

Estimating the number of people at risk for and living with HIV in China in 2005: methods and results

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Background: No new estimates of HIV infection have been available for China since 2003. However, since then, data availability has increased dramatically.

Objectives: To use internationally recommended methods to make new estimates of the number of people exposed to HIV in China, the number living with HIV, and the number of new HIV infections and deaths in 2005.

Methods: The UNAIDS Workbook method was adapted to meet the needs of China. Local data were used to estimate the size of each risk population and HIV prevalence by risk group for every prefecture. These estimates were combined into provincial and national estimates. The UNAIDS Estimates and Projections Package and Spectrum were used to derive estimates of incidence and mortality from prevalence data, taking into account treatment.

Results: It was estimated that 650 000 people are living with HIV/AIDS in China (range 540 000–760 000), of whom 70 000 were newly infected in 2005 (range 60 000–80 000). Between 20 000 and 30 000 people are estimated to have died of HIV in 2005. The new estimate compares with an estimate of 840 000 people living with HIV/AIDS in 2003 (range 650 000–1 020 000). The estimated number of infected former plasma donors fell from 199 000 to 55 000. Infections remain concentrated among drug injectors, those buying and selling sex, and men who have sex with men.

Conclusion: The new estimates are based on a much wider range of surveillance data as well as mass screening of former plasma donors, and are made at the prefecture level. More limited data from high prevalence provincial surveillance sites led to past estimates that now seem too high. New infections outpace death, and the HIV epidemic in China is still growing.

HIV in China remains concentrated among populations whose behaviour puts them at especially high risk of exposure to the virus—drug injectors, sex workers and their clients, men who have sex with men (MSM), and the regular sex partners of each of these groups. In addition, unsafe blood collection practices caused localised outbreaks in rural areas in some provinces in the mid 1990s.¹

A national sentinel surveillance system, in place since 1995, has recorded large differences in the distribution of infections nationwide, with some provinces* recording very high prevalence rates in at-risk populations, while others report virtually no infections.

Because of the concentrated and relatively recent nature of the HIV epidemic in China, the national Centre for Disease Control (China CDC) chose in 2003 to use the Workbook method recommended by the World Health Organization (WHO) and the Joint United Nations Programme on HIV/AIDS (UNAIDS) to estimate populations exposed to and infected with HIV. The 2003 estimate was made in Beijing by the National Centre for HIV/AIDS and STD Control, (NCAIDS), using data available at the national level. Health officials did, however, take into account the uneven distribution of the virus by creating separate spreadsheets for each province in the national Workbook. UNAIDS and WHO gave technical support during this estimation process.

Since the 2003 estimates were made, the surveillance system in China has been greatly expanded and strengthened, and mass screenings have been carried out in some key provinces and populations (including former plasma donors). More comprehensive behavioural surveillance coupled with development in indirect estimation methods have also significantly improved the estimates of the number of people at high risk for exposure to HIV. These data form the basis for the estimates described in this paper. The paper describes methods and data sources, process, and results. A discussion

of the strengths and limitations of the 2005 estimates and the implications for the national response to HIV follows.

OBJECTIVES

In mid 2005, China CDC began the process of making revised estimates of the number of people at risk for HIV in China, and the number currently infected. The aim was to make estimates at as detailed a level as was feasible, using all newly available data. China CDC hoped to gain a better understanding of the distribution of risk and infection at both a national and a local level. The active engagement of prefecture and provincial staff in the estimation process was expected to increase local capacity to analyse prevention and care needs and plan epidemiologically appropriate responses.

METHODS

The estimation process

The 2005 estimates were generated through a process that was broadly consultative. A national HIV/AIDS estimation working group was established, led by the Ministry of Health with participation from the China CDC; Peking University, Tsinghua University, and other universities. After piloting methods in one province, China CDC developed guidelines for estimation methodology and documentation (“2005 National HIV/AIDS Estimation Technical Guidance Protocol”) together

Abbreviations: ARV, antiretroviral; EPP, Estimates and Projection Package; FSW, female sex workers; IDU, injecting drug user; MSM, men who have sex with men; UNAIDS, Joint United Nations Programme on HIV/AIDS; WHO, World Health Organization.

* In this paper we use the word “province” to refer to all of China’s provinces, autonomous regions, and municipalities, as well as the Xinjiang Production and Construction Corps.

with an implementation manual. These tools were designed to ensure standardisation of methods and comparability of results across all provinces. CDC staff also provided training to provincial health staff through a series of meetings and workshops.

Provinces made draft estimates. HIV/AIDS experts from each province; as well as UNAIDS, WHO, and the United States CDC then formed five regional working groups to review the draft estimates. After review, each provincial health bureau (or health department) and CDC jointly finalised provincial estimates, and CDC worked with the national working group to prepare national estimates. Draft national estimates were reviewed by national and international experts, including representatives from WHO and UNAIDS Geneva headquarters; suggested adjustments to methodology and assumptions were incorporated into the final estimates whose results are reported here.

The breadth of experience of the working group partners ensured lively and detailed discussion of data validity and estimation results.

Data sources

Demographic data

The demographic data used in Workbook came primarily from publicly available prefecture/metropolitan area statistical bureau data.

HIV prevalence data

Data on HIV prevalence came primarily from HIV sentinel surveillance data, using 2005 data if available, or 2004 data if not. In cases where only data from earlier years were available, appropriate adjustments were made if considered necessary by local CDC officials. The national sentinel surveillance system has recently expanded greatly. In addition, the 2005 estimates used data from a parallel system of provincial sites which are available to provincial officials. Table 1 shows the number of sentinel sites for each at-risk population with data available in the 2003 and 2005 estimates process.

As table 1 shows, some populations are far more strongly represented than others. While progress is being made continually, it has not yet been possible to fill all the gaps within the framework of the national sentinel surveillance system. For this reason, the government and academic institutions have supported a number of epidemiological surveys—these were also used in the 2005 estimates process. Further, with the aim of providing services and support under the China Cares treatment programme, a number of provinces carried out mass screening for HIV among former plasma donors—an important source of information in this previously little-understood population. One of the most

affected provinces also carried out mass screening among sex workers, drug injectors, and the sex partners of people infected with HIV. The results informed assumptions about infection rates in similar epidemic situations in other provinces.

Data on the size of populations at high risk of exposure to HIV

For each population at high risk, high and low estimates were made for the population size. Most estimates used indirect multiplier methods, following international guidelines.⁵

To estimate the number of injecting drug users (IDUs) in each prefecture, Public Security Bureau listings of the numbers of drug users were combined with information from detoxification/treatment centres on the proportion of injectors among drug users and local surveys of registration completeness to derive the estimated number of drug injectors.

To estimate the number of sex workers, local mapping was available in many areas. In some cases, STI screening and treatment records were combined with treatment seeking data from behavioural surveys to estimate sex worker numbers.

Numbers of clients were estimated from the number of sex workers, using data about client numbers and frequency of visits provided by behavioural surveillance.

The 2005 protocols restricted estimates of MSM to the subpopulation thought to be at higher risk for exposure to HIV because they engage in multiple partnerships. An estimate of the population prevalence of this behaviour was made based on mappings of cruising areas and high risk MSM in a number of Chinese cities in 2004/05. For urban areas throughout China, this estimated population prevalence of high risk male-male sex was applied to the number of adult men to get an estimated number of men practicing high risk male-male sex. In rural areas, the population prevalence of risky male-male sex derived from urban studies was adjusted downwards to reflect more limited opportunities for partner exchange in rural areas. These adjusted prevalences were then applied to the number of adult men in urban areas to get estimates for the absolute numbers at risk.

Estimates of the number of people infected with HIV during commercial plasma donation were for the first time based on the results of intensive enumerations of former commercial plasma donors with HIV screening in 2004/05. These enumerations established a minimum number of former donors living with HIV. Estimates for the total number of infected former donors were adjusted upwards to reflect the fact that enumerations will inevitably miss a proportion of individuals.

The number of regular partners of HIV positive people with high risk behaviour was estimated from behavioural surveillance data on proportions married or living with an opposite sex partner.

Missing data

Inevitably in such a large nation, there were many prefectures that did not have all the data necessary to make an estimate. Missing data were imputed by using the values recorded in the prefecture most socioeconomically and geographically similar to the area with missing data, adjusted as appropriate using the judgment of local health officials and other experts as described below.

Estimation methods

The Workbook method for estimating the number of people living with HIV/AIDS was used to produce China's HIV and AIDS estimates, and this method has been described in detail

Table 1 Number of sentinel surveillance sites contributing data to China's national HIV estimates, 2003 and 2005

Groups	2003		2005	
	(national only)	National	Provincial	Total
Female sex workers	43	67	57	124
Drug users/IDUs	49	77	92	169
STD outpatients	72	120	147	267
MSM	1	3	0	3
Pregnant women	18	37	45	82
Truck drivers	11	25	23	48
Others	—	—	56	56
Total	194	329	420	749

IDUs, injecting drug users; MSM, men who have sex with men; STD, sexually transmitted disease.

Table 2 Estimated population sizes and numbers living with HIV, China, end 2005

	Population size estimate (range)	Estimated number living with HIV (range)	Estimated number living with HIV (mid-point)
Injecting drug users	1.8–2.9 million	230 800–344 900	287 900
Female sex workers	2.8–4.5 million	20 800–31 600	26 200
Clients of female sex workers	21.9–37.4 million	78 200–124 000	101 100
High risk men who have sex with men	3.6–7.1 million	34 700–60 400	47 500
Former plasma donors (FPD)	1.2–1.5 million	53 800–57 000	55 400
Regular partners of high risk groups/FPD	–	31 900–51 400	41 600
Other*	–	85 700–94 900	90 300
Total	–	535 900–764 200	650 000

*Includes children infected vertically, nosocomial infection other than plasma donation, tertiary transmission in high prevalence areas.

elsewhere² The Workbook method starts by estimating the size of each of the subpopulations at high risk of exposure to HIV, and then applies an HIV prevalence to each of these populations to get an estimated number of people infected, by exposure group. High and low estimates are used for both population sizes and HIV prevalence rates, reflecting the uncertainty associated with these estimates. This method yields the range in which the actual number of infections is believed to lie.

China has adapted the Workbook to include the following populations at high risk of exposure to HIV: female sex workers and their clients, drug injectors, men who have sex with other men and have a high partner turnover (disaggregated by urban and rural residence), and former plasma donors. In addition, secondary transmission is estimated in one of two ways: in areas where the epidemic has not been well established for 10 years or more, HIV infections are estimated in the regular sex partners of infected members of the high risk groups cited. In areas with long established epidemics, HIV infections in people without any immediate, current risk behaviour are estimated by applying HIV prevalence data from pregnant women to the female population. For the male population, prevalence is adjusted downward to reflect the fact that a larger proportion of male infections are primary. This second method was developed to capture infections that may be the result of earlier risk behaviours on the part of people who are no longer captured in the “high risk” estimates (such as former sex workers) as well as onward sexual transmission to regular sex partners and beyond.

Prefecture level estimates

In each prefecture, a high and a low estimate was selected for both population size and HIV prevalence for each of the populations at high risk of exposure to HIV. These came from different sentinel sites in the same prefecture, if available, or by comparing data with that of epidemiologically, geographically, and socioeconomically similar prefectures and making adjustments to form a range as appropriate.

Province level estimates

Two spreadsheet based workbooks were prepared for each province, with a spreadsheet for every prefecture or metropolitan area in the province. One was an Estimates Workbook adapted from the WHO/UNAIDS model—the prefecture level estimates were entered into the appropriate sheet of this estimation workbook. Thus, there are 31 provincial level estimation workbooks for the country. The second workbook was for documentation—the sources for each data point and any assumptions and comments are recorded on these sheets.

National level estimates

When all provincial workbooks had been completed in the process described below, a national Workbook with one spreadsheet per province was developed, and results aggregated into a national total.

The Workbook method gives a robust point prevalence estimate of those currently living with HIV. It has the important advantage that all data points (estimates of population sizes and HIV prevalence rates for each risk population) are clearly visible—in other words, it is the most transparent of the available methods for estimating current HIV prevalence. The Workbook does not, however, give any information about the development of the epidemic over time, so alone it cannot be used to estimate cumulative infections since the start of the epidemic, deaths, or new infections.

In order to estimate the number of new infections and HIV related deaths occurring in 2005, a second method was used. The HIV Estimates and Projection Package (EPP) software developed by UNAIDS/WHO and the Spectrum model have been described elsewhere.^{3,4} Briefly, EPP builds up a national prevalence curve from a number of regional and/or sub-population specific prevalence curves. This curve is fed into the Spectrum package, which uses demographic data about the country, information about the natural history of HIV infection, and numbers on life prolonging treatment to calculate the annual number of new infections and deaths since the start of the epidemic.

In using EPP in China, provinces were divided into three groups, according to epidemic type, as follows:

- *Plasma donor provinces.* These are provinces where infections among former commercial plasma donors made up more than 20% of the total. This group comprised Henan, Hebei, Hubei, Anhui, Shanxi, Jilin.
- *Longer running, IDU driven epidemic provinces.* This group comprised Yunnan, Xinjiang, Sichuan, Guangxi, and Guangdong.
- *More recent epidemic provinces.* The remaining 20 provinces fell into this group.

The HIV EPP was used to generate epidemic curves for IDUs, MSM, female sex workers (FSW), and clients plus the remaining population in each of the three groups. In the first group, an additional curve was generated for former plasma donors. The inputs for these curves were, at a minimum, the point prevalence from the 2005 Workbook (average weighted by the size of the risk population in each province), the point prevalence from the 2003 Workbook (adjusted proportionately according to data from sites that were new in 2005), and a last known 0 value date. In addition, time series

Table 3 Estimated number infected by province

Estimated number infected	Provinces
>50 000	Yunnan, Guangxi, Henan, Xinjiang, Guangdong
10 000–49 999	Sichuan, Guizhou, Hunan, Chongqing, Zhejiang, Hubei, Anhui, Jiangsu
1000–9999	Beijing, Fujian, Jiangxi, Shanghai, Shandong, Hebei, Shanxi, Heilongjiang, Liaoning, Jilin, Shaanxi, Gansu, Hainan, Tianjin, Inner Mongolia
<1000	Ningxia, Qinghai, Tibet*

*Results for Tibet were estimated by Tibet CDC.

data were input for each of the national sentinel sites that existed before 2003.

The aggregate national adult prevalence curve generated by EPP was fed into Spectrum. Information on antiretroviral (ARV) treatment for 2003–05 and mortality among those taking ARV was added to the model to generate information on new infections, AIDS cases, and mortality.

RESULTS

The results of the 2005 estimation process are shown in table 2. Overall, between 540 000 and 760 000 people are estimated to be living with HIV in China. Around one in 10 of those infections occurred during unsafe blood collection practices in the mid 1990s. Close to half of the remainder are the result of needle sharing while injecting drugs.

The geographical distribution of estimated cases is very uneven, as table 3 shows. Infections among injecting drug users are concentrated largely in seven provinces (Yunnan, Xinjiang, Guangxi, Guangdong, Guizhou, Sichuan, and Hunan) while those among former plasma donors occur largely in five quite different provinces (Henan, Hubei, Anhui, Hebei, and Shanxi). Populations at risk exist throughout the country.

It was estimated that between 60 000 and 80 000 of the people now living with HIV in China (close to 11%) were newly infected in 2005. Between 20 000 and 30 000 people are estimated to have died of HIV related causes during the course of that year.

DISCUSSION

The most notable fact about the 2005 estimates is that they are lower than estimates made using the Workbook tool two years earlier, for 2003. The 2003 estimates, which gave a range of between 650 000 and 1.02 million infections, were widely recognised to be the best possible, given the methods and data available at the time. However the estimation process itself revealed areas of weakness in data availability, both in terms of estimating the size of risk populations and in accurately reflecting HIV prevalence levels within those populations. Specifically, data from a relatively small number of national sentinel sites, that were chosen in part because they captured high prevalence, were unlikely to reflect the range and diversity of the HIV epidemic in China. In addition, more local data were needed to improve estimates of the number of people at risk.

The principal difference between the 2003 and 2005 estimates is the greater availability of appropriate data in the most recent round. The national HIV surveillance system has expanded to 329 sites, compared with 194 in 2003. In addition, data from provincial sites were taken into account, which was not the case in 2003. In 2003 a single high and a single low estimate for HIV prevalence was applied to the risk population for an entire province. In 2005, estimates were made separately for each prefecture using locally specific data. Methods and data sources for estimating the size of

populations with high risk behaviours have also improved, so the denominators to which prevalence rates are applied are likely to be more appropriate. Together, these improvements mean that the 2005 estimates are likely to reflect far more accurately the diversity of the HIV epidemic in China.

Because the data points used in the 2003 estimates came from national surveillance sites selected to give early warning of rising HIV infection in the places thought to be at highest risk for epidemic, they tended to give rather high estimates of HIV infection. Applying those rates only to the local population and using data from other sites—many with lower prevalence—in other prefectures has had the effect of reducing overall estimates of HIV infection.

A further major reduction is the result of revised estimates of the number of former plasma donors living with HIV. In 2003, some 199 000 former plasma donors were living with HIV. In 2005, the estimate was 55 000. The difference is in part because this group, infected primarily between 1993 and 1995, is now reaching a stage of high mortality. It is estimated that there have been at least 10 000 deaths in this group in 2005 alone, despite the rapid growth of the China Cares treatment programme. More importantly, however, the mass screenings in the most affected provinces in 2005 suggest that outbreaks of HIV among plasma donors were more localised than had previously been thought. Prevalence levels measured in the worst affected areas do not represent a general pattern province-wide.

There has been some concern that these new estimates would be misunderstood as indicating that HIV is now under control in China. This is not the case. New infections continue to outstrip deaths, despite the high mortality currently associated with those who were infected while donating plasma in the mid 1990s. Many sentinel sites show marked increases in infection among groups with high risk behaviour. The expanding surveillance system indicates that the practice of injection drug use, until recently thought to be concentrated mostly in western and southwestern provinces, is becoming established in other regions as well. HIV can spread very quickly through injecting populations, so this represents an obvious threat for the further spread of HIV. In addition, the behavioural surveillance system shows that drug injectors are often sexually active, including buying and selling sex. High turnover of sex partners among IDUs, together with an active sex industry in general, carries the potential for the continued expansion of the HIV epidemic in China. In addition, the rapid expansion of treatment and care programmes will increase life expectancy for people living with HIV, thus increasing HIV prevalence.

The 2005 estimates emphasise once again the importance of linking effective prevention programmes that will reduce needle sharing and unprotected sex with multiple partners with an expanding system of care and support for those already infected in China.

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