condom in Last Year	975	417	42.8
Last Sexual Act	975	580	59.5
Anal Sexual Behavior			
Always Used Condom in Last Year	32	3	9.4
Last Sexual Act	32	8	25.0
Casual Sexual Behavior			
Always Used Condom in Last Year	986	313	31.7
Last Sexual Behavior	986	555	56.3

Drug Use among Migrants

Of the 14 109 migrants included in our study, only 16 (0.11%) reported illegal drug use and only 5 (0.04%) reported intravenous drug use.

HIV Infection among Migrants from Case Reporting and Sentinel Surveillance

According to national case reporting data, in 2007 12.7% of 35 630 reported HIV cases were considered migrants[20] and among the 60 081 HIV/AIDS reported cases in 2008, 17.5% were migrants[21]. In 2009, 19.1% of 68 249 HIV/AIDS cases were among migrants and based on the at web-based case reporting system, at the end of June 2010 20.8% of HIV cases were among migrants (Figure 1)[22]. Literature searches about HIV infection rates among migrant workers in China showed that the lowest HIV prevalence was 0 and the highest was 0.30% from 2006 to 2009. The current study's lowest HIV prevalence among migrant workers based on sentinel surveillance data was 0 and the highest was 0.54%. A majority (76.8%) of the HIV prevalence from sentinel surveillance sites were between 0 and 0.20%. There were 22 migrant population sentinel surveillance sites in 2009 and the average HIV prevalence at these sites was 0.10%.

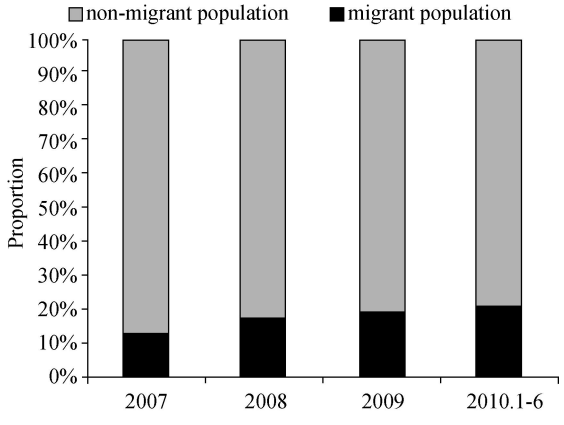

Figure 1. Changes in the roportion of reported HIV/AIDS cases among migrants and non-migrants in China from January 2007 to June 2010.

The HIV Epidemic Trend among Migrants Using the EPP Model

After sentinel surveillance data and epidemiological survey data were entered into the EPP model, the HIV data of migrants were modeled using the following parameters: the rate of growth of the epidemic (r), the fraction of new entrants to the population going into the at-risk category (f0), the start time of the epidemic (t0), and the behavior change parameter (phi). Since the sentinel surveillance sites reached the highest number of cases in 2009, the average HIV infection rate from this year may best reflect the current situation. After the EPP model was fit, the 2009 estimated HIV prevalence among migrants was adjusted to that of the 2009 average HIV prevalence from sentinel surveillance sites by changing model parameters. The final model indicated that the HIV prevalence among migrants in China will increase over the next 5 years (Figure 2).

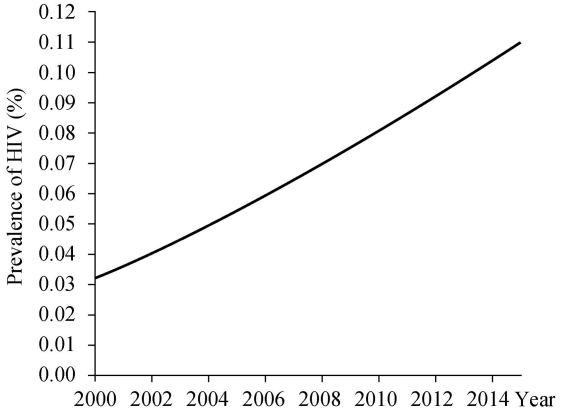

Figure 2. The HIV epidemic trend among migrants in china.

The 95% confidence intervals (CI) for every HIV prevalence after the year 2000 among migrants was calculated (Table 2). Results indicate that the HIV prevalence among migrants in 2009 was 0.075% (95% CI: 0.042%-0.108%). The prevalence is estimated to reach 0.110% (95% CI: 0.070%-0.150%) by the year 2015.

DISCUSSION

The results of this study indicate that the majority of migrants in China are male, at a sexually active age, and with low prevalence of consistent condom use. A portion of HIV positive migrants are unwilling to follow-up for management of their infection at a disease control institution because of the fear of exposing their HIV/AIDS status, especially those who are tested HIV positive in hospital[23]. Most migrants did not use a condom when they had sex with their regular sexual partners and casual sexual partners, increasing the risk of HIV transmission to their sexual partners, which could

Table 2. Estimated HIV Prevalence among Migrants in China from 2000 to 2015

Year	Prevalence (%)	95% CI Lower Limit of *P* (%)	95% CI Upper Limit of *P* (%)	Year	Prevalence (%)	95% CI Lower Limit of *P* (%)	95% CI Upper Limit of *P* (%)
2000	0.032	0.011	0.054	2008	0.069	0.038	0.101
2001	0.036	0.013	0.059	2009	0.075	0.042	0.108
2002	0.040	0.016	0.064	2010	0.081	0.046	0.115
2003	0.044	0.019	0.070	2011	0.087	0.051	0.122
2004	0.049	0.022	0.076	2012	0.092	0.056	0.129
2005	0.054	0.026	0.082	2013	0.098	0.060	0.136
2006	0.059	0.029	0.088	2014	0.104	0.065	0.143
2007	0.064	0.033	0.095	2015	0.110	0.070	0.150

accelerate HIV transmission to the general population.

The estimated HIV prevalence among migrants in China was 0.075% (95% CI: 0.042%-0.108%) in 2009, which is similar to the 2009 national HIV prevalence estimate[24] that indicates that the current HIV infection rate of migrants in China is at a low level. In this study, the average HIV infection rate among migrants, collected by sentinel surveillance, was relatively high because those migrants captured by sentinel surveillance were a relatively high-risk population. Therefore, in the process of model fitting, after the model parameters were adjusted, the 95% CI upper limit of HIV prevalence in the model was close to the average prevalence among migrants monitored by sentinel surveillance in 2009. Although the HIV/AIDS epidemic among migrants in China had a low prevalence in 2009, the overall epidemic is projected to increase in the next 5 years. Furthermore, the absolute number of migrants is large and the proportion having high risk sexual behavior is high, such that the spread of HIV among migrants will have an important impact on China's overall HIV epidemic trend in the future.

This study has several limitations. Some participants may not have felt comfortable truthfully answering questions about sexual behavior and drug use or may not remember their past behaviors and the results of this study may be subject to social desirability and recall biases. Previous studies have found a higher prevalence of IDU among migrants in China[25] and future studies should consider using urine-based testing to assess drug use. Also, the EPP model cannot evaluate the impact of interventions such as condom use promotion and future fluctuations in the size of the migrant population. The impact of the expanding coverage of ART on the epidemic trend among migrants could not be taken into account in the projection of HIV rates in this study because we cannot estimate the exact coverage of ART among migrants in the future, so we cannot predict how many migrants will accept ART in a year after 2009. ART can extend the life of HIV infected persons, making the cumulative number of surviving infected persons per year increase. Thus, the results estimated in this paper may underestimate the level of HIV infection among migrants. Data used in this study were mainly from 13 provinces, which may not completely represent migrants in all of China. These 13 provinces, however, were geographically diverse.

In many countries, including China, migrants have been identified as a high-risk group for HIV transmission and are considered a potential bridge population to the general population[26]. Although migrants are identified as a high-risk group, the result of this study indicate that the HIV infection rate among this population in China is still at a lower level than other high-risk populations, such as female sex workers and intravenous drug users. But some epidemiology surveys found that migrants are highly mobile; most of these were sexually active and many had casual sexual partners, commercial sex partners, or multiple sexual partners with low rates of condom use[27-28]. The high mobility of migrants makes it more difficult to monitor HIV infection and manage care. So with the spread of the HIV epidemic among migrants, the HIV infection rate could well be high in the future. Estimates from 2009 on the HIV/AIDS epidemic in China indicated a slower rate of increase of the HIV/AIDS epidemic in the whole country[24], but this study showed a persistent increase of HIV/AIDS infections among migrants over the next 5 years. With an increase in the number and mobility of migrants, the influence of migrants on the future of the HIV epidemic in China should be carefully considered and the government should take effective measures to control

the spread of HIV/AIDS among this population.

The EPP model is very useful in the estimation and projection of HIV epidemics, not only at country level but also for some local areas where there are enough data available. If there are abundant data about HIV infection rates in a particular group from multiple sources, the EPP model can balance the differences in these rates according to the sample size, and can also fully utilize the surveillance data and the epidemiology surveys. We believe the EPP model is the best choice to study HIV infection among a single group, or to define a new population, such as migrant population or students in college.

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