



**ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE  
LIVING WITH HIV IN INDIA 2008-09**

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3 **ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA**  
4 **2008-09**  
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**Abstract:**

Objectives: To update the estimation of the adult HIV prevalence and number of people living with HIV in India for the year 2008/2009 with the combination of improved data and methods.

Design: Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived.

Setting: HIV Sentinel sites spread over all the States of India.

Participants: Secondary data from HIV Sentinel Surveillance sites which includes attendees of Antenatal Clinics and sites under targeted interventions of high risk groups, namely, female sex workers (FSW), intravenous drug users (IDU) and men having sex with men (MSM).

Primary and secondary outcome measures: Estimates of adult HIV prevalence and people living with HIV in India and its States.

Results: The adult HIV prevalence in India has been estimated as 0.31% in 2009 against 0.41% in 2000. Among the high prevalence states, the HIV prevalence has declined in Tamil Nadu to 0.33% in 2009 and other states show either a plateau or a slightly declining trend over the time period 2006 – 2009. There are states in the low prevalence states where the adult HIV prevalence has risen over the last four years. The estimated number of people living with HIV in India is 2.4 million (1.93 – 3.04 million) in 2009. Of which, 39 percent are women, children under 15 years of age account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of all infections.

Conclusion: The adult HIV prevalence in India has declined to of level 0.31 percent and estimated number of PLHIV 2.4 million in 2009. The estimated adult prevalence has declined in few states, a plateau or a slightly declining trend over the time. In future, efforts may be made to examine the implications of the emerging trend of the HIV prevalence on the recent infections in the study population.

**Article Focus** – Modelling exercise to estimate the adult prevalence and burden of HIV in India using the HIV Sentinel Surveillance data.

**Key Messages** –

- Estimates indicate a slow down trend in the epidemic with current adult HIV prevalence at 0.31% in 2009.
- In 2009, 2.39 million people were estimated to be living with HIV with uncertainty bounds 1.93-3.04 millions.
- Among PLHIV, 61% are male and 39% are female and by age the percent distribution of HIV infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49 years and rest 13% are over 50 years of age.

**Strengths and Limitations-** Epidemiological assumptions used in Modeling based on evidence on limited studies in other countries, not on Indian population.

## ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA 2008-09

### Background:

Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived every year since 1998. The process is consultative amongst the national and international experts in the field of biostatistics and epidemiology. Technical supports are received from UN organizations particularly experts from the WHO and UNAIDS. Efforts are made to improve data both in terms of quality and representativeness as well as the methodology matching to epidemics. For instance, in 2006 with the expansion of sentinel surveillance to all districts [1] and sero-survey as a part of third round of National Family Health Survey (NFHS-3) [2] many of the assumptions are replaced with evidence based information. The latter provided an opportunity to calibrate the surveillance data [3, 4] particularly the data from ANC attendees used in the estimation process as a proxy to general population. In addition, globally used method for similar epidemic, e.g. WHO/UNAIDS workbook [5] along with Spectrum software [6] was used in 2006 and 2007 rounds of estimation. The WHO/UNAIDS Workbook having assimilated the average prevalence for each risk group, namely, FSW, IDU, MSM and ANC fitted a logistic model to get the trend of the epidemic. The calibration factors derived in 2006 were used in the 2007 round of estimation in view of non-availability of community based survey data to calibrate every year [7]. Also, it forwarded a limitation of curve fitting over the average HIV prevalence in the population within the Workbook. The

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3 issue was deliberated in the UNAIDS Global Reference group on Estimates, Modelling  
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5 and Projections ([www.epidem.org](http://www.epidem.org)) and it was suggested to adopt the combination of  
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7 Estimation and Projection Package (EPP) and Spectrum [8]. The present paper aims to  
8  
9 update the HIV estimation with the above combination. Specifically, it describes the  
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11 data and methods used for the 2008 & 2009 HIV burden estimates for India and  
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13 compares the resulting estimates with those of earlier years.  
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## 20 **Method and Material**

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24 The Estimation Projection Package (EPP) [9] and Spectrum AEM modules [6] have been  
25  
26 used for the estimation of prevalence and burden of HIV.  
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31 The EPP estimates the trends over time of HIV prevalence by fitting an epidemiological  
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33 model to the surveillance data provided by HIV sentinel surveillance systems. The basic  
34  
35 principle underlying EPP is to develop epidemic curves separately for different sub-  
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37 populations and then combine to produce a single epidemic curve estimating HIV  
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39 prevalence at the national level. For adult HIV prevalence epidemic curve generated for  
40  
41 each sub-population group, initial guesses were made using four parameters, namely  $t_0$   
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43 (start year of the HIV epidemic),  $r$  (the force of infection),  $f_0$  (the initial fraction of the  
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45 adult population at risk of infection used to determine the peak level of the epidemic  
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47 curve,  $\phi$  (the behaviour adjustment parameter which determines how the proportion of  
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49 new entrants in the adult population who are at risk of HIV infections changes over  
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51 time). The 2009 version of has also included the provision of antiretroviral therapy,  
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3 which increases survival of people living with HIV, hence increasing prevalence and  
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5 impacting the process of fitting an epidemiological model to the HIV epidemic.  
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## 8 9 **Data**

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12 The data sets inputted to EPP includes firstly, the population size of higher risk groups,  
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14 i.e., FSW, MSM and IDU; Secondly, the population size of lower risk groups which was  
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16 the general population; thirdly, sentinel surveillance data from 1998 to 2009 on HIV  
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18 prevalence among higher risk group populations and antenatal care clinic attendees for  
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20 lower risk groups representing general population.  
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26 **The size of the higher risk and lower risk population:** The size estimates—as detailed  
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28 out in the NACP-III policy document—for FSW, MSM and IDU has been considered. They  
29  
30 are updated with the mapping exercise conducted in 2009 in certain states by NACO and  
31  
32 State AIDS Control Societies (SACs). In states where the mapping exercise was not  
33  
34 concluded, the higher risk group population was estimated as a proportion of people  
35  
36 with higher risk behaviour as reported under the NACP-III document [10]. The lower risk  
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38 group category is determined through a simple calculation of the total adult population  
39  
40 minus the population size of the higher risk groups. The population size for people aged  
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42 15–49 years in 2009 has been derived through Demproj in the Spectrum Package. The  
43  
44 data used in Demproj for calculating the population size included the Census population  
45  
46 data of 1981, 1991 and 2001 and the Expert Group Population Estimates and Projections  
47  
48 of India [11, 12, 13, 14]. The breakdown by sex for the IDU population assumes that 90%  
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50 of the IDU population is male and 10% is female [10, 15].  
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3 **Programme Coverage:** As antiretroviral therapy (ART) programme coverage influences  
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5 the trend of HIV prevalence, the current ART coverage is extrapolated for the years  
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7 beyond 2009—which is consistent with the NACP-III planned target of 500,000 by  
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9 2015—and distributed among all risk group based on last year proportions in respective  
10  
11 risk groups [16].  
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16 **Demographic input and epidemiological assumptions:** The demographic inputs to EPP  
17  
18 include the proportion of male population, adult birth rate (15+), survival to age 15 ( $l_{15}$ ),  
19  
20 adult mortality in 15+ ( $\mu$ ) and adult population growth rate. The data source for the  
21  
22 above mentioned demographic indicators included Sample Registration System 2002 to  
23  
24 2008 [17]. The following two primary epidemiological assumptions were considered: (1)  
25  
26 The criteria for reassigning higher risk groups to the general population category: Based  
27  
28 on the second round of Behaviour Surveillance Survey conducted in 2006 [15], it was  
29  
30 determined that IDU and MSM after a 15 year duration would be reassigned to the  
31  
32 general population category whereas for FSW the timeframe for being reassigned to the  
33  
34 general population was reduced to 8 years and (2) AIDS mortality: AIDS mortality was  
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36 assumed to be higher by as much as 7% for injecting drug users vis-à-vis non- injecting  
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38 drug users.  
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48 **Defining the characteristics of the Epidemic** - The HIV epidemic in India, at national  
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50 level, is concentrated amongst female sex workers (FSW), men who have sex with men  
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52 (MSM) and injecting drug users (IDU). Amongst the 34 Indian States/Union Territories—  
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54 the epidemic is defined as a concentrated non-IDU epidemic for all the states with the  
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3 exception of Manipur and Nagaland where the epidemic is defined as a concentrated  
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5 IDU epidemic.  
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9 **Generating State-specific prevalence curves:** The States/Union Territory specific  
10 epidemic, for which first time States/Union Territory specific prevalence curves was  
11 generated under the 2008/2009 HIV estimates. Using the Bayesian melding approach,  
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13 1000 iterations were used for fitting the initial guesses for ANC sites and 3000 iterations  
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15 for higher risk group sites. The best fitting curves for all sub-population categories were  
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17 subsequently combined for producing state prevalence curves.  
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26 **Calibrating ANC prevalence curves in EPP Model:** Estimates of HIV prevalence is  
27 primarily based on times series prevalence data amongst ANC attendees. Due to the  
28 difference in sero-prevalence between the ANC attendees and those from population  
29 based surveys, the calibration of the prevalence curves based on the former is required.  
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31 The key source of information used for calibrating HIV prevalence curves has the 2006  
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33 National Family Health Survey (NFHS-3) [2] where state-specific information on HIV  
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35 prevalence is determined.  
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45 In EPP, when a calibration factor is used, the overall curve determined on the basis of  
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47 ANC HSS trend data which is scaled according to the calibration constant. Differences in  
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49 the prevalence level are modelled on the probit scale. The probit scale is chosen in such  
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51 a way that the differences between prevalence levels do not depend on the level itself.  
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55 The calibration factor was derived for individual states in five high prevalence states,  
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57 i.e., Andhra Pradesh, Karnataka, Maharashtra, Manipur and Tamil Nadu, based on  
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3 calculations from NFHS-3 while for Nagaland the calibration factor was determined from  
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5 a specific study undertaken by NACO [19]. For the remainder of the moderate and low  
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7 prevalence states, the common constant calibration factor was derived from the NFHS-3  
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9 on the basis of the rest of the (excluding aforesaid 6 high prevalence states) national  
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11 comparison between general population prevalence and ANC prevalence.  
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### 14 15 16 **Estimation of PLHIV for all age groups using Spectrum** 17

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20 Spectrum under its AIDS Impact Model (AIM) requires a number of inputs and parameters to  
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22 process estimates and projections of HIV related parameters that will allow fitting of the trend of  
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24 epidemic as initially determined in EPP. The first input into Spectrum is the projection of HIV  
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26 incidence determined in EPP. It is combined with the population projection and the other  
27  
28 programme coverage indicators and parameters to determine the indicators related to the impact  
29  
30 of the epidemic. The parameters included into Spectrum include the ART, PPTCT programme  
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32 coverage data, age and sex distribution of prevalence. For each of the 34 States/Union  
33  
34 Territories, adult and children ART treatment coverage—from 2004 to 2009 and the projected  
35  
36 coverage till 2015—along with duration of breastfeeding were used in AIM. An estimated  
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38 300,000 adults and 17,000 children utilized ART as on December 2009. Approximately 13,000  
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40 mothers had utilized PPTCT in India as by December 2009. Assumptions over other state-specific  
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42 HIV characteristics included age and sex distribution of new infections, proportion of those  
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44 newly infected, progressing need for treatment by time since infection, proportion of adults in  
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46 need of treatment, proportion of adults dying due to AIDS related causes without treatment by  
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48 time in need, annual mortality among children in need of treatment but not receiving treatment  
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50 by age, annual survival of adults and children on ART, probability of transmission of HIV from  
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mother-to-child etc. After finalizing the input of all these parameters, Spectrum re-processed the estimation and projection of the HIV epidemic.

**Uncertainty Analysis:** The point estimates are associated with uncertainty due to the prevalence/incidence curve produced by EPP and the input assumptions that are based on studies from population samples in selected countries. For addressing this associated uncertainty, a special programme in Spectrum [18] was used for producing uncertainty bounds around the usual point estimates for each indicator and for each year. A logistic curve is fitted to the resulting points, i.e., the 1000 different logistic curve generated is fitted for the prevalence data by varying the data before each fit with the ranges indicated next to the quality categories.

## Results and discussion

**National / States/Union Territory estimates of HIV Adult Prevalence:** While the adult HIV prevalence for each state and Union Territory was directly projected through EPP and Spectrum, the national adult HIV prevalence is determined through application of the simple aggregation number of PLHIV from all states divided by the total adult population and calculated as a multiple of hundred to determined a percentage.

The adult HIV prevalence (males and females together) in India in 2008 is estimated as 0.32% with uncertainty bounds 0.26%–0.41%, and 31% in 2009 with uncertainty bounds 0.25%–0.39%; the decline in HIV prevalence is by 0.02% during the previous two years.

The adult HIV prevalence was estimated at 0.25% for women and 0.36% for men in 2009. It was estimated at 0.26% for women and 0.38% for men in 2008 (Table 1). The results of 2008/2009 round of HIV estimates—in terms of trend and levels—are derived

from a methodology that allows for readjustment of the prevalence curves on the basis of additional HSS data. Accordingly, the estimated HIV prevalence came out 0.36% for the year 2006 and 0.34% for the year 2007. As these are exactly the same value derived under the 2006 and 2007 round of HIV estimates, the consistency in results are indicative that the process adopted by the Working Group on Estimates and the results derived therein are valid and a sound base for analysis (Figure 1).

<b>Table 1 : Adult HIV prevalence by sex and number of HIV infections for all ages with uncertainty bounds for the years 2008 and 2009, India</b>		
	<b>2008</b>	<b>2009</b>
<b>Adult 15-49 HIV prevalence</b>		
<b>Persons</b>	<b>0.32% (0.26 – 0.41)</b>	<b>0.31% (0.25 - 0.39)</b>
<b>Female</b>	<b>0.26%</b>	<b>0.25%</b>
<b>Male</b>	<b>0.38%</b>	<b>0.36%</b>
<b>Number of HIV infections (All ages)</b>		
<b>Persons (in Lakh)</b>	<b>24.42 (19.74 – 30.89)</b>	<b>23.95 (19.34 – 30.42)</b>
<b>Percent distribution of HIV infection by sex</b>		
<b>Female</b>	<b>38.5%</b>	<b>38.7%</b>
<b>Male</b>	<b>61.5%</b>	<b>61.3%</b>
<b>Percent distribution of HIV infections by age group</b>		
<b>&lt; 15</b>	<b>4.2%</b>	<b>4.4%</b>
<b>15-49</b>	<b>83.3%</b>	<b>82.4%</b>
<b>50+</b>	<b>12.5%</b>	<b>13.2%</b>

**State-wise HIV Adult Prevalence:** States/Union Territory wise estimates of adult HIV prevalence were the basis for estimating national adult HIV prevalence as detailed in earlier sections of the report. Over and above this process, an uncertainty analysis was conducted independently for each state in Spectrum. The state level data on adult HIV prevalence is provided in Map 1 and an analysis of central emerging trends is recapitulated therein.

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3 The adult HIV prevalence trend line in the six high epidemic states (see technical report),  
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5 i.e., Andhra Pradesh, Karnataka, Maharashtra, Manipur, Nagaland and Tamil Nadu, and  
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7 Mizoram. Mizoram is added to this group on the basis of the actual estimation derived  
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9 from the Spectrum. As reflective from the graph, HIV prevalence is on the decline in all  
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11 states over the four year period of 2006 to 2009; although the degree in decline varies  
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13 slightly. For instance, the HIV prevalence trend in Karnataka, Mizoram and Nagaland  
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15 appears more stable (Figure 2). As evident, in all three moderate prevalence states- Goa,  
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17 Gujarat and Pondicherry, adult HIV prevalence trends is declining from 2006 to 2009.  
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24 Regarding the low prevalence States/Union Territories, figure 2 highlights those where  
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26 the trend for HIV prevalence is stable to increasing between 2006 and 2009. These  
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28 include the seven States/Union Territories of Arunachal Pradesh, Assam, Chandigarh,  
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30 Jharkhand, Kerala, Meghalaya and Orissa.  
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36 The relatively greater increase in HIV prevalence is noted in Assam, Jharkhand and  
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38 Orissa vis-à-vis Arunachal Pradesh, Kerala and Meghalaya. The estimated HIV prevalence  
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40 for Chandigarh—as reflected in figure-2—is not considered a true reflection of the  
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42 nature of the epidemic in the Union Territory. Whilst noting the increase in the  
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44 estimated HIV prevalence, it must be considered that the trend is attributable to the  
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46 services Chandigarh provides to PLHIV from the neighbouring states of Punjab, Haryana  
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48 and even Himachal Pradesh. As ART information is included as one of the parameters for  
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50 the projection, the resulted trend is showing an increase, independent of the trend  
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3 observed in HSS. A separate analysis of the HIV epidemic in Chandigarh is thus required  
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5 to take into consideration the evidence and the trends of neighbouring states.  
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10 Figure-2 highlights the low prevalence states of Delhi, Haryana, Punjab, Rajasthan, Uttar  
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12 Pradesh, and West Bengal where HIV prevalence is either stable or declining. Evidently,  
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14 the degree for decline in HIV prevalence is not uniform between these states which may  
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16 be on account of the programmatic impact of ART coverage, and the strength of the  
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18 prevention interventions etc. The decline in HIV prevalence is lower in Haryana and  
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20 Punjab vis-à-vis Delhi, Rajasthan, Uttar Pradesh, and West Bengal.  
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### 28 **National and State estimates of number of people living with HIV**

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30 In 2009, the total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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32 (uncertainty bounds of 1.93 – 3.04 million) while in 2008; it was 2.44 million people were living  
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34 with HIV within the uncertainty bounds of 1.97-3.09 millions. Among PLHIV, by sex  
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36 approximately 61% are male and 39% are female and by age the percent distribution of HIV  
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38 infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49  
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40 years and rest 13% are over 50 years of age (Table 1).  
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45 The four high prevalence states of South India account for 57% of all HIV infections in  
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47 the country. Whilst Andhra Pradesh accounts for 500,000 cases; Maharashtra accounts  
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49 for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for  
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51 150,000 cases. Over 100,000 PLHIVs are reported in West Bengal, Gujarat, Bihar and  
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53 Uttar Pradesh and together these states account for 22% of HIV infections in India. The  
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55 number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000  
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3 to 100,000 and these states collectively account for 12% of HIV infections. Thus whilst  
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5 the states noted above are with low HIV prevalence; a large number of PLHIVs are  
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7 reported due to the states' overall large population size (Map 1).  
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11 The percent distribution of HIV burden amongst high prevalence states vis-à-vis the  
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13 remaining states in India is 57% and 43% respectively. Amongst the high prevalence  
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15 states, Andhra Pradesh accounts for the greatest proportion of cases at 21% vis-à-vis the  
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17 other states. Following Andhra Pradesh, Maharashtra accounts for approximately 18%  
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19 of HIV infection, Karnataka and Tamil Nadu reportedly account for 10% and 7% of all  
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21 cases whereas Manipur and Nagaland account for 1% of the estimated total.  
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### 29 **Conclusions**

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31 The India HIV estimates 2008/2009 confirms a slow down in the AIDS epidemic. National  
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33 adult HIV prevalence, or the number of adults living with HIV as a proportion of the total  
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35 population, has declined by 0.10% points from 0.41% in 2000 to 0.31% in 2009. Adult  
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37 HIV prevalence is either stable or declining in the high prevalence states whereas the  
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39 trend is varying across the low to moderate prevalence states. Among the high  
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41 prevalence states, the HIV prevalence has declined in Tamil Nadu between 2006 and  
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43 2009 to reach levels of 0.37% in 2008 and 0.33% in 2009. Manipur shows a declining  
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45 trend over the past four years. Andhra Pradesh, Karnataka, Maharashtra and Nagaland  
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47 show either a plateau or a slightly declining trend over the time period 2006 – 2009.  
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53 In the low prevalence states of Chandigarh, Orissa, Kerala, Jharkhand, Uttarakhand,  
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55 Jammu and Kashmir, Arunachal Pradesh and Meghalaya; adult HIV prevalence has risen  
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3 over the last four years which warrants the need for strengthening the trend of the HIV  
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5 epidemic.

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8 In descending order, states with the highest adult HIV prevalence in 2009 included  
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10 Manipur (1.4%); followed by Andhra Pradesh (0.90%), Mizoram (0.81%), Nagaland  
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12 (0.78%), Karnataka (0.63%) and Maharashtra (0.55%). Besides these, the states of Goa,  
13  
14 Chandigarh, Gujarat, Punjab and Tamil Nadu have an estimated adult HIV prevalence  
15  
16 greater than national prevalence (0.31%). Delhi, Orissa, West Bengal, Chhattisgarh and  
17  
18 Pondicherry have an estimated adult HIV prevalence of 0.28-0.30%. Other states have  
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20 lower levels of HIV.  
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28 The total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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30 (uncertainty bounds of 1.93 – 3.04 million) in 2009. Children under 15 years of age  
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32 account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of  
33  
34 all infections. Thirty-nine percent of all HIV infections are estimated to be among  
35  
36 women. This amounts to 0.93 million women with HIV in India.  
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### Contributorship

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AP contributed to conception, analysis and drafting of article. DS contributed to data analysis, interpretation and draft of the article. TB contributed to the implementation of the models, analysis and interpretation of data. DCSR contributed to the design, analysis and interpretation of data. SK contributed to the interpretation of data. MB contributed to the design, acquisition and analysis of data. YR contributed to the planning, acquisition and analysis of data. PH contributed to the analysis and interpretation of data. Deepak Bharadwaj contributed to the data analysis. NC contributed interpretation. All the authors read and approved the final manuscript.

### Data Sharing

49  
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We have used all published data.

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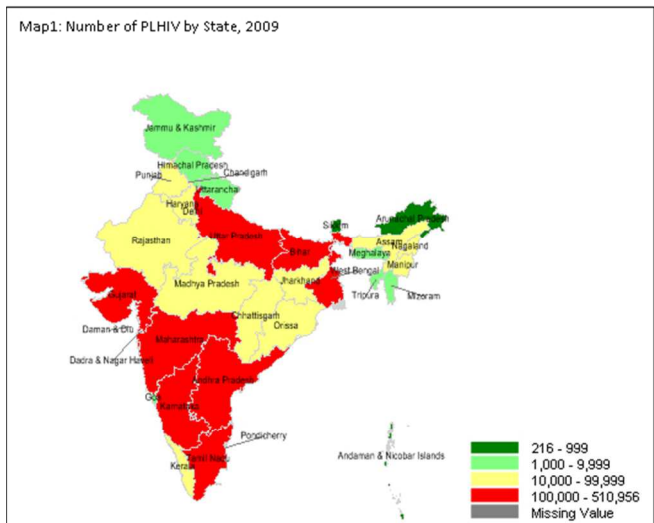
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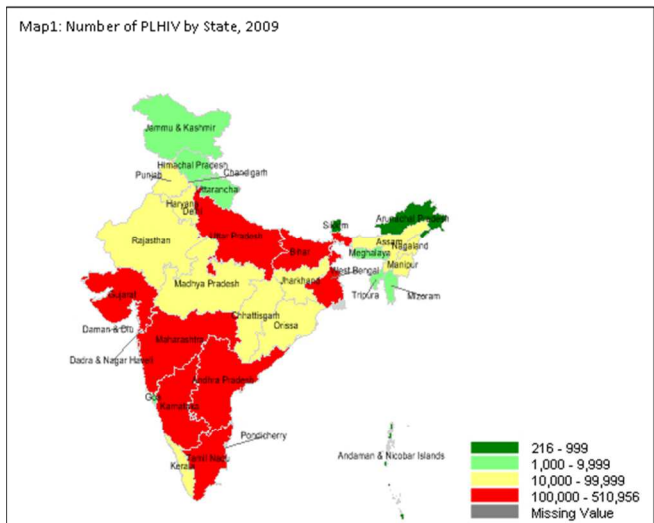
The authors declare that they have no competing interests.

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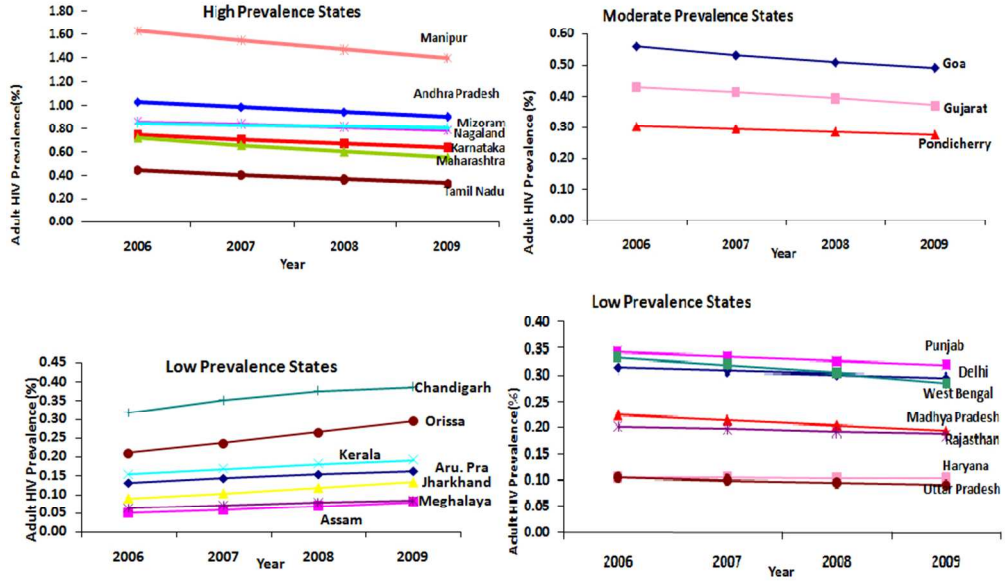
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Figure 2: Adult HIV Prevalence Trends from 2006 to 2009, India States



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**ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE  
LIVING WITH HIV IN INDIA 2008-09**

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## ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA 2008-09

### Background:

Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived every year since 1998. The process is consultative amongst the national and international experts in the field of biostatistics and epidemiology. Technical supports are received from UN organizations particularly experts from the WHO and UNAIDS. Efforts are made to improve data both in terms of quality and representativeness as well as the methodology matching to epidemics. For instance, in 2006 with the expansion of sentinel surveillance to all districts [1], sero-survey as a part of third round of National Family Health Survey (NFHS-3) [2] and the observation that there is a common practice of referral of HIV-positive/suspected cases to public hospitals and a preferential use of public hospitals by people in the lower socio-economic strata causing overestimation of the HIV burden in India [3, 4], many of the assumptions are replaced with evidence based information.

In fact, the NFHS-3 provided an opportunity to calibrate the surveillance data [5, 6] particularly the data from ANC attendees used in the estimation process as a proxy to general population. In addition, globally used method for similar epidemic, e.g. WHO/UNAIDS workbook [7] along with Spectrum software [8] was used in 2006 and 2007 rounds of estimation. The WHO/UNAIDS Workbook having assimilated the average prevalence for each risk group, namely, FSW, IDU, MSM and ANC fitted a logistic model to get the trend of the epidemic. The calibration factors derived in 2006 were used in the 2007 round of estimation in view of non-availability of community based survey data to calibrate every year [9]. Also, it forwarded a limitation of curve

1  
2 fitting over the average HIV prevalence in the population within the Workbook. The  
3  
4 issue was deliberated in the UNAIDS Global Reference group on Estimates, Modelling  
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6 and Projections and it was suggested to adopt the combination of Estimation and  
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8 Projection Package (EPP) and Spectrum [10]. The present paper aims to update the HIV  
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10 estimation with the above combination. Specifically, it describes the data and methods  
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12 used for the 2008 & 2009 HIV burden estimates for India and compares the resulting  
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14 estimates with those of earlier years.  
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## 21 **Method and Material**

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25 The Estimation Projection Package (EPP) [11] and Spectrum DemProj and AIM modules  
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27 [8] was used for the estimating prevalence and burden of HIV.  
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## 31 **Data**

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34 The Working Group reviewed and used four sets of data available from various sources  
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36 for the estimation process.  
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41 **Surveillance:** The following surveillance data available from 1998 to 2009 was used in  
42  
43 EPP for producing state and national curves. These represent HIV prevalence data from  
44  
45 HIV sentinel surveillance that was conducted amongst pregnant women attending  
46  
47 antenatal clinics and the key population groups of Female Sex Workers (FSW), Men  
48  
49 having Sex with Men (MSM) and Injecting Drug Users (IDUs). Through the scale up in  
50  
51 number of HIV Sentinel Surveillance (HSS) sites and increased focus on key population  
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53 sites, a wider geographical and population group coverage was achieved leading to more  
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accurate results. The following table reflects the scale up in numbers of surveillance sites per year for the populations groups that are used in the HIV estimates process.

Site Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2009
ANC	92	93	111	172	200	476	390	391	636	654	668
IDU	5	6	10	10	13	18	24	30	51	52	61
MSM	-	-	3	3	3	9	15	18	31	40	67
FSW	1	1	2	2	2	32	42	83	138	137	194
Total	98	100	126	187	218	535	471	522	856	883	990

Also, the working group used the estimated prevalence from the National Family and Health Survey (NFHS) conducted throughout the country with state level representation in the high prevalence states. The adult HIV prevalence from the NFHS-3 was used for calibration of the fitted curves.

**Population sizes (the size of the higher risk and lower risk population):** Secondly, for determining specific demographic parameters of key population groups, the size estimates for FSW, MSM and IDU provided under the NACP III document [12] was considered. This was updated with data from the 2009 mapping exercise conducted among key population in 2009 in specific states by NACO and State AIDS Control Societies (SACs). In states where the mapping exercise was not concluded, the higher risk group population was estimated as a proportion of people with higher risk behaviour as reported under the NACP-III document [13].

In addition, data inputs used for determining the size of the general population at lower risk for HIV were number of births, number of deaths, adult population growth rate and population size for people aged over 15 years across and in 34 states/Union Territories from the vital registration system [14]. National population estimates were obtained from



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2  
3 population projection for India and states from the period 2001 to 2026. The size of the  
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5 general population at lower risk for HIV were calculated as the total adult population  
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7 minus the population size of the higher risk groups. The population size for people aged  
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9 15–49 years in 2009 has been derived through Demproj in the Spectrum Package. The  
10  
11 data used in Demproj for calculating the population size included the Census population  
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13 data of 1981, 1991 and 2001 and the Expert Group Population Estimates and Projections  
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15 of India [15, 16, 17, 18]. The breakdown by sex for the IDU population assumes that 90%  
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17 of the IDU population is male and 10% is female [12, 19].  
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25 **Programme Coverage:** As antiretroviral therapy (ART) programme coverage influences  
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27 the trend of HIV prevalence, the current ART coverage is extrapolated for the years  
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29 beyond 2009—which is consistent with the NACP-III planned target of 500,000 by  
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31 2015—and distributed among all risk group based on last year proportions in respective  
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33 risk groups [20].  
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38 **Methods:**  
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42 The EPP estimates the trends over time of HIV prevalence by fitting an epidemiological  
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44 model to the surveillance data provided by HIV sentinel surveillance systems. The basic  
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46 principle underlying EPP is to develop epidemic curves separately for different sub-  
47  
48 populations and then combine to produce a single epidemic curve estimating HIV  
49  
50 prevalence at the national level. For adult HIV prevalence epidemic curve generated for  
51  
52 each sub-population group, initial guesses were made using four parameters, namely  $t_0$   
53  
54 (start year of the HIV epidemic),  $r$  (the force of infection),  $f_0$  (the initial fraction of the  
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56 adult population at risk of infection used to determine the peak level of the epidemic  
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3 curve,  $\phi$  (the behaviour adjustment parameter which determines how the proportion of  
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5 new entrants in the adult population who are at risk of HIV infections changes over time).  
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7 The 2009 version of has also included the provision of antiretroviral therapy, which  
8  
9 increases survival of people living with HIV, hence increasing prevalence and impacting  
10  
11 the process of fitting an epidemiological model to the HIV epidemic. Data from the  
12  
13 above sources were entered to EPP to produce curves of adult HIV prevalence among  
14  
15 different population groups including antenatal clinic attendees — as proxy for general  
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17 population — and key population groups.  
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23 The following two primary epidemiological assumptions were considered whilst  
24  
25 analyzing data under the 2009 version of EPP: (1) a specific criterion was considered for  
26  
27 reassigning higher risk groups to the general population category. Based on the second  
28  
29 round of Behaviour Surveillance Survey conducted in 2006 [19], it was determined that  
30  
31 IDU and MSM after a 15 year duration would be reassigned to the general population  
32  
33 category whereas for FSW the timeframe for being reassigned to the general population  
34  
35 was reduced to 8 years and (2) AIDS mortality was assumed to be higher by as much as  
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37 7% for injecting drug users vis-à-vis non- injecting drug users.  
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43 **Defining the characteristics of the Epidemic** - The HIV epidemic in India, at national  
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45 level, is concentrated amongst female sex workers (FSW), men who have sex with men  
46  
47 (MSM) and injecting drug users (IDU). Amongst the 34 Indian States/Union  
48  
49 Territories—the epidemic is defined as a concentrated non-IDU epidemic for all the  
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51 states with the exception of Manipur and Nagaland where the epidemic is defined as a  
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53 concentrated IDU epidemic.  
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3 **Generating State-specific prevalence curves:** The States/Union Territory specific  
4 epidemic, for which first time States/Union Territory specific prevalence curves was  
5 generated under the 2008/2009 HIV estimates. Using the Bayesian melding approach,  
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7 1000 iterations were used for fitting the initial guesses for ANC sites and 3000 iterations  
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9 for higher risk group sites. The best fitting curves for all sub-population categories were  
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11 subsequently combined for producing state prevalence curves.  
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19 **Calibrating ANC prevalence curves in EPP Model:** Estimates of HIV prevalence is  
20 primarily based on times series prevalence data amongst ANC attendees in HSS. Due to the  
21 difference in sero-prevalence between the ANC attendees and those from population based  
22 surveys, the calibration of the prevalence curves based on the former is required. The key  
23 source of information used for calibrating HIV prevalence curves has the 2006 National  
24 Family Health Survey (NFHS-3) [2] where state-specific information on HIV prevalence is  
25 determined. The curve for antenatal clinic attendees was calibrated from National Family  
26 Health Survey (NFHS-3) 2005-06 for general population. In order to have an appropriate  
27 calibration of the HIV prevalence trends determined in spectrum, the point values of  
28 prevalence determined from the NFHS-3 in 2006 as a reference for calibrating the  
29 prevalence trend for general population, initially determined through ANC.  
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46 In EPP, when a calibration factor is used, the overall curve determined on the basis of  
47 ANC HSS trend data which is scaled according to the calibration constant. Differences in  
48 the prevalence level are modeled on the probit scale. The probit scale is chosen in such a  
49 way that the differences between prevalence levels do not depend on the level itself. The  
50 calibration factor was derived for individual states in five high prevalence states, i.e.,  
51 Andhra Pradesh, Karnataka, Maharashtra, Manipur and Tamil Nadu, based on  
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3 calculations from NFHS-3 while for Nagaland the calibration factor was determined from  
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5 a specific study undertaken by NACO [21]. For the remainder of the moderate and low  
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7 prevalence states, the common constant calibration factor of 0.69 was derived from the  
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9 NFHS-3 on the basis of the rest of the states (excluding aforesaid 6 high prevalence  
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11 states) national comparison between general population prevalence and ANC prevalence.  
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15 **Estimation of PLHIV for all age groups using Spectrum** In order to estimate the  
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17 number of people living with HIV and HIV prevalence for all ages, the projected adult  
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19 HIV prevalence for each state was fed into Spectrum along with programme data on  
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21 Antiretroviral (ART) programme coverage, percent of mothers and children given  
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23 nevirapine prophylaxis and certain demographic and epidemiological parameters.  
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27  
28 Spectrum under its AIDS Impact Model (AIM) requires a number of inputs and parameters to  
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30 process estimates and projections of HIV related parameters that will allow fitting of the trend of  
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32 epidemic as initially determined in EPP. The first input into Spectrum is the projection of HIV  
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34 incidence determined in EPP. It is combined with the population projection and the other  
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36 programme coverage indicators and parameters to determine the indicators related to the impact of  
37  
38 the epidemic. The parameters included into Spectrum include the ART, PPTCT programme  
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40 coverage data, age and sex distribution of prevalence. For each of the 34 States/Union Territories,  
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42 adult and children ART treatment coverage—from 2004 to 2009 and the projected coverage till  
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44 2015—along with duration of breastfeeding were used in AIM. An estimated 300,000 adults and  
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46 17,000 children utilized ART as on December 2009. Approximately 13,000 mothers had utilized  
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48 PPTCT in India as by December 2009. Assumptions over other state-specific HIV characteristics  
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50 included age and sex distribution of new infections, proportion of those newly infected,  
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52 progressing need for treatment by time since infection, proportion of adults in need of treatment,  
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54 proportion of adults dying due to AIDS related causes without treatment by time in need, annual  
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2 mortality among children in need of treatment but not receiving treatment by age, annual survival  
3 of adults and children on ART, probability of transmission of HIV from mother-to-child etc.  
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5 After finalizing the input of all these parameters, Spectrum re-processed the estimation and  
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7 projection of the HIV epidemic.  
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13 **Uncertainty Analysis:** The point estimates are associated with uncertainty due to the  
14 prevalence/incidence curve produced by EPP and the input assumptions that are based on studies  
15 from population samples in selected countries. For addressing this associated uncertainty, a  
16 special programme in Spectrum [22] was used for producing uncertainty bounds around the usual  
17 point estimates for each indicator and for each year. A logistic curve is fitted to the resulting  
18 points, i.e., the 1000 different logistic curve generated is fitted for the prevalence data by varying  
19 the data before each fit with the ranges indicated next to the quality categories.  
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## 28 **Results and discussion**

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31 The tools used for generating HIV estimates and the data used as mentioned above allows  
32 for production of estimated HIV prevalence and incidence trends from the beginning of  
33 the epidemic to the current year and projection for the future.  
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38 **National / States/Union Territory estimates of HIV Adult Prevalence:** While the adult  
39 HIV prevalence for each state and Union Territory was directly projected through EPP  
40 and Spectrum, the national adult HIV prevalence is determined through application of the  
41 simple aggregation number of PLHIV from all states divided by the total adult population  
42 and calculated as a multiple of hundred to determined a percentage.  
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51 The adult HIV prevalence (males and females together) in India in 2008 is estimated as  
52 0.32% with uncertainty bounds 0.26%–0.41%, and 0.31% in 2009 with uncertainty  
53 bounds 0.25%–0.39. The adult HIV prevalence was estimated at 0.25% for women and  
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(Table 2). The results of 2008/2009 round of HIV estimates—in terms of trend and levels—are derived from a methodology that allows for readjustment of the prevalence curves on the basis of additional HSS data. Accordingly, the estimated HIV prevalence came out 0.36% for the year 2006 and 0.34% for the year 2007. As these are exactly the same value derived under the 2006 and 2007 round of HIV estimates, the consistency in results are indicative that the process adopted by the Working Group on Estimates and the results derived therein are valid and a sound base for analysis (Figure 1).

Table 2 : Adult HIV prevalence by sex and number of HIV infections for all ages with uncertainty bounds for the years 2008 and 2009, India		
	2008	2009
Adult 15-49 HIV prevalence		
Persons	0.32% (0.26 – 0.41)	0.31% (0.25 - 0.39)
Female	0.26%	0.25%
Male	0.38%	0.36%
Number of HIV infections (All ages)		
Persons (in Lakh)	24.42 (19.74 – 30.89)	23.95 (19.34 – 30.42)
Percent distribution of HIV infection by sex		
Female	38.5%	38.7%
Male	61.5%	61.3%
Percent distribution of HIV infections by age group		
< 15	4.2%	4.4%
15-49	83.3%	82.4%
50+	12.5%	13.2%

**State-wise HIV Adult Prevalence:** States/Union Territory wise estimates of adult HIV prevalence were the basis for estimating national adult HIV prevalence as detailed in earlier sections of the report. Over and above this process, an uncertainty analysis was conducted independently for each state in Spectrum. The state level estimates on adult HIV prevalence is provided in Map 1 and an analysis of central emerging trends is recapitulated therein.

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3 As reflective from Figure 2, the HIV prevalence is on the decline in all states over the  
4 past four year period of 2006 to 2009; although the degree in decline varies slightly. For  
5 instance, the HIV prevalence trend appears stable in six high prevalence states, i.e.,  
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7 Andhra Pradesh, Karnataka, Maharashtra, Manipur, Nagaland and Tamil Nadu and  
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9 Mizoram (which is added to this group on the basis of consistently reporting HIV  
10 prevalence among ANC clinic attendees >1% in past four years in HSS). Further, , in all  
11  
12 three moderate prevalence states- Goa, Gujarat and Pondicherry, adult HIV prevalence  
13 trends is declining from 2006 to 2009.  
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22 Regarding the low prevalence States/Union Territories, figure 2 highlights those where  
23 the trend for HIV prevalence is stable to increasing between 2006 and 2009. These  
24 include the seven States/Union Territories of Arunachal Pradesh, Assam, Chandigarh,  
25  
26 Jharkhand, Kerala, Meghalaya and Orissa.  
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34 The relatively greater increase in HIV prevalence is noted in Assam, Jharkhand and  
35 Orissa vis-à-vis Arunachal Pradesh, Kerala and Meghalaya. The estimated HIV  
36 prevalence for Chandigarh—as reflected in figure-2—is not considered a true reflection  
37 of the nature of the epidemic in the Union Territory. Whilst noting the increase in the  
38 estimated HIV prevalence, it must be considered that the trend is attributable to the  
39 services Chandigarh provides to PLHIV from the neighbouring states of Punjab, Haryana  
40 and even Himachal Pradesh. As ART information is included as one of the parameters for  
41 the projection, the resulted trend is showing an increase, independent of the trend  
42 observed in HSS. A separate analysis of the HIV epidemic in Chandigarh is thus required  
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60 to take into consideration the evidence and the trends of neighbouring states.

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Figure-2 highlights the low prevalence states of Delhi, Haryana, Punjab, Rajasthan, Uttar Pradesh, and West Bengal where HIV prevalence is either stable or declining. Evidently, the degree for decline in HIV prevalence is not uniform between these states which may be on account of the programmatic impact of ART coverage, and the strength of the prevention interventions etc. The decline in HIV prevalence is lower in Haryana and Punjab vis-à-vis Delhi, Rajasthan, Uttar Pradesh, and West Bengal.

### **National and State estimates of number of people living with HIV**

In 2009, the total number of people living with HIV (PLHIV) in India is estimated at 2.4 million (uncertainty bounds of 1.93 – 3.04 million) while in 2008; it was 2.44 million people were living with HIV within the uncertainty bounds of 1.97-3.09 millions. Among PLHIV, by sex approximately 61% are male and 39% are female and by age the percent distribution of HIV infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49 years and rest 13% are over 50 years of age (Table 1).

The four high prevalence states of South India account for 57% of all HIV infections in the country. Whilst Andhra Pradesh accounts for 500,000 cases; Maharashtra accounts for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for 150,000 cases. Over 100,000 PLHIVs are reported in West Bengal, Gujarat, Bihar and Uttar Pradesh and together these states account for 22% of HIV infections in India. The number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000 to 100,000 and these states collectively account for 12% of HIV infections. Thus whilst the states noted above are with low HIV prevalence; a large number of PLHIVs are reported due to the states' overall large population size (Map 1).



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3 The percent distribution of HIV burden amongst high prevalence states vis-à-vis the  
4 remaining states in India is 57% and 43% respectively. Amongst the high prevalence  
5 states, Andhra Pradesh accounts for the greatest proportion of cases at 21% vis-à-vis the  
6 other states. Following Andhra Pradesh, Maharashtra accounts for approximately 18% of  
7 HIV infection, Karnataka and Tamil Nadu reportedly account for 10% and 7% of all  
8 cases whereas Manipur and Nagaland account for 1% of the estimated total.  
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### 19 **Conclusions**

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21 The India HIV estimates 2008/2009 indicate a slowdown in the AIDS epidemic. National  
22 adult HIV prevalence, or the number of adults living with HIV as a proportion of the total  
23 population, has declined by 0.05% points from 0.36% (0.29% - 0.45%) in 2006 to 0.31%  
24 (0.25% - 0.39%) in 2009. The results of 2008-09 round of estimates match perfectly with  
25 previously announced estimates. The estimation of 2008-09 has utilized EPP against  
26 UNAIDS/WHO workbook in 2006. . Results from the 2008/09 estimate replace the  
27 previously announced numbers; however, they should not be directly compared with the  
28 previous years. This is because the method of estimation and projection took in  
29 consideration old data and additional new information generated from new rounds of  
30 surveillance. The assumptions, methodologies and data used to produce the estimates  
31 have gradually changed as a result of ongoing enhancement of knowledge on the  
32 epidemic. Hence a comparison between the latest estimates with those published in  
33 previous years may yield misleading conclusions.  
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54 Adult HIV prevalence is either stable or declining in the high prevalence states whereas  
55 the trend is varying across the low to moderate prevalence states. Among the high  
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2 prevalence states, the HIV prevalence has declined in Tamil Nadu between 2006 and  
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4 2009 to reach levels of 0.37% in 2008 and 0.33% in 2009. Manipur shows a declining  
5  
6 trend over the past four years. Andhra Pradesh, Karnataka, Maharashtra and Nagaland  
7  
8 show either a plateau or a slightly declining trend over the time period 2006 – 2009.  
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11 In the low prevalence states of Chandigarh, Orissa, Kerala, Jharkhand, Uttarakhand,  
12  
13 Jammu and Kashmir, Arunachal Pradesh and Meghalaya; adult HIV prevalence has risen  
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15 over the last four years which warrants the need for strengthening the trend of the HIV  
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17 epidemic.  
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21 In descending order, states with the highest adult HIV prevalence in 2009 included  
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23 Manipur (1.4%); followed by Andhra Pradesh (0.90%), Mizoram (0.81%), Nagaland  
24  
25 (0.78%), Karnataka (0.63%) and Maharashtra (0.55%). Besides these, the states of Goa,  
26  
27 Chandigarh, Gujarat, Punjab and Tamil Nadu have an estimated adult HIV prevalence  
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29 greater than national prevalence (0.31%). Delhi, Orissa, West Bengal, Chhattisgarh and  
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31 Pondicherry have an estimated adult HIV prevalence of 0.28-0.30%. Other states have  
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33 lower levels of HIV.  
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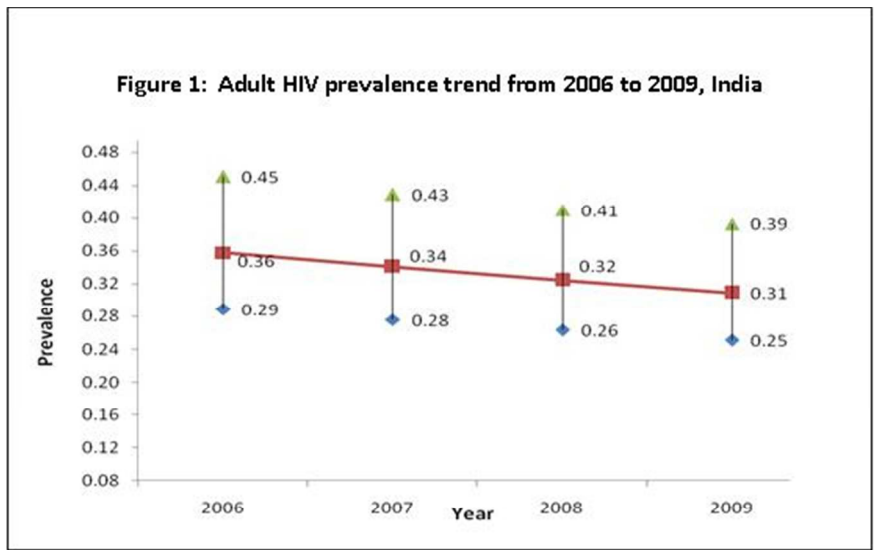
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41 The total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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43 (uncertainty bounds of 1.93 – 3.04 million) in 2009. Children under 15 years of age  
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45 account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of  
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47 all infections. Thirty-nine percent of all HIV infections are estimated to be among  
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49 women. This amounts to 0.93 million women with HIV in India.  
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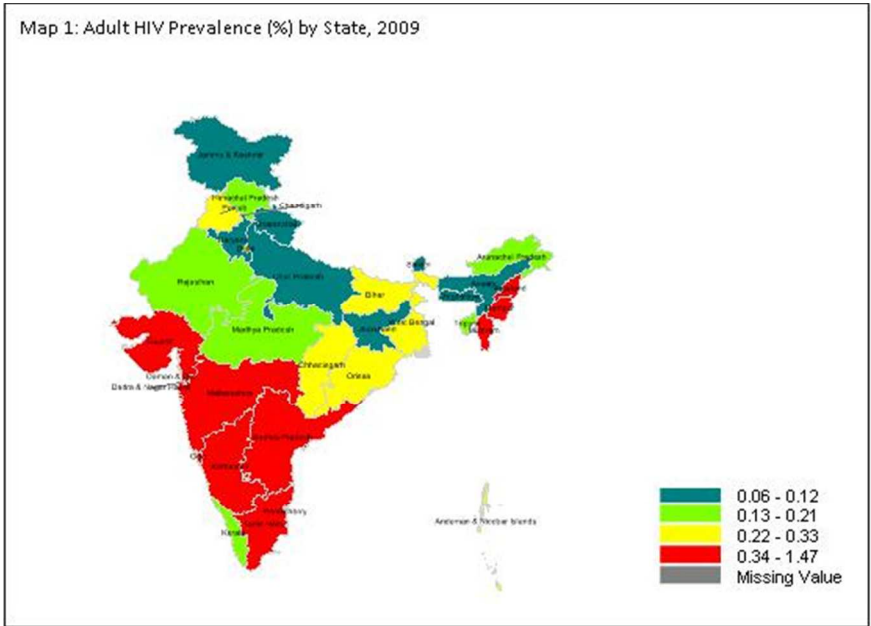
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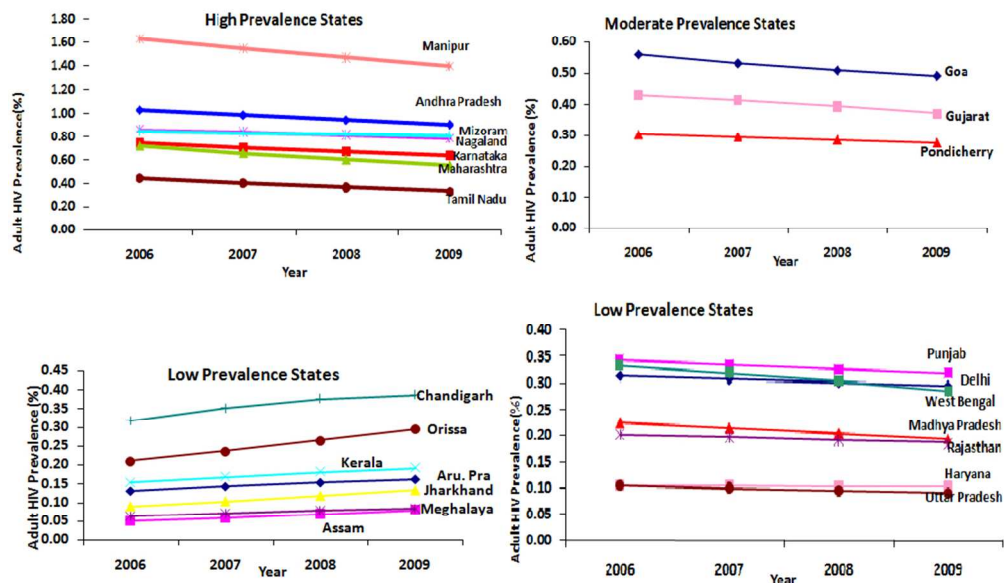
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Figure 2: Adult HIV Prevalence Trends from 2006 to 2009, India States



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**Research check list: Estimates of HIV Prevalence and Number of People Living With HIV in India  
2008-09**

<b>Sr. No.</b>	<b>Item</b>	<b>Remarks</b>
<b>1.</b>	CONSORT statement	<b>Not required</b>
<b>2.</b>	PRISMA statement	<b>Not required</b>
<b>3.</b>	EVEREST statement	<b>Not required</b>
<b>4.</b>	STARD statement	<b>Not required</b>
<b>5.</b>	STROBE statement	<b>Not required</b>
<b>6.</b>	MOOSE statement	<b>Not required</b>
<b>7.</b>	ANY OTHER statement	<b>The study is secondary data analysis</b>

For peer review only



## ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA 2008-09

### Background:

Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived every year since 1998. The process is consultative amongst the national and international experts in the field of biostatistics and epidemiology. Technical supports are received from UN organizations particularly experts from the WHO and UNAIDS. Efforts are made to improve data both in terms of quality and representativeness as well as the methodology matching to epidemics. For instance, in 2006 with the expansion of sentinel surveillance to all districts [1], sero-survey as a part of third round of National Family Health Survey (NFHS-3) [2] and the observation that there is a common practice of referral of HIV-positive/suspected cases to public hospitals and a preferential use of public hospitals by people in the lower socio-economic strata causing overestimation of the HIV burden in India [3, 4], many of the assumptions are replaced with evidence based information. In fact, the NFHS-3 provided an opportunity to calibrate the surveillance data [5, 6] particularly the data from ANC attendees used in the estimation process as a proxy to general population. In addition, globally used method for similar epidemic, e.g. WHO/UNAIDS workbook [7] along with Spectrum software [8] was used in 2006 and 2007 rounds of estimation. The WHO/UNAIDS Workbook having assimilated the average prevalence for each risk group, namely, FSW, IDU, MSM and ANC fitted a logistic model to get the trend of the epidemic. The calibration factors derived in 2006 were used in the 2007 round of estimation in view of non-availability of community based survey data to calibrate every year [9]. Also, it forwarded a limitation of curve

1  
2 fitting over the average HIV prevalence in the population within the Workbook. The  
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4 issue was deliberated in the UNAIDS Global Reference group on Estimates, Modelling  
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6 and Projections and it was suggested to adopt the combination of Estimation and  
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8 Projection Package (EPP) and Spectrum [10]. The present paper aims to update the HIV  
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10 estimation with the above combination. Specifically, it describes the data and methods  
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12 used for the 2008 & 2009 HIV burden estimates for India and compares the resulting  
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14 estimates with those of earlier years.  
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## 20 21 **Method and Material**

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24 The Estimation Projection Package (EPP) [11] and Spectrum DemProj and AIM modules  
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26 [8] was used for the estimating prevalence and burden of HIV.  
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## 30 31 **Data**

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34 The Working Group reviewed and used four sets of data available from various sources  
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36 for the estimation process.  
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41 **Surveillance:** The following surveillance data available from 1998 to 2009 was used in  
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43 EPP for producing state and national curves. These represent HIV prevalence data from  
44  
45 HIV sentinel surveillance that was conducted amongst pregnant women attending  
46  
47 antenatal clinics and the key population groups of Female Sex Workers (FSW), Men  
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49 having Sex with Men (MSM) and Injecting Drug Users (IDUs). Through the scale up in  
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51 number of HIV Sentinel Surveillance (HSS) sites and increased focus on key population  
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53 sites, a wider geographical and population group coverage was achieved leading to more  
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accurate results. The following table reflects the scale up in numbers of surveillance sites per year for the populations groups that are used in the HIV estimates process.

Table 1: Scale up of HIV Sentinel Sites in India, 1998-2009

Site Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2009
ANC	92	93	111	172	200	476	390	391	636	654	668
IDU	5	6	10	10	13	18	24	30	51	52	61
MSM	1	1	3	3	3	9	15	18	31	40	67
FSW	1	1	2	2	2	32	42	83	138	137	194
Total	98	100	126	187	218	535	471	522	856	883	990

Also, the working group used the estimated prevalence from the National Family and Health Survey (NFHS) conducted throughout the country with state level representation in the high prevalence states. The adult HIV prevalence from the NFHS-3 was used for calibration of the fitted curves.

**Population sizes (the size of the higher risk and lower risk population):** Secondly, for determining specific demographic parameters of key population groups, the size estimates for FSW, MSM and IDU provided under the NACP III document [12] was considered. This was updated with data from the 2009 mapping exercise conducted among key population in 2009 in specific states by NACO and State AIDS Control Societies (SACs). In states where the mapping exercise was not concluded, the higher risk group population was estimated as a proportion of people with higher risk behaviour as reported under the NACP-III document [13].

In addition, data inputs used for determining the size of the general population at lower risk for HIV were number of births, number of deaths, adult population growth rate and population size for people aged over 15 years across and in 34 states/Union Territories from the vital registration system [14]. National population estimates were obtained from

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2  
3 **population projection for India and states from the period 2001 to 2026.** The size of the  
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5 general population at lower risk for HIV were calculated as the total adult population  
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7 minus the population size of the higher risk groups. The population size for people aged  
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9 15–49 years in 2009 has been derived through Demproj in the Spectrum Package. The  
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11 data used in Demproj for calculating the population size included the Census population  
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13 data of 1981, 1991 and 2001 and the Expert Group Population Estimates and Projections  
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15 of India [15, 16, 17, 18]. The breakdown by sex for the IDU population assumes that 90%  
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17 of the IDU population is male and 10% is female [12, 19].  
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25 **Programme Coverage:** As antiretroviral therapy (ART) programme coverage influences  
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27 the trend of HIV prevalence, the current ART coverage is extrapolated for the years  
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29 beyond 2009—which is consistent with the NACP-III planned target of 500,000 by  
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31 2015—and distributed among all risk group based on last year proportions in respective  
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33 risk groups [20].  
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38 Methods:

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41 The EPP estimates the trends over time of HIV prevalence by fitting an epidemiological  
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43 model to the surveillance data provided by HIV sentinel surveillance systems. The basic  
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45 principle underlying EPP is to develop epidemic curves separately for different sub-  
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47 populations and then combine to produce a single epidemic curve estimating HIV  
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49 prevalence at the national level. For adult HIV prevalence epidemic curve generated for  
50  
51 each sub-population group, initial guesses were made using four parameters, namely  $t_0$   
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53 (start year of the HIV epidemic),  $r$  (the force of infection),  $f_0$  (the initial fraction of the  
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55 adult population at risk of infection used to determine the peak level of the epidemic  
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3 curve,  $\phi$  (the behaviour adjustment parameter which determines how the proportion of  
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5 new entrants in the adult population who are at risk of HIV infections changes over time).  
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7 The 2009 version of has also included the provision of antiretroviral therapy, which  
8  
9 increases survival of people living with HIV, hence increasing prevalence and impacting  
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11 the process of fitting an epidemiological model to the HIV epidemic. Data from the  
12  
13 above sources were entered to EPP to produce curves of adult HIV prevalence among  
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15 different population groups including antenatal clinic attendees — as proxy for general  
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17 population — and key population groups.  
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23 The following two primary epidemiological assumptions were considered whilst  
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25 analyzing data under the 2009 version of EPP: (1) a specific criterion was considered for  
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27 reassigning higher risk groups to the general population category. Based on the second  
28  
29 round of Behaviour Surveillance Survey conducted in 2006 [19], it was determined that  
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31 IDU and MSM after a 15 year duration would be reassigned to the general population  
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33 category whereas for FSW the timeframe for being reassigned to the general population  
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35 category whereas for FSW the timeframe for being reassigned to the general population  
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37 was reduced to 8 years and (2) AIDS mortality was assumed to be higher by as much as  
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39 7% for injecting drug users vis-à-vis non- injecting drug users.  
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43 **Defining the characteristics of the Epidemic** - The HIV epidemic in India, at national  
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45 level, is concentrated amongst female sex workers (FSW), men who have sex with men  
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47 (MSM) and injecting drug users (IDU). Amongst the 34 Indian States/Union  
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49 Territories—the epidemic is defined as a concentrated non-IDU epidemic for all the  
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51 states with the exception of Manipur and Nagaland where the epidemic is defined as a  
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53 concentrated IDU epidemic.  
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3 **Generating State-specific prevalence curves:** The States/Union Territory specific  
4 epidemic, for which first time States/Union Territory specific prevalence curves was  
5 generated under the 2008/2009 HIV estimates. Using the Bayesian melding approach,  
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7 1000 iterations were used for fitting the initial guesses for ANC sites and 3000 iterations  
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9 for higher risk group sites. The best fitting curves for all sub-population categories were  
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11 subsequently combined for producing state prevalence curves.  
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19 **Calibrating ANC prevalence curves in EPP Model:** Estimates of HIV prevalence is  
20 primarily based on times series prevalence data amongst ANC attendees in HSS. Due to the  
21 difference in sero-prevalence between the ANC attendees and those from population based  
22 surveys, the calibration of the prevalence curves based on the former is required. The key  
23 source of information used for calibrating HIV prevalence curves has the 2006 National  
24 Family Health Survey (NFHS-3) [2] where state-specific information on HIV prevalence is  
25 determined. The curve for antenatal clinic attendees was calibrated from National Family  
26 Health Survey (NFHS-3) 2005-06 for general population. In order to have an appropriate  
27 calibration of the HIV prevalence trends determined in spectrum, the point values of  
28 prevalence determined from the NFHS-3 in 2006 as a reference for calibrating the  
29 prevalence trend for general population, initially determined through ANC.  
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46 In EPP, when a calibration factor is used, the overall curve determined on the basis of  
47 ANC HSS trend data which is scaled according to the calibration constant. Differences in  
48 the prevalence level are modeled on the probit scale. The probit scale is chosen in such a  
49 way that the differences between prevalence levels do not depend on the level itself. The  
50 calibration factor was derived for individual states in five high prevalence states, i.e.,  
51 Andhra Pradesh, Karnataka, Maharashtra, Manipur and Tamil Nadu, based on  
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calculations from NFHS-3 while for Nagaland the calibration factor was determined from a specific study undertaken by NACO [21]. For the remainder of the moderate and low prevalence states, the common constant calibration factor of 0.69 was derived from the NFHS-3 on the basis of the rest of the states (excluding aforesaid 6 high prevalence states) national comparison between general population prevalence and ANC prevalence.

**Estimation of PLHIV for all age groups using Spectrum** In order to estimate the number of people living with HIV and HIV prevalence for all ages, the projected adult HIV prevalence for each state was fed into Spectrum along with programme data on Antiretroviral (ART) programme coverage, percent of mothers and children given nevirapine prophylaxis and certain demographic and epidemiological parameters.

Spectrum under its AIDS Impact Model (AIM) requires a number of inputs and parameters to process estimates and projections of HIV related parameters that will allow fitting of the trend of epidemic as initially determined in EPP. The first input into Spectrum is the projection of HIV incidence determined in EPP. It is combined with the population projection and the other programme coverage indicators and parameters to determine the indicators related to the impact of the epidemic. The parameters included into Spectrum include the ART, PPTCT programme coverage data, age and sex distribution of prevalence. For each of the 34 States/Union Territories, adult and children ART treatment coverage—from 2004 to 2009 and the projected coverage till 2015—along with duration of breastfeeding were used in AIM. An estimated 300,000 adults and 17,000 children utilized ART as on December 2009. Approximately 13,000 mothers had utilized PPTCT in India as by December 2009. Assumptions over other state-specific HIV characteristics included age and sex distribution of new infections, proportion of those newly infected, progressing need for treatment by time since infection, proportion of adults in need of treatment, proportion of adults dying due to AIDS related causes without treatment by time in need, annual

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2 mortality among children in need of treatment but not receiving treatment by age, annual survival  
3 of adults and children on ART, probability of transmission of HIV from mother-to-child etc.  
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5 After finalizing the input of all these parameters, Spectrum re-processed the estimation and  
6  
7 projection of the HIV epidemic.  
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13 **Uncertainty Analysis:** The point estimates are associated with uncertainty due to the  
14 prevalence/incidence curve produced by EPP and the input assumptions that are based on studies  
15 from population samples in selected countries. For addressing this associated uncertainty, a  
16 special programme in Spectrum [22] was used for producing uncertainty bounds around the usual  
17 point estimates for each indicator and for each year. A logistic curve is fitted to the resulting  
18 points, i.e., the 1000 different logistic curve generated is fitted for the prevalence data by varying  
19 the data before each fit with the ranges indicated next to the quality categories.  
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## 28 **Results and discussion**

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31 **The tools used for generating HIV estimates and the data used as mentioned above allows**  
32 **for production of estimated HIV prevalence and incidence trends from the beginning of**  
33 **the epidemic to the current year and projection for the future.**  
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38 **National / States/Union Territory estimates of HIV Adult Prevalence:** While the adult  
39 HIV prevalence for each state and Union Territory was directly projected through EPP  
40 and Spectrum, the national adult HIV prevalence is determined through application of the  
41 simple aggregation number of PLHIV from all states divided by the total adult population  
42 and calculated as a multiple of hundred to determined a percentage.  
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51 The adult HIV prevalence (males and females together) in India in 2008 is estimated as  
52 0.32% with uncertainty bounds 0.26%–0.41%, and 0.31% in 2009 with uncertainty  
53 bounds 0.25%–0.39. The adult HIV prevalence was estimated at 0.25% for women and  
54 0.36% for men in 2009. It was estimated at 0.26% for women and 0.38% for men in 2008  
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(Table 2). The results of 2008/2009 round of HIV estimates—in terms of trend and levels—are derived from a methodology that allows for readjustment of the prevalence curves on the basis of additional HSS data. Accordingly, the estimated HIV prevalence came out 0.36% for the year 2006 and 0.34% for the year 2007. As these are exactly the same value derived under the 2006 and 2007 round of HIV estimates, the consistency in results are indicative that the process adopted by the Working Group on Estimates and the results derived therein are valid and a sound base for analysis (Figure 1).

Table 2 : Adult HIV prevalence by sex and number of HIV infections for all ages with uncertainty bounds for the years 2008 and 2009, India		
	2008	2009
Adult 15-49 HIV prevalence		
Persons	0.32% (0.26 – 0.41)	0.31% (0.25 - 0.39)
Female	0.26%	0.25%
Male	0.38%	0.36%
Number of HIV infections (All ages)		
Persons (in Lakh)	24.42 (19.74 – 30.89)	23.95 (19.34 – 30.42)
Percent distribution of HIV infection by sex		
Female	38.5%	38.7%
Male	61.5%	61.3%
Percent distribution of HIV infections by age group		
< 15	4.2%	4.4%
15-49	83.3%	82.4%
50+	12.5%	13.2%

**State-wise HIV Adult Prevalence:** States/Union Territory wise estimates of adult HIV prevalence were the basis for estimating national adult HIV prevalence as detailed in earlier sections of the report. Over and above this process, an uncertainty analysis was conducted independently for each state in Spectrum. The state level estimates on adult HIV prevalence is provided in Map 1 and an analysis of central emerging trends is recapitulated therein.

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2  
3 As reflective from Figure 2, the HIV prevalence is on the decline in all states over the  
4 past four year period of 2006 to 2009; although the degree in decline varies slightly. For  
5 instance, the HIV prevalence trend appears stable in six high prevalence states, i.e.,  
6  
7 Andhra Pradesh, Karnataka, Maharashtra, Manipur, Nagaland and Tamil Nadu and  
8  
9 Mizoram (which is added to this group on the basis of consistently reporting HIV  
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11 prevalence among ANC clinic attendees >1% in past four years in HSS). Further, , in all  
12  
13 three moderate prevalence states- Goa, Gujarat and Pondicherry, adult HIV prevalence  
14  
15 trends is declining from 2006 to 2009.  
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22 Regarding the low prevalence States/Union Territories, figure 2 highlights those where  
23 the trend for HIV prevalence is stable to increasing between 2006 and 2009. These  
24 include the seven States/Union Territories of Arunachal Pradesh, Assam, Chandigarh,  
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26 Jharkhand, Kerala, Meghalaya and Orissa.  
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34 The relatively greater increase in HIV prevalence is noted in Assam, Jharkhand and  
35 Orissa vis-à-vis Arunachal Pradesh, Kerala and Meghalaya. The estimated HIV  
36 prevalence for Chandigarh—as reflected in figure-2—is not considered a true reflection  
37 of the nature of the epidemic in the Union Territory. Whilst noting the increase in the  
38 estimated HIV prevalence, it must be considered that the trend is attributable to the  
39 services Chandigarh provides to PLHIV from the neighbouring states of Punjab, Haryana  
40 and even Himachal Pradesh. As ART information is included as one of the parameters for  
41 the projection, the resulted trend is showing an increase, independent of the trend  
42 observed in HSS. A separate analysis of the HIV epidemic in Chandigarh is thus required  
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60 to take into consideration the evidence and the trends of neighbouring states.

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Figure-2 highlights the low prevalence states of Delhi, Haryana, Punjab, Rajasthan, Uttar Pradesh, and West Bengal where HIV prevalence is either stable or declining. Evidently, the degree for decline in HIV prevalence is not uniform between these states which may be on account of the programmatic impact of ART coverage, and the strength of the prevention interventions etc. The decline in HIV prevalence is lower in Haryana and Punjab vis-à-vis Delhi, Rajasthan, Uttar Pradesh, and West Bengal.

### **National and State estimates of number of people living with HIV**

In 2009, the total number of people living with HIV (PLHIV) in India is estimated at 2.4 million (uncertainty bounds of 1.93 – 3.04 million) while in 2008; it was 2.44 million people were living with HIV within the uncertainty bounds of 1.97-3.09 millions. Among PLHIV, by sex approximately 61% are male and 39% are female and by age the percent distribution of HIV infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49 years and rest 13% are over 50 years of age (Table2).

The four high prevalence states of South India account for 57% of all HIV infections in the country. Whilst Andhra Pradesh accounts for 500,000 cases; Maharashtra accounts for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for 150,000 cases. Over 100,000 PLHIVs are reported in West Bengal, Gujarat, Bihar and Uttar Pradesh and together these states account for 22% of HIV infections in India. The number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000 to 100,000 and these states collectively account for 12% of HIV infections. Thus whilst the states noted above are with low HIV prevalence; a large number of PLHIVs are reported due to the states' overall large population size (Map 1).

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3 The percent distribution of HIV burden amongst high prevalence states vis-à-vis the  
4 remaining states in India is 57% and 43% respectively. Amongst the high prevalence  
5 states, Andhra Pradesh accounts for the greatest proportion of cases at 21% vis-à-vis the  
6 other states. Following Andhra Pradesh, Maharashtra accounts for approximately 18% of  
7 HIV infection, Karnataka and Tamil Nadu reportedly account for 10% and 7% of all  
8 cases whereas Manipur and Nagaland account for 1% of the estimated total.  
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### 19 **Conclusions**

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21 The India HIV estimates 2008/2009 indicate a slowdown in the AIDS epidemic. National  
22 adult HIV prevalence, or the number of adults living with HIV as a proportion of the total  
23 population, has declined by 0.05% points from 0.36% (0.29% - 0.45%) in 2006 to 0.31%  
24 (0.25% - 0.39%) in 2009. Though the estimation of 2008/09 has utilized EPP and  
25 Spectrum tool against UNAIDS/WHO workbook and Spectrum in 2006, the results of  
26 2008-09 round of estimates match perfectly with previously announced estimates.  
27 However the results of 2008-09 round of estimates cannot be directly compared with the  
28 previous years because the methodology and data used to produce the estimates have  
29 gradually changed as a result of ongoing enhancement of knowledge on the epidemic.  
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45 Adult HIV prevalence is either stable or declining in the high prevalence states whereas  
46 the trend is varying across the low to moderate prevalence states. Among the high  
47 prevalence states, the HIV prevalence has declined in Tamil Nadu between 2006 and  
48 2009 to reach levels of 0.37% in 2008 and 0.33% in 2009. Manipur shows a declining  
49 trend over the past four years. Andhra Pradesh, Karnataka, Maharashtra and Nagaland  
50 show either a plateau or a slightly declining trend over the time period 2006 – 2009.  
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3 In the low prevalence states of Chandigarh, Orissa, Kerala, Jharkhand, Uttarakhand,  
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5 Jammu and Kashmir, Arunachal Pradesh and Meghalaya; adult HIV prevalence has risen  
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7 over the last four years which warrants the need for strengthening the trend of the HIV  
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9 epidemic.

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11 In descending order, states with the highest adult HIV prevalence in 2009 included  
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13 Manipur (1.4%); followed by Andhra Pradesh (0.90%), Mizoram (0.81%), Nagaland  
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15 (0.78%), Karnataka (0.63%) and Maharashtra (0.55%). Besides these, the states of Goa,  
16  
17 Chandigarh, Gujarat, Punjab and Tamil Nadu have an estimated adult HIV prevalence  
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19 greater than national prevalence (0.31%). Delhi, Orissa, West Bengal, Chhattisgarh and  
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21 Pondicherry have an estimated adult HIV prevalence of 0.28-0.30%. Other states have  
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23 lower levels of HIV.  
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31 The total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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33 (uncertainty bounds of 1.93 – 3.04 million) in 2009. Children under 15 years of age  
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35 account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of  
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37 all infections. Thirty-nine percent of all HIV infections are estimated to be among  
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39 women. This amounts to 0.93 million women with HIV in India.  
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**ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE  
LIVING WITH HIV IN INDIA 2008-09**

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## ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA 2008-09

### Abstract:

Objectives: To update the estimation of the adult HIV prevalence and number of people living with HIV in India for the year 2008/2009 with the combination of improved data and methods.

Design: Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived.

Setting: HSS sites spread over all the States of India.

Participants: Secondary data from HIV Sentinel Surveillance sites which includes attendees of Antenatal Clinics and sites under targeted interventions of high risk groups, namely, female sex workers (FSW), intravenous drug users (IDU) and men having sex with men (MSM).

Primary and secondary outcome measures: Estimates of adult HIV prevalence and people living with HIV in India and its States.

Results: The adult HIV prevalence in India has declined to an estimated 0.31% (0.25%–0.39%) in 2009 against 0.36% (0.29%–0.45%) in 2006. Among the high prevalence states, the HIV prevalence has declined in Tamil Nadu to 0.33% in 2009 and other states show either a plateau or a slightly declining trend over the time period 2006 – 2009.

There are states in the low prevalence states where the adult HIV prevalence has risen over the last four years. The estimated number of people living with HIV in India is 2.4 million (1.93 – 3.04 million) in 2009. Of which, 39 percent are women, children under 15

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2 years of age account for 4.4% of all infections, whilst people aged 15 – 49 years account  
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4 for 82.4% of all infections.  
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7 Conclusion: The estimated adult prevalence has declined in few states, a plateau or a  
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9 slightly declining trend over the time. In future, efforts may be made to examine the  
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11 implications of the emerging trend of the HIV prevalence on the recent infections in the  
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13 study population.  
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## 28 **Article Summary**

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31 1) Article Focus – Modelling exercise to estimate the adult prevalence and burden of HIV  
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33 in India using the HIV Sentinel Surveillance data.  
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38 2) Key Messages - up to three bullet points outlining the key messages and significance  
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40 of the study  
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45 • Estimates indicate a slow down trend in the epidemic with current adult HIV prevalence  
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47 at 0.31% in 2009.  
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50 • In 2009, 2.39 million people were estimated to be living with HIV with uncertainty  
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52 bounds 1.93-3.04 millions.  
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55 • Males account for a greater proportion of the epidemic's burden vis-à-vis females at  
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57 61% and 39% respectively. The percent distribution of HIV infection by age is estimated  
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3 at 4% among children below the age of 15 years, 83% among adults and 13% among  
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5 those aged over 50 years.  
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### 10 11 12 3) Strengths and Limitations.

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14 Epidemiological assumptions used in Modeling based on evidence on limited studies in  
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16 other countries, not on Indian population.  
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### 24 **Background:**

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26 Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions,  
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28 estimates of HIV prevalence and burden in India have been derived every year since  
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30 1998. The process is consultative amongst the national and international experts in the  
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32 field of biostatistics and epidemiology. Technical supports are received from UN  
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34 organizations particularly experts from the WHO and UNAIDS. Efforts are made to  
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36 improve data both in terms of quality and representativeness as well as the methodology  
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38 matching to epidemics. For instance, in 2006 with the expansion of sentinel surveillance  
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40 to all districts [1], sero-survey as a part of third round of National Family Health Survey  
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42 (NFHS-3) [2] and the observation that there is a common practice of referral of HIV-  
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44 positive/suspected cases to public hospitals and a preferential use of public hospitals by  
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46 people in the lower socio-economic strata causing overestimation of the HIV burden in  
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48 India [3, 4], many of the assumptions are replaced with evidence based information.  
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53 In fact, the NFHS-3 provided an opportunity to calibrate the surveillance data [5, 6]  
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55 particularly the data from ANC attendees used in the estimation process as a proxy to  
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3 general population. In addition, globally used method for similar epidemic, e.g.  
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5 WHO/UNAIDS workbook [7] along with Spectrum software [8] was used in 2006 and  
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7 2007 rounds of estimation. The WHO/UNAIDS Workbook having assimilated the  
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9 average prevalence for each risk group, namely, FSW, IDU, MSM and ANC fitted a  
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11 logistic model to get the trend of the epidemic. The calibration factors derived in 2006  
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13 were used in the 2007 round of estimation in view of non-availability of community  
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15 based survey data to calibrate every year [9]. Also, it forwarded a limitation of curve  
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17 fitting over the average HIV prevalence in the population within the Workbook. The  
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19 issue was deliberated in the UNAIDS Global Reference group on Estimates, Modelling  
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21 and Projections and it was suggested to adopt the combination of Estimation and  
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23 Projection Package (EPP) and Spectrum [10]. The present paper aims to update the HIV  
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25 estimation with the above combination. Specifically, it describes the data and methods  
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27 used for the 2008 & 2009 HIV burden estimates for India and compares the resulting  
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29 estimates with those of earlier years.  
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## 38 **Method and Material**

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41 The Estimation Projection Package (EPP) [11] and Spectrum DemProj and AIM modules  
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43 [12] was used for the estimating prevalence and burden of HIV.  
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## 47 **Data**

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50 The Working Group reviewed and used four sets of data available from various sources  
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52 for the estimation process.  
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**Surveillance:** The following surveillance data available from 1998 to 2009 was used in EPP for producing state and national curves. These represent HIV prevalence data from HIV sentinel surveillance that was conducted amongst pregnant women attending antenatal clinics and the key population groups of Female Sex Workers (FSW), Men having Sex with Men (MSM) and Injecting Drug Users (IDUs). Through the scale up in number of HIV Sentinel Surveillance (HSS) sites and increased focus on key population sites, a wider geographical and population group coverage was achieved leading to more accurate results. The following table reflects the scale up in numbers of surveillance sites per year for the populations groups that are used in the HIV estimates process.

Site Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2009
ANC	92	93	111	172	200	476	390	391	636	654	668
IDU	5	6	10	10	13	18	24	30	51	52	61
MSM	-	-	3	3	3	9	15	18	31	40	67
FSW	1	1	2	2	2	32	42	83	138	137	194
Total	98	100	126	187	218	535	471	522	856	883	990

Also, the working group used the estimated prevalence from the National Family and Health Survey (NFHS) conducted throughout the country with state level representation in the high prevalence states. The adult HIV prevalence from the NFHS-3 was used for calibration of the fitted curves.

**Population sizes (the size of the higher risk and lower risk population):** Secondly, for determining specific demographic parameters of key population groups, the size estimates for FSW, MSM and IDU provided under the NACP III document [13] was considered. This was updated with data from the 2009 mapping exercise conducted among key population in 2009 in specific states by NACO and State AIDS Control Societies (SACs). In states where the mapping exercise was not concluded, the higher

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3 risk group population was estimated as a proportion of people with higher risk behaviour  
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5 as reported under the NACP-III document [14].  
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10 In addition, data inputs used for determining the size of the general population at lower  
11 risk for HIV were number of births, number of deaths, adult population growth rate and  
12 population size for people aged over 15 years across and in 34 states/Union Territories  
13 from the vital registration system [15]. National population estimates were obtained from  
14 population projection for India and states from the period 2001 to 2026. The size of the  
15 general population at lower risk for HIV were calculated as the total adult population  
16 minus the population size of the higher risk groups. The population size for people aged  
17 15–49 years in 2009 has been derived through Demproj in the Spectrum Package. The  
18 data used in Demproj for calculating the population size included the Census population  
19 data of 1981, 1991 and 2001 and the Expert Group Population Estimates and Projections  
20 of India [16, 17, 18, 19]. The breakdown by sex for the IDU population assumes that 90%  
21 of the IDU population is male and 10% is female [13, 20].  
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**Programme Coverage:** As antiretroviral therapy (ART) programme coverage influences  
55 the trend of HIV prevalence, the current ART coverage is extrapolated for the years  
56 beyond 2009—which is consistent with the NACP-III planned target of 500,000 by  
57 2015—and distributed among all risk group based on last year proportions in respective  
58 risk groups [21].  
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Methods:

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3 The EPP estimates the trends over time of HIV prevalence by fitting an epidemiological  
4 model to the surveillance data provided by HIV sentinel surveillance systems. The basic  
5 principle underlying EPP is to develop epidemic curves separately for different sub-  
6 populations and then combine to produce a single epidemic curve estimating HIV  
7 prevalence at the national level. For adult HIV prevalence epidemic curve generated for  
8 each sub-population group, initial guesses were made using four parameters, namely  $t_0$   
9 (start year of the HIV epidemic),  $r$  (the force of infection),  $f_0$  (the initial fraction of the  
10 adult population at risk of infection used to determine the peak level of the epidemic  
11 curve,  $\phi$  (the behaviour adjustment parameter which determines how the proportion of  
12 new entrants in the adult population who are at risk of HIV infections changes over time).  
13 The 2009 version of has also included the provision of antiretroviral therapy, which  
14 increases survival of people living with HIV, hence increasing prevalence and impacting  
15 the process of fitting an epidemiological model to the HIV epidemic. Data from the  
16 above sources were entered to EPP to produce curves of adult HIV prevalence among  
17 different population groups including antenatal clinic attendees — as proxy for general  
18 population — and key population groups.

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42 The following two primary epidemiological assumptions were considered whilst  
43 analyzing data under the 2009 version of EPP: (1) a specific criterion was considered for  
44 reassigning higher risk groups to the general population category. Based on the second  
45 round of Behaviour Surveillance Survey conducted in 2006 [20], it was determined that  
46 IDU and MSM after a 15 year duration would be reassigned to the general population  
47 category whereas for FSW the timeframe for being reassigned to the general population  
48 was reduced to 8 years and (2) non-AIDS mortality was assumed to be higher by as much  
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3 as 7% for injecting drug users vis-à-vis non- injecting drug users meant to account for the  
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5 higher risk of mortality experienced by all IDU regardless of HIV status.  
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9 **Defining the characteristics of the Epidemic** - The HIV epidemic in India, at national  
10 level, is concentrated amongst female sex workers (FSW), men who have sex with men  
11 (MSM) and injecting drug users (IDU). Amongst the 34 Indian States/Union  
12 Territories—the epidemic is defined as a concentrated non-IDU epidemic for all the  
13 states with the exception of Manipur and Nagaland where the epidemic is defined as a  
14 concentrated IDU epidemic.  
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24 **Generating State-specific prevalence curves:** The States/Union Territory specific  
25 epidemic, for which first time States/Union Territory specific prevalence curves was  
26 generated under the 2008/2009 HIV estimates. Using the Bayesian melding approach,  
27 1000 iterations were used for fitting the initial guesses for ANC sites and 3000 iterations  
28 for higher risk group sites. The best fitting curves for all sub-population categories were  
29 subsequently combined for producing state prevalence curves.  
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40 **Calibrating ANC prevalence curves in EPP Model:** Estimates of HIV prevalence is  
41 primarily based on times series prevalence data amongst ANC attendees in HSS. Due to the  
42 difference in sero-prevalence between the ANC attendees and those from population based  
43 surveys, the calibration of the prevalence curves based on the former is required. The key  
44 source of information used for calibrating HIV prevalence curves has the 2006 National  
45 Family Health Survey (NFHS-3) [2] where state-specific information on HIV prevalence is  
46 determined. The curve for antenatal clinic attendees was calibrated from National Family  
47 Health Survey (NFHS-3) 2005-06 for general population. In order to have an appropriate  
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3 calibration of the HIV prevalence trends determined in spectrum, the point values of  
4 prevalence determined from the NFHS-3 in 2006 as a reference for calibrating the  
5 prevalence trend for general population, initially determined through ANC.  
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11 In EPP, when a calibration factor is used, the overall curve determined on the basis of  
12 ANC HSS trend data which is scaled according to the calibration constant. Differences in  
13 the prevalence level are modeled on the probit scale. The probit scale is chosen in such a  
14 way that the differences between prevalence levels do not depend on the level itself. The  
15 calibration factor was derived for individual states in five high prevalence states, i.e.,  
16 Andhra Pradesh, Karnataka, Maharashtra, Manipur and Tamil Nadu, based on  
17 calculations from NFHS-3 while for Nagaland the calibration factor was determined from  
18 a specific study undertaken by NACO [22]. For the remainder of the moderate and low  
19 prevalence states, the common constant calibration factor of 0.69 was derived from the  
20 NFHS-3 on the basis of the rest of the states (excluding aforesaid 6 high prevalence  
21 states) national comparison between general population prevalence and ANC prevalence.  
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38 **Estimation of PLHIV for all age groups using Spectrum** In order to estimate the  
39 number of people living with HIV and HIV prevalence for all ages, the projected adult  
40 HIV prevalence for each state was fed into Spectrum along with programme data on  
41 Antiretroviral (ART) programme coverage, percent of mothers and children given  
42 nevirapine prophylaxis and certain demographic and epidemiological parameters.  
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51 Spectrum under its AIDS Impact Model (AIM) requires a number of inputs and parameters  
52 to process estimates and projections of HIV related parameters that will allow fitting of the  
53 trend of epidemic as initially determined in EPP. The first input into Spectrum is the  
54 projection of HIV incidence determined in EPP. It is combined with the population  
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projection and the other programme coverage indicators and parameters to determine the indicators related to the impact of the epidemic. The parameters included into Spectrum include the ART, PPTCT programme coverage data, age and sex distribution of prevalence. For each of the 34 States/Union Territories, adult and children ART treatment coverage—from 2004 to 2009 and the projected coverage till 2015—along with duration of breastfeeding were used in AIM. An estimated 300,000 adults and 17,000 children utilized ART as on December 2009. Approximately 13,000 mothers had utilized PPTCT in India as by December 2009. Assumptions over other state-specific HIV characteristics included age and sex distribution of new infections, proportion of those newly infected progressing need for treatment by time since infection, proportion of adults in need of treatment, proportion of adults dying due to AIDS related causes without treatment by time in need, annual mortality among children in need of treatment but not receiving treatment by age, annual survival of adults and children on ART, probability of transmission of HIV from mother-to-child etc. [12,23] After finalizing the input of all these parameters, Spectrum re-processed the estimation and projection of the HIV epidemic.

**Uncertainty Analysis:** The point estimates are associated with uncertainty due to the prevalence/incidence curve produced by EPP and the input assumptions that are based on studies from population samples in selected countries. For addressing this associated uncertainty, a special programme in Spectrum [24] was used for producing uncertainty bounds around the usual point estimates for each indicator and for each year. A logistic curve is fitted to the resulting points, i.e., the 1000 different logistic curve generated is fitted for the prevalence data by varying the data before each fit with the ranges indicated next to the quality categories.

## Results and discussion

The tools used for generating HIV estimates and the data used as mentioned above allows for production of estimated HIV prevalence and incidence trends from the beginning of the epidemic to the current year and projection for the future.

**National / States/Union Territory estimates of HIV Adult Prevalence:** While the adult HIV prevalence for each state and Union Territory was directly projected through EPP and Spectrum, the national adult HIV prevalence is determined through application of the simple aggregation number of PLHIV from all states divided by the total adult population and calculated as a multiple of hundred to determined a percentage.

The adult HIV prevalence (males and females together) in India in 2008 is estimated as 0.32% with uncertainty bounds 0.26%–0.41%, and 0.31% in 2009 with uncertainty bounds 0.25%–0.39. The adult HIV prevalence was estimated at 0.25% for women and 0.36% for men in 2009. It was estimated at 0.26% for women and 0.38% for men in 2008 (Table 2). The results of 2008/2009 round of HIV estimates—in terms of trend and levels—are derived from a methodology that allows for readjustment of the prevalence curves on the basis of additional HSS data. Accordingly, the estimated HIV prevalence came out 0.36% for the year 2006 and 0.34% for the year 2007. As these are exactly the same value derived under the 2006 and 2007 round of HIV estimates, the consistency in results are indicative that the process adopted by the Working Group on Estimates and the results derived therein are valid and a sound base for analysis (Figure 1).

Table 2 : Adult HIV prevalence by sex and number of HIV infections for all ages with uncertainty bounds for the years 2008 and 2009, India		
	2008	2009
Adult 15-49 HIV prevalence		
Persons	0.32% (0.26 – 0.41)	0.31% (0.25 - 0.39)
Female	0.26%	0.25%
Male	0.38%	0.36%

Number of HIV infections (All ages)		
Persons (in million)	2.44 (1.97-3.09)	2.40 (1.93-3.04)
Percent distribution of HIV infection by sex		
Female	38.5%	38.7%
Male	61.5%	61.3%
Percent distribution of HIV infections by age group		
< 15	4.2%	4.4%
15-49	83.3%	82.4%
50+	12.5%	13.2%

**State-wise HIV Adult Prevalence:** States/Union Territory wise estimates of adult HIV prevalence were the basis for estimating national adult HIV prevalence as detailed in earlier sections of the report. Over and above this process, an uncertainty analysis was conducted independently for each state in Spectrum. The state level estimates on adult HIV prevalence is provided in Map 1 and an analysis of central emerging trends is recapitulated therein.

As reflective from Figure 2, the HIV prevalence is on the decline in all states over the past four year period of 2006 to 2009; although the degree in decline varies slightly. For instance, the HIV prevalence trend appears stable in six high prevalence states, i.e., Andhra Pradesh, Karnataka, Maharashtra, Manipur, Nagaland and Tamil Nadu and Mizoram (which is added to this group on the basis of consistently reporting HIV prevalence among ANC clinic attendees >1% in past four years in HSS). Further, in all three moderate prevalence states- Goa, Gujarat and Pondicherry, adult HIV prevalence trends is declining from 2006 to 2009.

Regarding the low prevalence States/Union Territories, figure 2 highlights those where the trend for HIV prevalence is stable to increasing between 2006 and 2009. These

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3 include the seven States/Union Territories of Arunachal Pradesh, Assam, Chandigarh,  
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5 Jharkhand, Kerala, Meghalaya and Orissa.  
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10 The relatively greater increase in HIV prevalence is noted in Assam, Jharkhand and  
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12 Orissa vis-à-vis Arunachal Pradesh, Kerala and Meghalaya. The estimated HIV  
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14 prevalence for Chandigarh—as reflected in figure-2—is not considered a true reflection  
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16 of the nature of the epidemic in the Union Territory. Whilst noting the increase in the  
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18 estimated HIV prevalence, it must be considered that the trend is attributable to the  
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20 services Chandigarh provides to PLHIV from the neighbouring states of Punjab, Haryana  
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22 and even Himachal Pradesh. As ART information is included as one of the parameters for  
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24 the projection, the resulted trend is showing an increase, independent of the trend  
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26 observed in HSS. A separate analysis of the HIV epidemic in Chandigarh is thus required  
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28 to take into consideration the evidence and the trends of neighbouring states.  
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36 Figure-2 highlights the low prevalence states of Delhi, Haryana, Punjab, Rajasthan, Uttar  
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38 Pradesh, and West Bengal where HIV prevalence is either stable or declining. Evidently,  
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40 the degree for decline in HIV prevalence is not uniform between these states which may  
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42 be on account of the programmatic impact of ART coverage, and the strength of the  
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44 prevention interventions etc. The decline in HIV prevalence is lower in Haryana and  
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46 Punjab vis-à-vis Delhi, Rajasthan, Uttar Pradesh, and West Bengal.  
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### 52 **National and State estimates of number of people living with HIV**

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54 In 2009, the total number of people living with HIV (PLHIV) in India is estimated at 2.4  
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56 million (uncertainty bounds of 1.93 – 3.04 million) while in 2008; it was 2.44 million  
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people were living with HIV within the uncertainty bounds of 1.97-3.09 millions. Among PLHIV, by sex approximately 61% are male and 39% are female and by age the percent distribution of HIV infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49 years and rest 13% are over 50 years of age (Table2).

The four high prevalence states of South India account for 57% of all HIV infections in the country. Whilst Andhra Pradesh accounts for 500,000 cases; Maharashtra accounts for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for 150,000 cases. Over 100,000 PLHIVs are reported in West Bengal, Gujarat, Bihar and Uttar Pradesh and together these states account for 22% of HIV infections in India. The number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000 to 100,000 and these states collectively account for 12% of HIV infections. Thus whilst the states noted above are with low HIV prevalence; a large number of PLHIVs are reported due to the states' overall large population size (Map 1).

The percent distribution of HIV burden amongst high prevalence states vis-à-vis the remaining states in India is 57% and 43% respectively. Amongst the high prevalence states, Andhra Pradesh accounts for the greatest proportion of cases at 21% vis-à-vis the other states. Following Andhra Pradesh, Maharashtra accounts for approximately 18% of HIV infection, Karnataka and Tamil Nadu reportedly account for 10% and 7% of all cases whereas Manipur and Nagaland account for 1% of the estimated total.

## Conclusions

The India HIV estimates 2008/2009 indicate a slowdown in the AIDS epidemic. National adult HIV prevalence, or the number of adults living with HIV as a proportion of the total

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population, has declined by 0.05% points from 0.36% (0.29% - 0.45%) in 2006 to 0.31% (0.25% - 0.39%) in 2009. Though the estimation of 2008/09 has utilized EPP and Spectrum tool against UNAIDS/WHO workbook and Spectrum in 2006, the results of 2008-09 round of estimates match perfectly with previously announced estimates. However the results of 2008-09 round of estimates cannot be directly compared with the previous years because the methodology and data used to produce the estimates have gradually changed as a result of ongoing enhancement of knowledge on the epidemic.

Adult HIV prevalence is either stable or declining in the high prevalence states whereas the trend is varying across the low to moderate prevalence states. Among the high prevalence states, the HIV prevalence has declined in Tamil Nadu between 2006 and 2009 to reach levels of 0.37% in 2008 and 0.33% in 2009. Manipur shows a declining trend over the past four years. Andhra Pradesh, Karnataka, Maharashtra and Nagaland show either a plateau or a slightly declining trend over the time period 2006 – 2009.

In the low prevalence states of Chandigarh, Orissa, Kerala, Jharkhand, Uttarakhand, Jammu and Kashmir, Arunachal Pradesh and Meghalaya; adult HIV prevalence has risen over the last four years which warrants the need for strengthening the trend of the HIV epidemic.

In descending order, states with the highest adult HIV prevalence in 2009 included Manipur (1.4%); followed by Andhra Pradesh (0.90%), Mizoram (0.81%), Nagaland (0.78%), Karnataka (0.63%) and Maharashtra (0.55%). Besides these, the states of Goa, Chandigarh, Gujarat, Punjab and Tamil Nadu have an estimated adult HIV prevalence greater than national prevalence (0.31%). Delhi, Orissa, West Bengal, Chhattisgarh and

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3 Pondicherry have an estimated adult HIV prevalence of 0.28-0.30%. Other states have  
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5 lower levels of HIV.  
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10 The total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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12 (uncertainty bounds of 1.93 – 3.04 million) in 2009. Children under 15 years of age  
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14 account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of  
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16 all infections. Thirty-nine percent of all HIV infections are estimated to be among  
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18 women. This amounts to 0.93 million women with HIV in India.  
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### 21 22 23 24 25 26 **Competing Interests Statement**

27  
28 There are no competing interests.  
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### 31 32 33 **Contributorship Statement**

34  
35 The authors are the member of the working group on India's HIV estimation and have  
36  
37 contributed equally in the design, analysis, interpretation and critical review of the paper.  
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### 42 43 **Data Sharing Statement**

44  
45 We have used all published data.  
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## ESTIMATE OF HIV PREVALENCE AND NUMBER OF PEOPLE LIVING WITH HIV IN INDIA 2008-09

### Background:

Based on HIV sentinel surveillance (HSS) data and a set of epidemiological assumptions, estimates of HIV prevalence and burden in India have been derived every year since 1998. The process is consultative amongst the national and international experts in the field of biostatistics and epidemiology. Technical supports are received from UN organizations particularly experts from the WHO and UNAIDS. Efforts are made to improve data both in terms of quality and representativeness as well as the methodology matching to epidemics. For instance, in 2006 with the expansion of sentinel surveillance to all districts [1], sero-survey as a part of third round of National Family Health Survey (NFHS-3) [2] and the observation that there is a common practice of referral of HIV-positive/suspected cases to public hospitals and a preferential use of public hospitals by people in the lower socio-economic strata causing overestimation of the HIV burden in India [3, 4], many of the assumptions are replaced with evidence based information. In fact, the NFHS-3 provided an opportunity to calibrate the surveillance data [5, 6] particularly the data from ANC attendees used in the estimation process as a proxy to general population. In addition, globally used method for similar epidemic, e.g. WHO/UNAIDS workbook [7] along with Spectrum software [8] was used in 2006 and 2007 rounds of estimation. The WHO/UNAIDS Workbook having assimilated the average prevalence for each risk group, namely, FSW, IDU, MSM and ANC fitted a logistic model to get the trend of the epidemic. The calibration factors derived in 2006 were used in the 2007 round of estimation in view of non-availability of community based survey data to calibrate every year [9]. Also, it forwarded a limitation of curve

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2 fitting over the average HIV prevalence in the population within the Workbook. The  
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4 issue was deliberated in the UNAIDS Global Reference group on Estimates, Modelling  
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6 and Projections and it was suggested to adopt the combination of Estimation and  
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8 Projection Package (EPP) and Spectrum [10]. The present paper aims to update the HIV  
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10 estimation with the above combination. Specifically, it describes the data and methods  
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12 used for the 2008 & 2009 HIV burden estimates for India and compares the resulting  
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14 estimates with those of earlier years.  
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## 20 21 **Method and Material**

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24 The Estimation Projection Package (EPP) [11] and Spectrum DemProj and AIM modules  
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26 [8] was used for the estimating prevalence and burden of HIV.  
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## 30 31 **Data**

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34 The Working Group reviewed and used four sets of data available from various sources  
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36 for the estimation process.  
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41 **Surveillance:** The following surveillance data available from 1998 to 2009 was used in  
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43 EPP for producing state and national curves. These represent HIV prevalence data from  
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45 HIV sentinel surveillance that was conducted amongst pregnant women attending  
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47 antenatal clinics and the key population groups of Female Sex Workers (FSW), Men  
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49 having Sex with Men (MSM) and Injecting Drug Users (IDUs). Through the scale up in  
50  
51 number of HIV Sentinel Surveillance (HSS) sites and increased focus on key population  
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53 sites, a wider geographical and population group coverage was achieved leading to more  
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accurate results. The following table reflects the scale up in numbers of surveillance sites per year for the populations groups that are used in the HIV estimates process.

Table 1: Scale up of HIV Sentinel Sites in India, 1998-2009

Site Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2009
ANC	92	93	111	172	200	476	390	391	636	654	668
IDU	5	6	10	10	13	18	24	30	51	52	61
MSM	1	1	3	3	3	9	15	18	31	40	67
FSW	1	1	2	2	2	32	42	83	138	137	194
Total	98	100	126	187	218	535	471	522	856	883	990

Also, the working group used the estimated prevalence from the National Family and Health Survey (NFHS) conducted throughout the country with state level representation in the high prevalence states. The adult HIV prevalence from the NFHS-3 was used for calibration of the fitted curves.

**Population sizes (the size of the higher risk and lower risk population):** Secondly, for determining specific demographic parameters of key population groups, the size estimates for FSW, MSM and IDU provided under the NACP III document [12] was considered. This was updated with data from the 2009 mapping exercise conducted among key population in 2009 in specific states by NACO and State AIDS Control Societies (SACs). In states where the mapping exercise was not concluded, the higher risk group population was estimated as a proportion of people with higher risk behaviour as reported under the NACP-III document [13].

In addition, data inputs used for determining the size of the general population at lower risk for HIV were number of births, number of deaths, adult population growth rate and population size for people aged over 15 years across and in 34 states/Union Territories from the vital registration system [14]. National population estimates were obtained from

1  
2  
3 **population projection for India and states from the period 2001 to 2026.** The size of the  
4  
5 general population at lower risk for HIV were calculated as the total adult population  
6  
7 minus the population size of the higher risk groups. The population size for people aged  
8  
9 15–49 years in 2009 has been derived through Demproj in the Spectrum Package. The  
10  
11 data used in Demproj for calculating the population size included the Census population  
12  
13 data of 1981, 1991 and 2001 and the Expert Group Population Estimates and Projections  
14  
15 of India [15, 16, 17, 18]. The breakdown by sex for the IDU population assumes that 90%  
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17 of the IDU population is male and 10% is female [12, 19].  
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25 **Programme Coverage:** As antiretroviral therapy (ART) programme coverage influences  
26  
27 the trend of HIV prevalence, the current ART coverage is extrapolated for the years  
28  
29 beyond 2009—which is consistent with the NACP-III planned target of 500,000 by  
30  
31 2015—and distributed among all risk group based on last year proportions in respective  
32  
33 risk groups [20].  
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38 Methods:

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41 The EPP estimates the trends over time of HIV prevalence by fitting an epidemiological  
42  
43 model to the surveillance data provided by HIV sentinel surveillance systems. The basic  
44  
45 principle underlying EPP is to develop epidemic curves separately for different sub-  
46  
47 populations and then combine to produce a single epidemic curve estimating HIV  
48  
49 prevalence at the national level. For adult HIV prevalence epidemic curve generated for  
50  
51 each sub-population group, initial guesses were made using four parameters, namely  $t_0$   
52  
53 (start year of the HIV epidemic),  $r$  (the force of infection),  $f_0$  (the initial fraction of the  
54  
55 adult population at risk of infection used to determine the peak level of the epidemic  
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3 curve,  $\phi$  (the behaviour adjustment parameter which determines how the proportion of  
4  
5 new entrants in the adult population who are at risk of HIV infections changes over time).  
6  
7 The 2009 version of has also included the provision of antiretroviral therapy, which  
8  
9 increases survival of people living with HIV, hence increasing prevalence and impacting  
10  
11 the process of fitting an epidemiological model to the HIV epidemic. **Data from the**  
12  
13 **above sources were entered to EPP to produce curves of adult HIV prevalence among**  
14  
15 **different population groups including antenatal clinic attendees — as proxy for general**  
16  
17 **population — and key population groups.**  
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22  
23 The following two primary epidemiological assumptions were considered **whilst**  
24  
25 **analyzing data under the 2009 version of EPP:** (1) a specific criterion was considered for  
26  
27 reassigning higher risk groups to the general population category. Based on the second  
28  
29 round of Behaviour Surveillance Survey conducted in 2006 [19], it was determined that  
30  
31 IDU and MSM after a 15 year duration would be reassigned to the general population  
32  
33 category whereas for FSW the timeframe for being reassigned to the general population  
34  
35 category whereas for FSW the timeframe for being reassigned to the general population  
36  
37 was reduced to 8 years and (2) AIDS mortality was assumed to be higher by as much as  
38  
39 7% for injecting drug users vis-à-vis non- injecting drug users.  
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43 **Defining the characteristics of the Epidemic** - The HIV epidemic in India, at national  
44  
45 level, is concentrated amongst female sex workers (FSW), men who have sex with men  
46  
47 (MSM) and injecting drug users (IDU). Amongst the 34 Indian States/Union  
48  
49 Territories—the epidemic is defined as a concentrated non-IDU epidemic for all the  
50  
51 states with the exception of Manipur and Nagaland where the epidemic is defined as a  
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53 concentrated IDU epidemic.  
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3 **Generating State-specific prevalence curves:** The States/Union Territory specific  
4 epidemic, for which first time States/Union Territory specific prevalence curves was  
5 generated under the 2008/2009 HIV estimates. Using the Bayesian melding approach,  
6  
7 1000 iterations were used for fitting the initial guesses for ANC sites and 3000 iterations  
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9 for higher risk group sites. The best fitting curves for all sub-population categories were  
10  
11 subsequently combined for producing state prevalence curves.  
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19 **Calibrating ANC prevalence curves in EPP Model:** Estimates of HIV prevalence is  
20 primarily based on times series prevalence data amongst ANC attendees in HSS. Due to the  
21 difference in sero-prevalence between the ANC attendees and those from population based  
22 surveys, the calibration of the prevalence curves based on the former is required. The key  
23 source of information used for calibrating HIV prevalence curves has the 2006 National  
24 Family Health Survey (NFHS-3) [2] where state-specific information on HIV prevalence is  
25 determined. The curve for antenatal clinic attendees was calibrated from National Family  
26 Health Survey (NFHS-3) 2005-06 for general population. In order to have an appropriate  
27 calibration of the HIV prevalence trends determined in spectrum, the point values of  
28 prevalence determined from the NFHS-3 in 2006 as a reference for calibrating the  
29 prevalence trend for general population, initially determined through ANC.  
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46 In EPP, when a calibration factor is used, the overall curve determined on the basis of  
47 ANC HSS trend data which is scaled according to the calibration constant. Differences in  
48 the prevalence level are modeled on the probit scale. The probit scale is chosen in such a  
49 way that the differences between prevalence levels do not depend on the level itself. The  
50 calibration factor was derived for individual states in five high prevalence states, i.e.,  
51 Andhra Pradesh, Karnataka, Maharashtra, Manipur and Tamil Nadu, based on  
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3 calculations from NFHS-3 while for Nagaland the calibration factor was determined from  
4  
5 a specific study undertaken by NACO [21]. For the remainder of the moderate and low  
6  
7 prevalence states, the common constant calibration factor of 0.69 was derived from the  
8  
9 NFHS-3 on the basis of the rest of the states (excluding aforesaid 6 high prevalence  
10  
11 states) national comparison between general population prevalence and ANC prevalence.  
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14  
15 **Estimation of PLHIV for all age groups using Spectrum** In order to estimate the  
16  
17 number of people living with HIV and HIV prevalence for all ages, the projected adult  
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19 HIV prevalence for each state was fed into Spectrum along with programme data on  
20  
21 Antiretroviral (ART) programme coverage, percent of mothers and children given  
22  
23 nevirapine prophylaxis and certain demographic and epidemiological parameters.  
24  
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27  
28 Spectrum under its AIDS Impact Model (AIM) requires a number of inputs and parameters to  
29  
30 process estimates and projections of HIV related parameters that will allow fitting of the trend of  
31  
32 epidemic as initially determined in EPP. The first input into Spectrum is the projection of HIV  
33  
34 incidence determined in EPP. It is combined with the population projection and the other  
35  
36 programme coverage indicators and parameters to determine the indicators related to the impact of  
37  
38 the epidemic. The parameters included into Spectrum include the ART, PPTCT programme  
39  
40 coverage data, age and sex distribution of prevalence. For each of the 34 States/Union Territories,  
41  
42 adult and children ART treatment coverage—from 2004 to 2009 and the projected coverage till  
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44 2015—along with duration of breastfeeding were used in AIM. An estimated 300,000 adults and  
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46 17,000 children utilized ART as on December 2009. Approximately 13,000 mothers had utilized  
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48 PPTCT in India as by December 2009. Assumptions over other state-specific HIV characteristics  
49  
50 included age and sex distribution of new infections, proportion of those newly infected,  
51  
52 progressing need for treatment by time since infection, proportion of adults in need of treatment,  
53  
54 proportion of adults dying due to AIDS related causes without treatment by time in need, annual  
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2 mortality among children in need of treatment but not receiving treatment by age, annual survival  
3 of adults and children on ART, probability of transmission of HIV from mother-to-child etc.  
4  
5 After finalizing the input of all these parameters, Spectrum re-processed the estimation and  
6  
7 projection of the HIV epidemic.  
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13 **Uncertainty Analysis:** The point estimates are associated with uncertainty due to the  
14 prevalence/incidence curve produced by EPP and the input assumptions that are based on studies  
15 from population samples in selected countries. For addressing this associated uncertainty, a  
16 special programme in Spectrum [22] was used for producing uncertainty bounds around the usual  
17 point estimates for each indicator and for each year. A logistic curve is fitted to the resulting  
18 points, i.e., the 1000 different logistic curve generated is fitted for the prevalence data by varying  
19 the data before each fit with the ranges indicated next to the quality categories.  
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## 28 **Results and discussion**

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31 **The tools used for generating HIV estimates and the data used as mentioned above allows**  
32 **for production of estimated HIV prevalence and incidence trends from the beginning of**  
33 **the epidemic to the current year and projection for the future.**  
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38 **National / States/Union Territory estimates of HIV Adult Prevalence:** While the adult  
39 HIV prevalence for each state and Union Territory was directly projected through EPP  
40 and Spectrum, the national adult HIV prevalence is determined through application of the  
41 simple aggregation number of PLHIV from all states divided by the total adult population  
42 and calculated as a multiple of hundred to determined a percentage.  
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51 The adult HIV prevalence (males and females together) in India in 2008 is estimated as  
52 0.32% with uncertainty bounds 0.26%–0.41%, and 0.31% in 2009 with uncertainty  
53 bounds 0.25%–0.39. The adult HIV prevalence was estimated at 0.25% for women and  
54 0.36% for men in 2009. It was estimated at 0.26% for women and 0.38% for men in 2008  
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(Table 2). The results of 2008/2009 round of HIV estimates—in terms of trend and levels—are derived from a methodology that allows for readjustment of the prevalence curves on the basis of additional HSS data. Accordingly, the estimated HIV prevalence came out 0.36% for the year 2006 and 0.34% for the year 2007. As these are exactly the same value derived under the 2006 and 2007 round of HIV estimates, the consistency in results are indicative that the process adopted by the Working Group on Estimates and the results derived therein are valid and a sound base for analysis (Figure 1).

Table 2 : Adult HIV prevalence by sex and number of HIV infections for all ages with uncertainty bounds for the years 2008 and 2009, India		
	2008	2009
Adult 15-49 HIV prevalence		
Persons	0.32% (0.26 – 0.41)	0.31% (0.25 - 0.39)
Female	0.26%	0.25%
Male	0.38%	0.36%
Number of HIV infections (All ages)		
Persons (in Lakh)	24.42 (19.74 – 30.89)	23.95 (19.34 – 30.42)
Percent distribution of HIV infection by sex		
Female	38.5%	38.7%
Male	61.5%	61.3%
Percent distribution of HIV infections by age group		
< 15	4.2%	4.4%
15-49	83.3%	82.4%
50+	12.5%	13.2%

**State-wise HIV Adult Prevalence:** States/Union Territory wise estimates of adult HIV prevalence were the basis for estimating national adult HIV prevalence as detailed in earlier sections of the report. Over and above this process, an uncertainty analysis was conducted independently for each state in Spectrum. The state level estimates on adult HIV prevalence is provided in Map 1 and an analysis of central emerging trends is recapitulated therein.

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3 As reflective from Figure 2, the HIV prevalence is on the decline in all states over the  
4 past four year period of 2006 to 2009; although the degree in decline varies slightly. For  
5 instance, the HIV prevalence trend appears stable in six high prevalence states, i.e.,  
6  
7 Andhra Pradesh, Karnataka, Maharashtra, Manipur, Nagaland and Tamil Nadu and  
8  
9 Mizoram (which is added to this group on the basis of consistently reporting HIV  
10  
11 prevalence among ANC clinic attendees >1% in past four years in HSS). Further, , in all  
12  
13 three moderate prevalence states- Goa, Gujarat and Pondicherry, adult HIV prevalence  
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15 trends is declining from 2006 to 2009.  
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23 Regarding the low prevalence States/Union Territories, figure 2 highlights those where  
24  
25 the trend for HIV prevalence is stable to increasing between 2006 and 2009. These  
26  
27 include the seven States/Union Territories of Arunachal Pradesh, Assam, Chandigarh,  
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29 Jharkhand, Kerala, Meghalaya and Orissa.  
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35 The relatively greater increase in HIV prevalence is noted in Assam, Jharkhand and  
36  
37 Orissa vis-à-vis Arunachal Pradesh, Kerala and Meghalaya. The estimated HIV  
38  
39 prevalence for Chandigarh—as reflected in figure-2—is not considered a true reflection  
40  
41 of the nature of the epidemic in the Union Territory. Whilst noting the increase in the  
42  
43 estimated HIV prevalence, it must be considered that the trend is attributable to the  
44  
45 services Chandigarh provides to PLHIV from the neighbouring states of Punjab, Haryana  
46  
47 and even Himachal Pradesh. As ART information is included as one of the parameters for  
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49 the projection, the resulted trend is showing an increase, independent of the trend  
50  
51 observed in HSS. A separate analysis of the HIV epidemic in Chandigarh is thus required  
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53 to take into consideration the evidence and the trends of neighbouring states.  
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Figure-2 highlights the low prevalence states of Delhi, Haryana, Punjab, Rajasthan, Uttar Pradesh, and West Bengal where HIV prevalence is either stable or declining. Evidently, the degree for decline in HIV prevalence is not uniform between these states which may be on account of the programmatic impact of ART coverage, and the strength of the prevention interventions etc. The decline in HIV prevalence is lower in Haryana and Punjab vis-à-vis Delhi, Rajasthan, Uttar Pradesh, and West Bengal.

### **National and State estimates of number of people living with HIV**

In 2009, the total number of people living with HIV (PLHIV) in India is estimated at 2.4 million (uncertainty bounds of 1.93 – 3.04 million) while in 2008; it was 2.44 million people were living with HIV within the uncertainty bounds of 1.97-3.09 millions. Among PLHIV, by sex approximately 61% are male and 39% are female and by age the percent distribution of HIV infection is estimated at 4% are children below the age of 15 years, 83% are adults aged 15–49 years and rest 13% are over 50 years of age (Table2).

The four high prevalence states of South India account for 57% of all HIV infections in the country. Whilst Andhra Pradesh accounts for 500,000 cases; Maharashtra accounts for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for 150,000 cases. Over 100,000 PLHIVs are reported in West Bengal, Gujarat, Bihar and Uttar Pradesh and together these states account for 22% of HIV infections in India. The number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000 to 100,000 and these states collectively account for 12% of HIV infections. Thus whilst the states noted above are with low HIV prevalence; a large number of PLHIVs are reported due to the states' overall large population size (Map 1).

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3 The percent distribution of HIV burden amongst high prevalence states vis-à-vis the  
4 remaining states in India is 57% and 43% respectively. Amongst the high prevalence  
5 states, Andhra Pradesh accounts for the greatest proportion of cases at 21% vis-à-vis the  
6 other states. Following Andhra Pradesh, Maharashtra accounts for approximately 18% of  
7 HIV infection, Karnataka and Tamil Nadu reportedly account for 10% and 7% of all  
8 cases whereas Manipur and Nagaland account for 1% of the estimated total.  
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### 19 **Conclusions**

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21 The India HIV estimates 2008/2009 indicate a slowdown in the AIDS epidemic. National  
22 adult HIV prevalence, or the number of adults living with HIV as a proportion of the total  
23 population, has declined by 0.05% points from 0.36% (0.29% - 0.45%) in 2006 to 0.31%  
24 (0.25% - 0.39%) in 2009. Though the estimation of 2008/09 has utilized EPP and  
25 Spectrum tool against UNAIDS/WHO workbook and Spectrum in 2006, the results of  
26 2008-09 round of estimates match perfectly with previously announced estimates.  
27 However the results of 2008-09 round of estimates cannot be directly compared with the  
28 previous years because the methodology and data used to produce the estimates have  
29 gradually changed as a result of ongoing enhancement of knowledge on the epidemic.  
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45 Adult HIV prevalence is either stable or declining in the high prevalence states whereas  
46 the trend is varying across the low to moderate prevalence states. Among the high  
47 prevalence states, the HIV prevalence has declined in Tamil Nadu between 2006 and  
48 2009 to reach levels of 0.37% in 2008 and 0.33% in 2009. Manipur shows a declining  
49 trend over the past four years. Andhra Pradesh, Karnataka, Maharashtra and Nagaland  
50 show either a plateau or a slightly declining trend over the time period 2006 – 2009.  
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3 In the low prevalence states of Chandigarh, Orissa, Kerala, Jharkhand, Uttarakhand,  
4  
5 Jammu and Kashmir, Arunachal Pradesh and Meghalaya; adult HIV prevalence has risen  
6  
7 over the last four years which warrants the need for strengthening the trend of the HIV  
8  
9 epidemic.

10  
11 In descending order, states with the highest adult HIV prevalence in 2009 included  
12  
13 Manipur (1.4%); followed by Andhra Pradesh (0.90%), Mizoram (0.81%), Nagaland  
14  
15 (0.78%), Karnataka (0.63%) and Maharashtra (0.55%). Besides these, the states of Goa,  
16  
17 Chandigarh, Gujarat, Punjab and Tamil Nadu have an estimated adult HIV prevalence  
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19 greater than national prevalence (0.31%). Delhi, Orissa, West Bengal, Chhattisgarh and  
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21 Pondicherry have an estimated adult HIV prevalence of 0.28-0.30%. Other states have  
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23 lower levels of HIV.  
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31 The total number of people living with HIV (PLHIV) in India is estimated at 2.4 million  
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33 (uncertainty bounds of 1.93 – 3.04 million) in 2009. Children under 15 years of age  
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35 account for 4.4% of all infections, whilst people aged 15 – 49 years account for 82.4% of  
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37 all infections. Thirty-nine percent of all HIV infections are estimated to be among  
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39 women. This amounts to 0.93 million women with HIV in India.  
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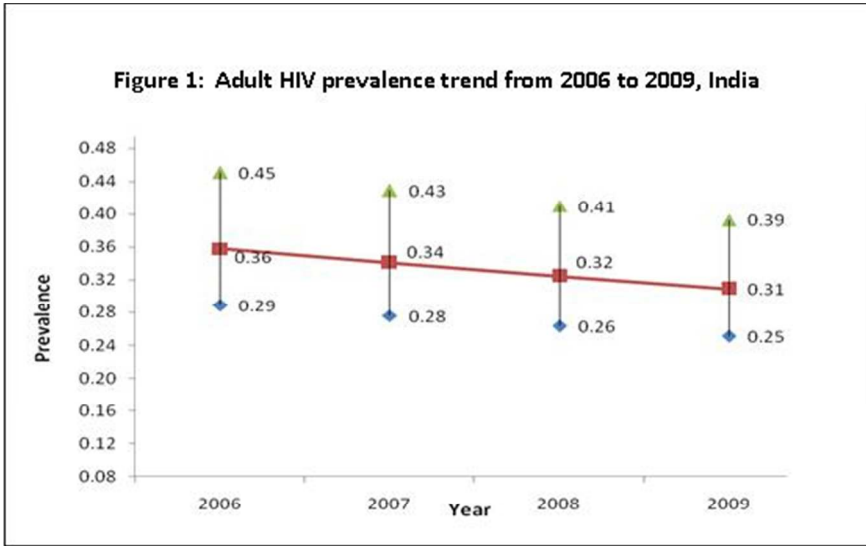


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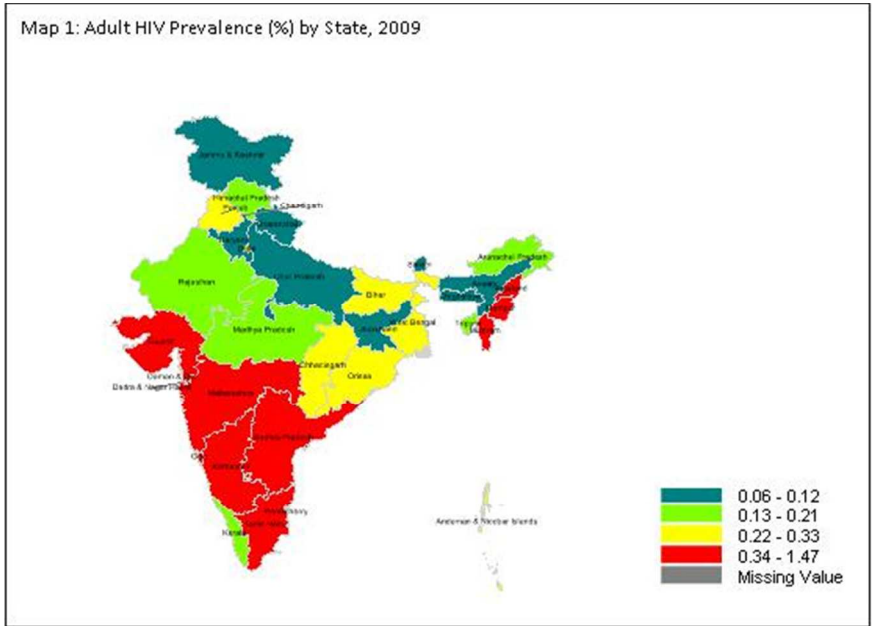
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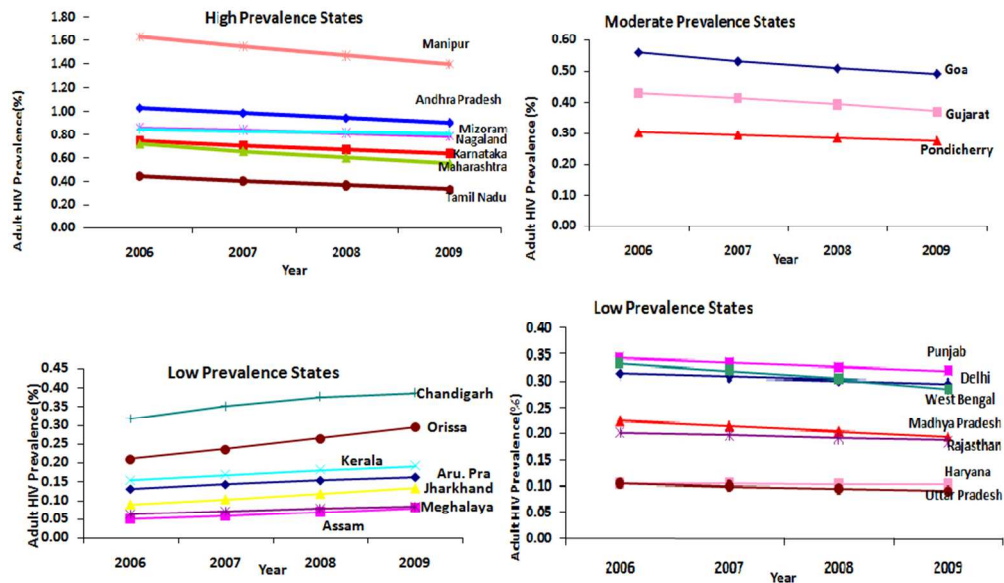
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225x180mm (72 x 72 DPI)

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Figure 2: Adult HIV Prevalence Trends from 2006 to 2009, India States



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