



Sustained progress, but no room for complacency: Results of 2015 HIV estimations in India

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Background & objectives: Evidence-based planning has been the cornerstone of India's response to HIV/AIDS. Here we describe the process, method and tools used for generating the 2015 HIV estimates and provide a summary of the main results.

Methods: Spectrum software supported by the UNAIDS was used to produce HIV estimates for India as a whole and its States/Union Territories. This tool takes into consideration the size and HIV prevalence of defined population groups and programme data to estimate HIV prevalence, incidence and mortality over time as well as treatment needs.

Results: India's national adult prevalence of HIV was 0.26 per cent in 2015. Of the 2.1 million people living with HIV/AIDS, the largest numbers were in Andhra Pradesh, Maharashtra and Karnataka. New HIV infections were an estimated 86,000 in 2015, reflecting a decline by around 32 per cent from 2007. The declining trend in incidence was mirrored in most States, though an increasing trend was detected in Assam, Chandigarh, Chhattisgarh, Gujarat, Sikkim, Tripura and Uttar Pradesh. AIDS-related deaths were estimated to be 67,600 in 2015, reflecting a 54 per cent decline from 2007. There were variations in the rate and trend of decline across India for this indicator also.

Interpretation & conclusions: While key indicators measured through Spectrum modelling confirm success of the National AIDS Control Programme, there is no room for complacency as rising incidence trends in some geographical areas and population pockets remain the cause of concern. Progress achieved so far in responding to HIV/AIDS needs to be sustained to end the HIV epidemic.

Key words Antiretroviral therapy - Estimation and Projection Package - HIV estimation - HIV sentinel surveillance - prevention of mother-to-child transmission - spectrum

The HIV sentinel surveillance launched by National AIDS Control Organization (NACO) in 1998 which was later upgraded to second-generation HIV surveillance, has been instrumental to HIV estimation and projections in India¹. These efforts have paid off as strategic information to monitor and address India's epidemic which is concentrated in specific locations and population groups including people who inject drugs, men who have sex with men (MSM), transgender people, female sex workers (FSW) and their clients. Consistent data collection and their use to understand epidemic levels and trends across geographic areas and key populations have been critical to control the HIV epidemic in India.

Over the past three decades, with the gradual scale-up of the service delivery for HIV prevention and care across the country, there has been a commensurate emergence of data sources and data elements for HIV in India. Under the National AIDS Control Programme (NACP), newer and more comprehensive data by geography and population group have been made available. A constant endeavour of monitoring and evaluation with the Strategic Information and Management Unit of the NACO has been steadily enhancing the accuracy of information generated and ensuring its representativeness, comprehensiveness and its effective use over time.

Strategic information management and use has constituted an important strategy under the various phases of the national programme. HIV estimation and projections have remained one of the pillars of strategic information and a key source of evidence on the HIV epidemic in India^{1,2}. Research across the globe and in India emphasizes the importance of generating HIV estimates periodically for multiple reasons. It enables the nation as a whole and States to take stock of HIV-epidemic trends and burden of the disease, understand the efficacy of various HIV prevention and treatment interventions, and provides pertinent information to inform policy and programme formulation³⁻⁶. HIV estimates also help in monitoring the progress and evaluating the success achieved in responding to the epidemic in relation to the goals set by international as well as national agencies.

Core elements of India's strategic information system are surveillance, programme monitoring, research and evaluation. Data obtained from these different sources are validated, triangulated and utilized to produce HIV estimates of the number of new HIV infections, people living with HIV (PLHIV),

AIDS-related deaths and other indicators through modelling. Modelled estimates are generated because it is not possible to count the exact number of people who get infected, are living with HIV and who die from AIDS-related causes^{7,8}. Lower and upper bounds are generated representing the estimate's confidence interval.

HSS and HIV estimation of key indicators, including HIV prevalence, HIV incidence, number of PLHIV, AIDS-related deaths, people requiring antiretroviral therapy (ART) and prevention of mother-to-child transmission (PMTCT), are undertaken periodically in India for use in planning processes⁹.

HIV estimates in India have been generated annually since 1997-1998². Refined tools and data have been used under each round of estimation to improve the quality of results generated for key indicators. This study presents the process, method and tools used to produce national- and State-level estimates of HIV prevalence, new HIV infections, AIDS-related deaths and ART needs in 2015, for the latest HIV estimation round in India.

Material & Methods

The study is the outcome of the 2015 HIV estimation exercise for India as a whole and its 34 States and Union Territories. It has been carried out by the National Expert Committee on HIV Estimation during March-November 2015. Secondary data on demographics from Census and Sample Registration System (SRS), Office of the Registrar General, India, was utilized in the estimations process. Trend in HIV prevalence from national HSS and aggregated anonymous data for ART and PMTCT coverage data from Annual Reports of the NACP were also used. No individual-level data were used in the estimation process at any stage or in any form.

The Spectrum tool¹⁰ supported by the UNAIDS was used to produce HIV estimates globally. Spectrum is a mathematical model used to map, understand and determine the consequences of the HIV epidemic in countries over time. The model takes into consideration the size of and HIV prevalence among defined population groups and sub-groups including pregnant women attending antenatal clinics and key population groups at high risk of HIV infection, such as FSWs, MSM and people who inject drugs. In addition, the Spectrum requires epidemiological parameters to be set, for example, AIDS treatment eligibility and programme data such as numbers of HIV-positive adults, children

and pregnant women receiving ART to estimate HIV prevalence, incidence and mortality over time.

There are two modules in the Spectrum, namely, DemProj module and the AIDS Impact Module (AIM). The Estimation and Projection Package (EPP) has in the recent years been introduced as part of AIM for estimating HIV prevalence and incidence for all ages¹⁰. DemProj module projects the total population of a country by age and sex using a cohort component method which is based on assumptions about fertility, mortality and migration. Demographic data inputs in DemProj include population size by age and sex in the first year of the projection, level and trends of fertility and mortality by age, sex ratio at birth and age and sex distribution of net migration. The time period of the population projection for India was set from 1981 to 2021; 1981 was chosen as the base year because the first case of HIV was detected in India in 1986, and thus the epidemic is assumed to have started earlier. State-specific age and sex population projections were carried out and were used as input in the model after crossmatching them with Census results for 1991, 2001 and 2011 to ensure consistency.

The EPP models HIV prevalence among specific population groups based on data from HSS and routine monitoring of programmes (*i.e.*, number of people registered on ART). The EPP makes use of all the available data, fitting multiple curves through several thousand iterations using Bayesian Melding techniques, and gives the best curve fit that explains HIV-epidemic trends among each defined key population. The EPP also has provisions for calibration of the best curve fit thus generated. Usually, HIV prevalence values obtained from periodically conducted probability-based national population surveys are used for calibration. For India, the population-based HIV prevalence values were sourced from the third round of the National Family Health Survey (NFHS)¹¹. Finally, the EPP back calculates to derive the estimated number of new infections (incidence) that occurred during the course of epidemic.

AIM takes the incidence curve generated by EPP as well as ART and PMTCT coverage as inputs. It applies transmission and survival probabilities, epidemiological assumptions related to fertility and HIV, CD4 transition patterns, HIV incidence by age and preventive effects of the ART. AIM projects the consequences of the epidemic in terms of number of people living with HIV/AIDS, new HIV infections and AIDS-related deaths by sex and age.

Key developments were introduced by the UNAIDS in Spectrum 5.30 version (<http://www.avenirhealth.org/software-spectrum.php>), especially when compared with the 2011 version¹⁰. For instance, in the PMTCT programme statistics section in the AIM model, ART initiation during pregnancy was divided into two predetermined categories (*i.e.*, <4 week before delivery and after 4 week). Transmission rates were updated based on the PROMISE study which indicated that triple-drug ART was best to prevent mother-to-child transmission of HIV¹². In the adult model, ART dropout was added, and variability of total fertility rate (TFR) reduction over time was introduced. TFR is the average number of live births to a woman by the age of 50 if she were subject, throughout her life, to the prevailing pattern of childbearing at each age group. Other newer Spectrum outputs included estimates of the number of PLHIV on ART by age, non-AIDS deaths among HIV-positive people and HIV incidence and AIDS-related mortality per 10,000 populations. The paediatric model was revised to follow children by CD4 count. New assumptions were introduced such as mortality among PLHIV who are on ART by CD4 category.

The curve fitting procedures were modified in the EPP to give more weight to data from surveys when these were used. The 'best curve fit' used in the EPP 2011 has been replaced in the EPP 2013 with the Bayesian median (for each year) to allow for more stable fits of curves across several data points. Mortality related to injecting drug use was changed to use separate values for HIV-positive and HIV-negative people who inject drugs. Adjustments were made for ANC data in generalized epidemics to deal with changes over time in ANC composition; however, this parameter did not affect estimation results in concentrated epidemic settings as was the case in India. The Spectrum was adjusted to allow users input into the EPP migration data derived from research and studies conducted in the national context. This was necessary for the EPP to be able to correctly calculate mortality across population groups.

Data sources

Demographic inputs: The source for demographic inputs into the Spectrum included latest round of Census in 2011¹³, Census Expert Group Population Projections¹⁴, SRS¹⁵, NFHS 2005-2006 (NFHS-3)¹¹, National Integrated Behavioural and Biological Surveillance (IBBS 2014-15)¹⁶ and expert research

work. The key demographic inputs included population census data by age and sex, TFR, age-specific distribution of fertility, sex ratio and life expectancy at birth, age-specific mortality, inter-census net migration rate and migration by age and sex.

State-specific population projections for 1981-2021 were generated using all these inputs as well as the latest census age and sex distribution data which became available in 2015. In addition, population size estimates for key population groups including FSWs, MSMs and people who inject drugs were updated as per the NACO's mapping exercise and were used as demographic input in the modelling¹⁷.

Epidemiological inputs: Data on HIV prevalence obtained from HSS in 1998-2015 were employed as the basis for modelling the HIV epidemic. The second-generation surveillance data used for the model included prevalence data from the (IBBS 2014-2015), and from the previous two rounds of Integrated Behavioural and Biological Assessment (2006 and 2009) conducted among select key population groups in the States of Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra and Nagaland^{16,18}.

Programme inputs: Treatment coverage data were collated State- and year-wise using the ART and PMTCT programme data from Strategic Information Management System of NACO. These data were reviewed for quality and input in the Spectrum. ART coverage data were compiled for the period ending March 2015 and entered separately for males, females and children. For the following years, ART coverage was projected for each State/Union Territory up to 2021 by taking into account the current coverage and target coverage rate for 2021 (considered as between 90 and 95% in the high coverage States in southern parts of India and up to 80% in low coverage States in northern and central parts of India). ART coverage data from Chandigarh and Delhi were reviewed and adjusted for the large number of people living with HIV originating from neighbouring States who sought treatment in these urban tertiary care centres. In the case of Chandigarh, the bulk of people living with HIV receiving ART were domiciled in neighbouring States of Punjab and Haryana. This proportion of non-resident patients was removed from Chandigarh and added to Punjab and Haryana, respectively, in all the current and previous years. The same adjustment was made in the case of Delhi as the capital city also receives a

large number of patients from neighbouring States/Union Territories.

India has transitioned from a single-dose nevirapine (SD NVP) strategy to the Option B+ strategy, for PMTCT, under the NACP. Since 2014, lifelong ART using triple drug regimen is being provided to all pregnant and breastfeeding women living with HIV, regardless of their CD4 count or WHO clinical stage¹⁹. Accordingly, data on the coverage of SD NVP, Option B and B+, derived from the NACO's national database¹⁹, were entered into the Spectrum for each State/Union Territory. From 2015 onwards, coverage of SD NVP was kept constant at 0 per cent because the programme was completely transitioned to Option B+ in all States/Union Territories. Assuming that by 2021, the coverage of Option B+ will be 90 per cent in all States/Union Territories, the indicator 'ART started before current pregnancy' was projected from its actual 2014 level recorded through programme monitoring to a considered target of 70 per cent in 2021, and the indicator, 'ART started during current pregnancy greater than four weeks before delivery' was projected from the 2014 level to 20 per cent in 2021.

HIV prevalence data among the general population, obtained from the 2005 to 2006 NFHS-3, were used for calibrating the HIV prevalence trends among pregnant women attending antenatal care (ANC)¹¹. HIV prevalence data from national 2014 to 2015 IBBS among key population groups including FSWs, MSMs and people who inject drugs were used for calibrating the HIV prevalence trend among key population¹⁶. Assumptions on the average duration of risk behaviour were derived from the 2006 Behavioural Surveillance Survey²⁰. The average duration of sex work among FSWs and of the use of injecting drugs among people who inject drug was set at 8 and 15 years, respectively. However, no duration was specified for duration of sex among MSMs.

The method of modelling: For India's 2015 HIV estimations, modelling was initiated using the same Spectrum version that was used for the 2012 HIV estimations, Spectrum 4.53 Beta 19. This was done to ensure continuity of key assumptions in the EPP component and to ensure consistency in the epidemic curve. Spectrum 4.53 Beta 19 helped generate an epidemic curve from 1981 to 2021, consistent with earlier projections and calibration points to account for prevalence obtained in 2006 from the NFHS-3 for the general population and for key population groups

from the 2014 to 2015 IBBS. The incidence curve was imported into Spectrum 5.30 to run calculations and produce estimates for all the HIV indicators. This allowed for application of newly introduced modelling parameters based on the latest global and regional evidence, especially with regard to AIDS-related mortality and infection in the context of treatment.

Incidence and relevant programme coverage data regarding ART and PMTCT were inputted into the model using Spectrum 5.30. In this process, a few specific parameters were customised to the Indian context including ART eligibility for specific population groups regardless of their CD4 count (*i.e.*, pregnant women, HIV-negative partners in serodiscordant couples) as per India's HIV policy¹⁹. In addition, HIV transmission rate for people on ART was reset to 0.70 from the Spectrum default value of 0.92 because, while these rates have been demonstrated in other parts of the world among PLHIV who were put on treatment early^{19,21}, national studies in India showed late enrolment in treatment with median CD4 cell count of 120 cells/ μ l at treatment initiation. Similarly, studies in India showed that adherence to treatment was only around 60-70 per cent during 2007-2010²¹⁻²³.

Models for each one of India's States and Union Territories were developed separately and then integrated into a national model. Through this process, estimations of HIV prevalence, HIV incidence, the number of PLHIV, AIDS-related deaths and HIV-positive pregnant women requiring ART were produced for each of India's States and Union Territories. Estimates were generated for these indicators for all the years from 2007 to 2015 with a lower and upper uncertainty bound. The State-specific estimates were added to derive national estimates for each of the main indicators.

Results

Estimates of HIV prevalence rate, number of PLHIV, new HIV infections, AIDS-related deaths and of treatment needs (ART and PMTCT) were desired. National-level results for each of these indicators were based on aggregation of State-level estimates. The model provided uncertainty bounds by calculating the range of plausible values for each of the output indicators, acknowledging that the figures were estimations based on the best available evidence and calculation methods at the time of estimation, which should not be construed as absolute point figures.

National-level estimates: National adult prevalence (15-49 yr) was estimated to be 0.37 per cent (0.29-0.47%) in 2000 and 0.38 per cent (0.31-0.47%) in 2001-2003/2004 which was considered the peak following which it declined to 0.26 per cent (0.22-0.32%) in 2015. The decrease in HIV prevalence was 5 per cent during 2003-2005, 14 per cent during 2006-2010 and 10 per cent during 2011-15 (Fig. 1A). In 2015, HIV prevalence among adult males was estimated at 0.30 per cent, while that among females it was 0.22 per cent.

The number of people living with HIV steadily rose from 1990 to 2004, and thereafter stabilized. It was 2.02 million (1.52-2.71 million) in 2000 and 2.28 million (1.83-2.90 million) in 2004, while by 2015, it had dropped to 2.12 million (Fig. 1B). In 2015, children aged under 15 yr accounted for 6.6 per cent of the total HIV infections, 10.5 per cent were among people aged 50 yr or older. Females accounted for 40 per cent of HIV infections.

The average annual rate of increase in the number of people living with HIV was 40.1 per cent in the 1990-1995 period, 12.4 per cent in 1996-2000 and 2.2 per cent in 2001-2004. The number of people living with HIV declined afterwards at an annual rate of 0.7 per cent. The number of people living with HIV per 100,000 population was estimated at around 200 in 2000, 211 in 2004 and 166 in 2015.

The annual number of new HIV infections steadily declined following a peak in 1997 (Fig. 1C). In that year, around 28,500 (17,200 to 45,500) of new infections were estimated to have occurred. The Annual Rate of Decrease (ARD) was at an average of 6.4 per cent per year, but reduced further over the past decade. While during 2001-2005 and 2006-2010, they decreased at an estimated 9.3 and 7.4 per cent, respectively, and from 1997 to 2000, they decreased at an ARD of 4.1 per cent per year. In 2011-2015, ARD in new HIV infections was 3.4 per cent, the lowest rate ever registered.

AIDS-related deaths steadily rose from the beginning of the epidemic increasing from 80,038 (56,665 to 1,49,863) in 2000 to a peak of around 1,49,238 (1,06,463 to 2,88,829) in 2006. With initiation in 2004 of the ART programme, which was only scaled up in 2006-2007, the programme started to provide treatment to PLHIV with a CD4 count of ≤ 200 cells/ μ l up to 2008, CD4 ≤ 250 cells/ μ l in 2009-2010, CD4 ≤ 350 cells/ μ l in 2012-15 and CD4 < 500 cells/ μ l as of April 2016. The scale-up in treatment across the country resulted in

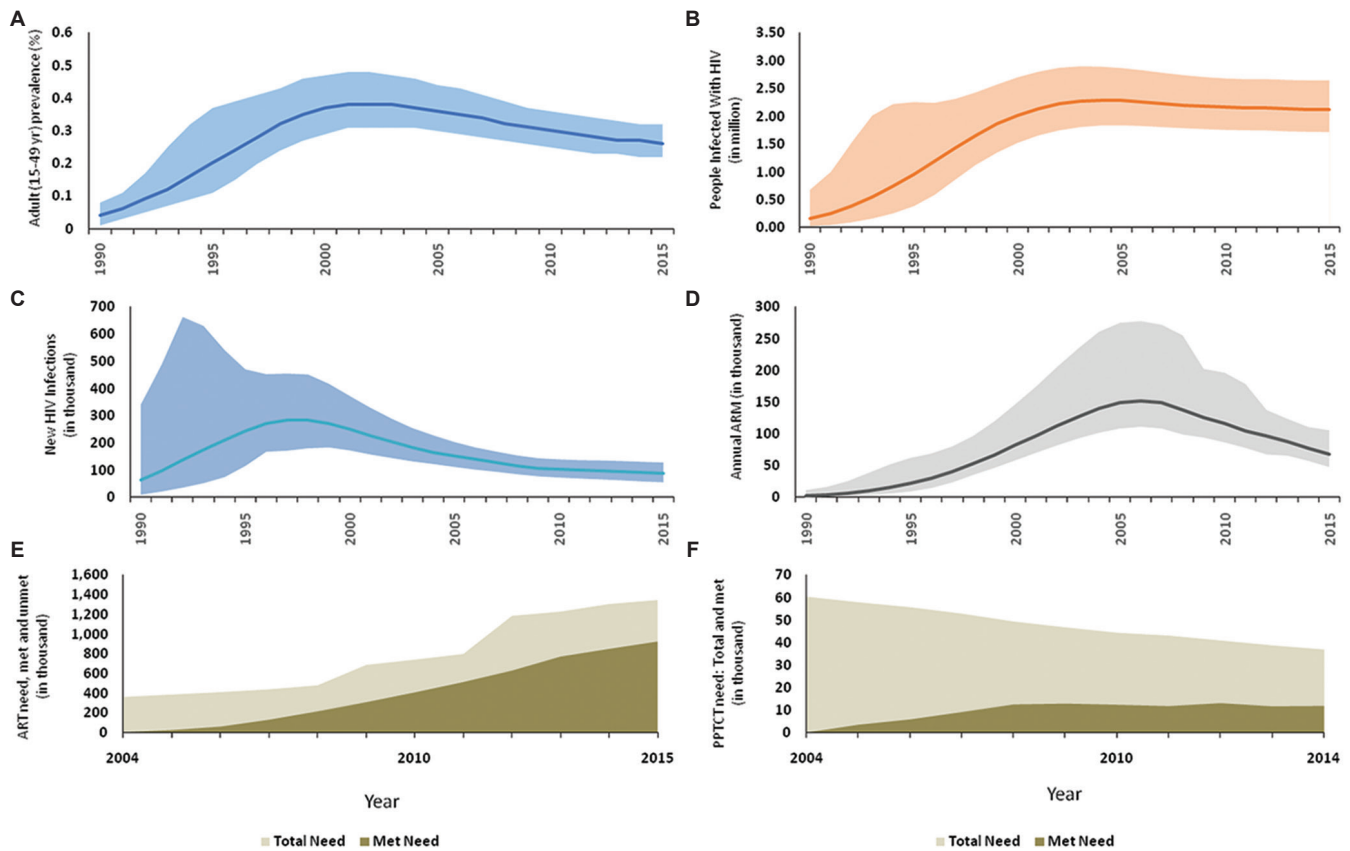


Fig. 1. (A) Adult (15-49 yr) prevalence (%), (B) people infected with HIV (in million), (C) new HIV infections (in thousands), (D) annual AIDS Related Mortality (ARM) (in thousands), (E) antiretroviral therapy (ART) need, met and unmet (in thousands), (F) PPTCT (Prevention of parent to child transmission) need: Total and met (in thousands) India.

annual AIDS-related death rates falling to reach around 68,000 (46,000 to 10,600) in 2015 (Fig. 1D).

Out of an estimated 68,000 AIDS-related deaths in 2015, nearly 8,000 were among children. The decline in AIDS-related deaths was consistent with the scale-up of the national ART programme from around 65,000 people living with HIV receiving ART in 2004 to around 90,000 in 2014. The ART in AIDS-related deaths was overall 8.5 per cent, though more specifically from 2006 to 2010, the ART was 6.5 per cent and was 10.3 per cent during 2011-2015. In total, annual AIDS-related deaths declined by 54 per cent from 2007 to 2015. The estimated annual AIDS-related mortality per 100,000 population was 8 in 2000 and rose to 14 in 2006. Thereafter, it dropped to 5 in 2015. With a CD4 count cut-off of ≤ 350 cells/ μ l, the total estimated need for ART was 1.34 million in December 2015 (Fig. 1E). Out of this number, 1.27 million were people aged 15 yr and the remainder were children. This represented a three-fold increase in people needing ART since 2004 (Fig. 1E), an exponential growth which was largely due

to revisions in treatment eligibility criteria introduced in India to allow a greater number of PLHIV to enrol in treatment earlier.

As a result of expanding numbers of people gaining access to treatment, and hence surviving longer, AIDS-related mortality declined. With around 85,000 adult people on ART at the end of 2014, the coverage of ART treatment, out of those eligible for ART, reached around 60 per cent (Fig. 1D). This represented a nearly 28-fold increase compared with an ART coverage of 7.7 per cent in 2005. However, based on the eligibility criteria of ≤ 500 cells/ μ l introduced in 2015, ART coverage was an estimated 40 per cent of PLHIV in need of treatment.

Around 35,200 mothers needed PMTCT services in 2015 which was 42 per cent less than the need in 2004. This trend was also consistent with the declining TFR in the country and with a more or less stable population of females living with HIV. PMTCT coverage in 2014 was around one-third of pregnant women in need which was more than five times higher than the level registered in 2005 (Fig. 1F).

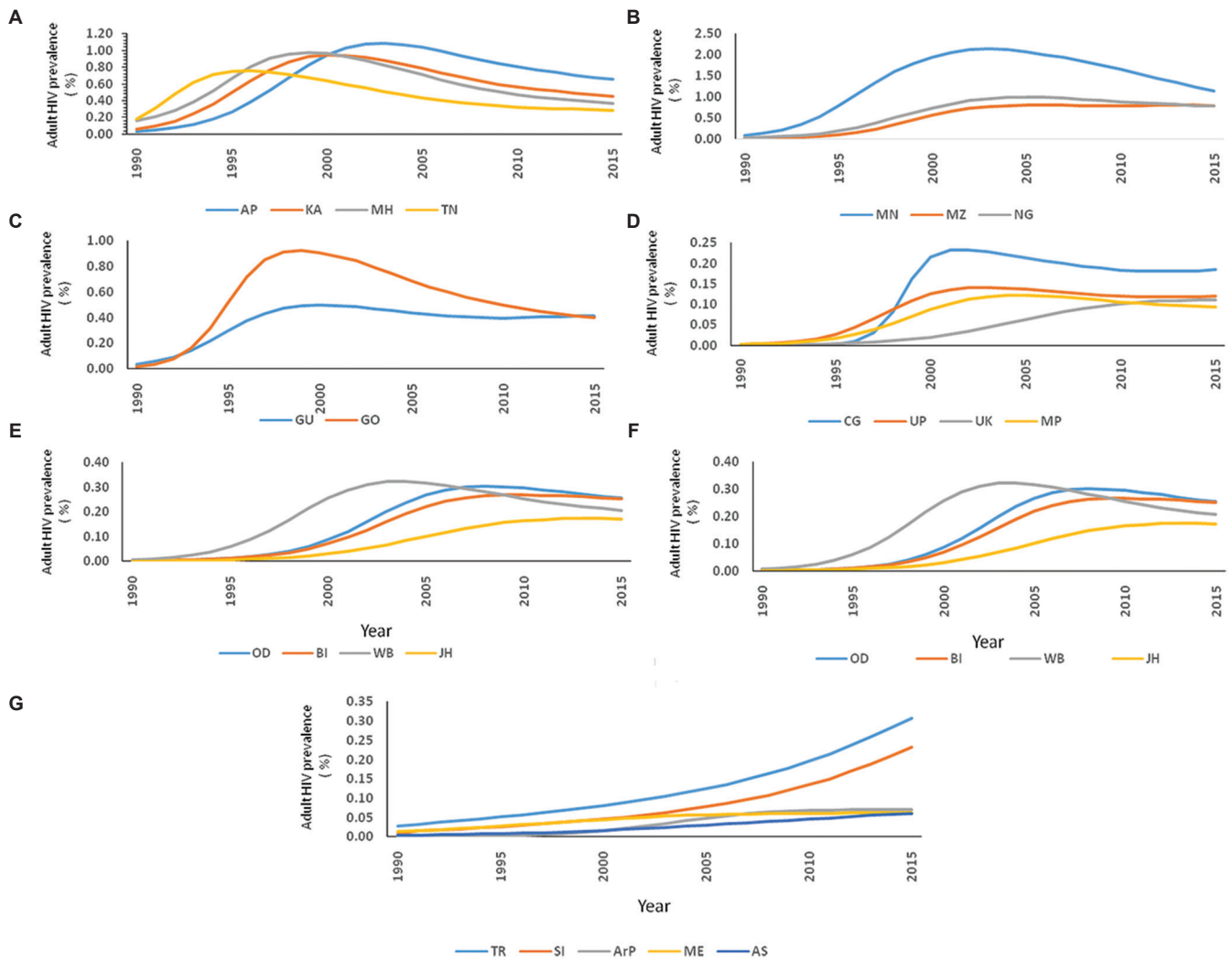


Fig. 2. Adult (15-49 yr) HIV prevalence (in %) by States, 1990-2015. AP, Andhra Pradesh; KA, Karnataka; MH, Maharashtra; TN, Tamil Nadu; MN, Manipur; MZ, Mizoram; NG, Nagaland; GU, Gujarat; GO, Goa; CG, Chhattisgarh; UP, Uttar Pradesh; UK, Uttarakhand; MP, Madhya Pradesh, OD, Odisha; BI, Bihar; WB, West Bengal; JH, Jharkhand; DE, Delhi; RJ, Rajasthan; DU, Daman and Diu; HR, Haryana; HP, Himachal Pradesh; JK, Jammu Kashmir; TR, Tripura; SI, Sikkim; ArP, Arunachal Pradesh; ME, Meghalaya; AS, Assam.

State-level estimates: There was variance across States/Union Territories in the level of the epidemic and trends in key indicators. Regarding adult HIV prevalence (15-49 yr), 11 States in 2015 had an estimated prevalence higher than the national average of 0.26 per cent, including the three northeastern States of Manipur (MN) (1.15%), Mizoram (MZ) (0.80%) and Nagaland (0.78%). These were followed by the erstwhile high HIV prevalence States of Andhra Pradesh (AP) and Telangana, Karnataka (KA), Maharashtra (MH) and Tamil Nadu (TN) in south India, the low-to-moderate HIV prevalence States of Gujarat (GU), Goa (GO), Chandigarh (CG) and Tripura (in West, Central and

North-east India). HIV prevalence in Odisha (OD), Bihar (BI), Sikkim (SI), Delhi (DE), Rajasthan (RJ) and West Bengal (WB) was between 0.20 and 0.25 per cent, while in the remaining States, it was <0.20 per cent in 2015.

While HIV prevalence in most of the States and Union Territories, including the former high prevalence States of Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Manipur and Nagaland (NG), either declined or remained stable in other States such as Assam (AS), Delhi, Jharkhand (JK), Punjab (PU), Haryana (HR), Tripura (TR) and Uttarakhand (UK), it rose from 2007 to 2015 (Fig. 2).

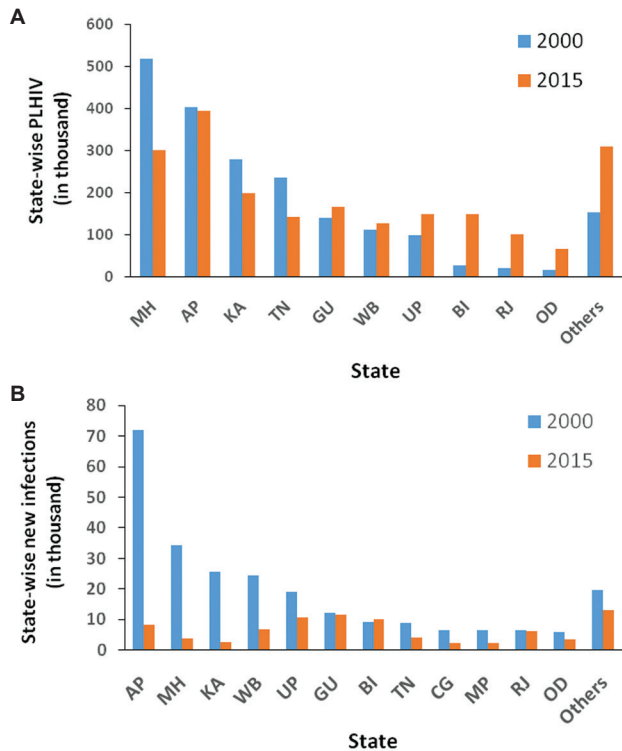


Fig. 3. (A) State-wise people living with HIV (PLHIV) (in thousands), **(B)** State-wise new infections (in thousands). Abbreviations as given in Fig. 2. Others, rest of the States.

Regarding the volume of HIV infections, Andhra Pradesh and Telangana (394,700), Maharashtra (301,500), Karnataka (199,100) and Gujarat (166,300) had the largest number of PLHIV in 2015. These States accounted for almost 50 per cent of the total of PLHIV in India. These are also some of the most populous States in the country, especially Andhra Pradesh, Telangana and Maharashtra.

The eight States accounting for the highest number of PLHIV were in a descending order: Bihar, Uttar Pradesh, Tamil Nadu, West Bengal, Rajasthan, Odisha, Madhya Pradesh and Punjab. Together, these comprised 39 per cent of the total of PLHIV in the country. The remaining 22 States accounted for 11 per cent of PLHIV.

The direction and level of the State-specific epidemics have evolved over the last 15 years. This was evident if the number of people living with HIV was compared across States and Union Territories in 2015 and 2000 (Fig. 3A).

The group of States accounting for the highest number of annual new HIV infections has also changed over time (Fig. 3B). In 2000, Andhra Pradesh

was estimated to have the greatest number of new HIV infections (72,000), followed by Maharashtra (34,000) and Karnataka (26,000). Together, these three southern States - which were previously categorized as high-prevalence States - contributed 52 per cent of the total new infections in the country. In 2015, these three States contributed a smaller proportion (17%) of the total new infections. Instead, six geographically dispersed States in western, northern/central, eastern and southern parts of India, including Gujarat, Uttar Pradesh, Bihar, Andhra Pradesh, West Bengal and Rajasthan, had more than 5,000 new infections, up to a maximum of 12,000. These six States together account for 54 per cent of the total new HIV infections in India.

The number of new HIV infections per 100,000 population declined in almost every State/Union Territory after attaining a peak which varied depending on the year of start of the epidemic (Fig. 4). Only exceptions were the small north-eastern States of Tripura and Sikkim where HIV incidence per 100,000 population did not yet achieve their peak. On the other hand, in Tamil Nadu, Gujarat, Uttar Pradesh, Assam and Chhattisgarh, incidence per 100,000 population was mostly stable during 2010-2015.

States/Union Territories with the highest estimated number of PLHIV also accounted for the highest estimated AIDS-related mortality. This was particularly the case before India's ART Programme was initiated in 2004. For instance, States with the highest prevalence in 2000 such as Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka, together contributed about 80 per cent of the total AIDS-related deaths in the country. Trends in AIDS-related mortality changed significantly after the introduction of ART treatment, especially once the treatment programme was expanded. Much fewer AIDS-related deaths occurred in 2015 compared to 2000 in earlier high-prevalent States such as Tamil Nadu, Karnataka and Maharashtra, while a lesser drop occurred in Andhra Pradesh. On the contrary, the same AIDS-related mortality was registered in 2000 and 2015 in Gujarat and higher in West Bengal and Uttar Pradesh in 2015, compared to 2000.

Annual AIDS-related deaths per 100,000 population declined in most of the States/Union Territories after these attained a peak in 2005-2007. However, the rate of decline varied across the country. The maximum declines occurred in Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra, where annual AIDS-related deaths decreased from

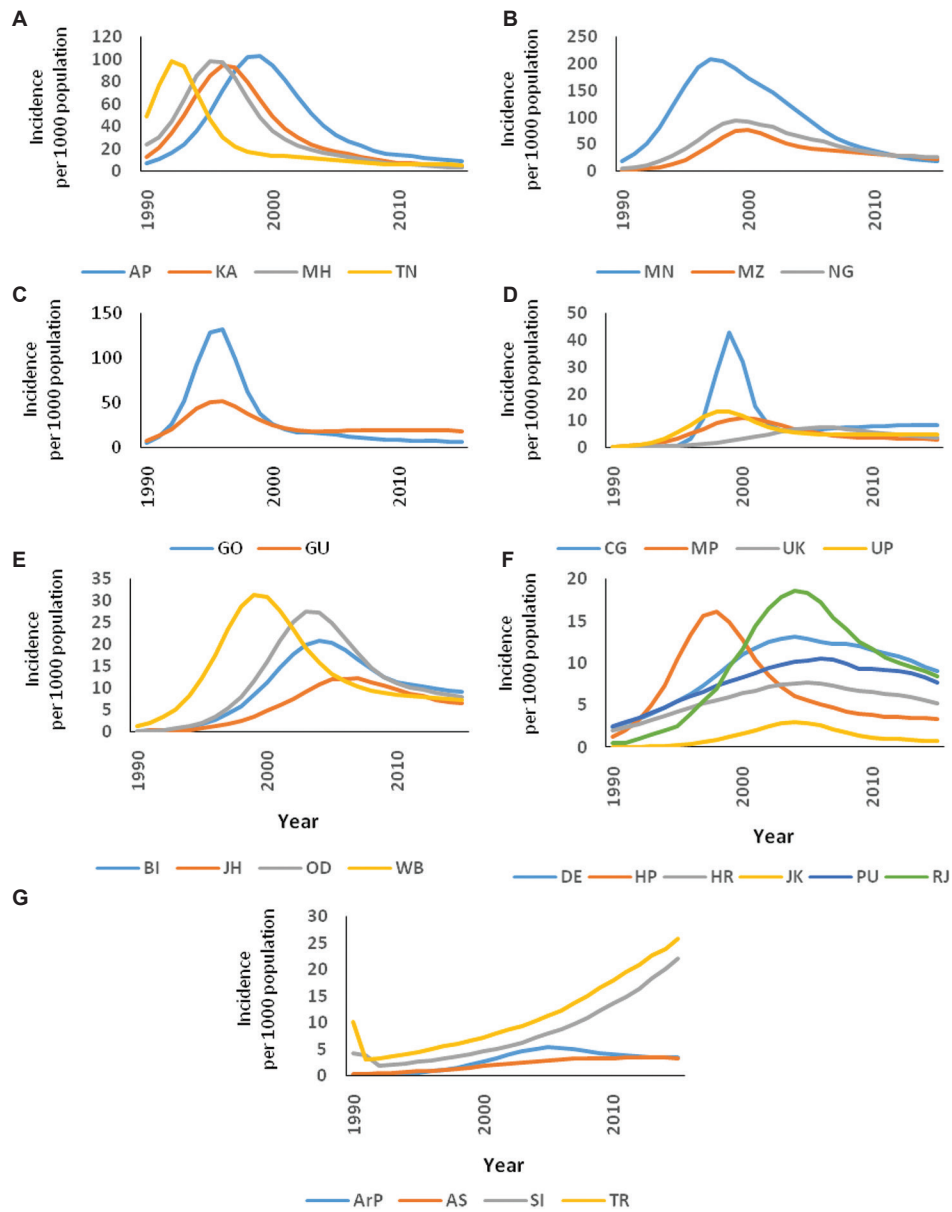


Fig. 4. (A-G) Incidence per 100,000 population by States, 1990-2015. Abbreviations as given in Fig. 2.

25-38 per 100,000 in 2004-2007 to 5-12 per 100,000 in 2015. Mizoram continued to have high numbers of annual AIDS-related deaths despite declines after a peak in 2005. Bihar, Uttarakhand, Jharkhand, Odisha, Rajasthan, Tripura, Sikkim and Arunachal Pradesh constituted an exception to the general declining trend in AIDS-related mortality. In these States, the peak in AIDS-related mortality has not either reached or has reached only recently in the last few years (Fig. 5).

Discussion

India generates annual HIV estimates for the national and the State level, on a periodic basis, using

the latest available demographic, epidemiologic and programmatic data. The primary focus of the exercise is to ensure the quality of data that is used as input into the Spectrum tool and to improve the modelling parameters used for generating State estimates, to ensure the technical integrity of results.

India's 2015 HIV estimates provided updated information on the status of HIV epidemic in the country and across its States/Union Territories on key indicators including HIV prevalence, number of people living with HIV, HIV incidence, annual new HIV infections and AIDS-related deaths as well as ART and

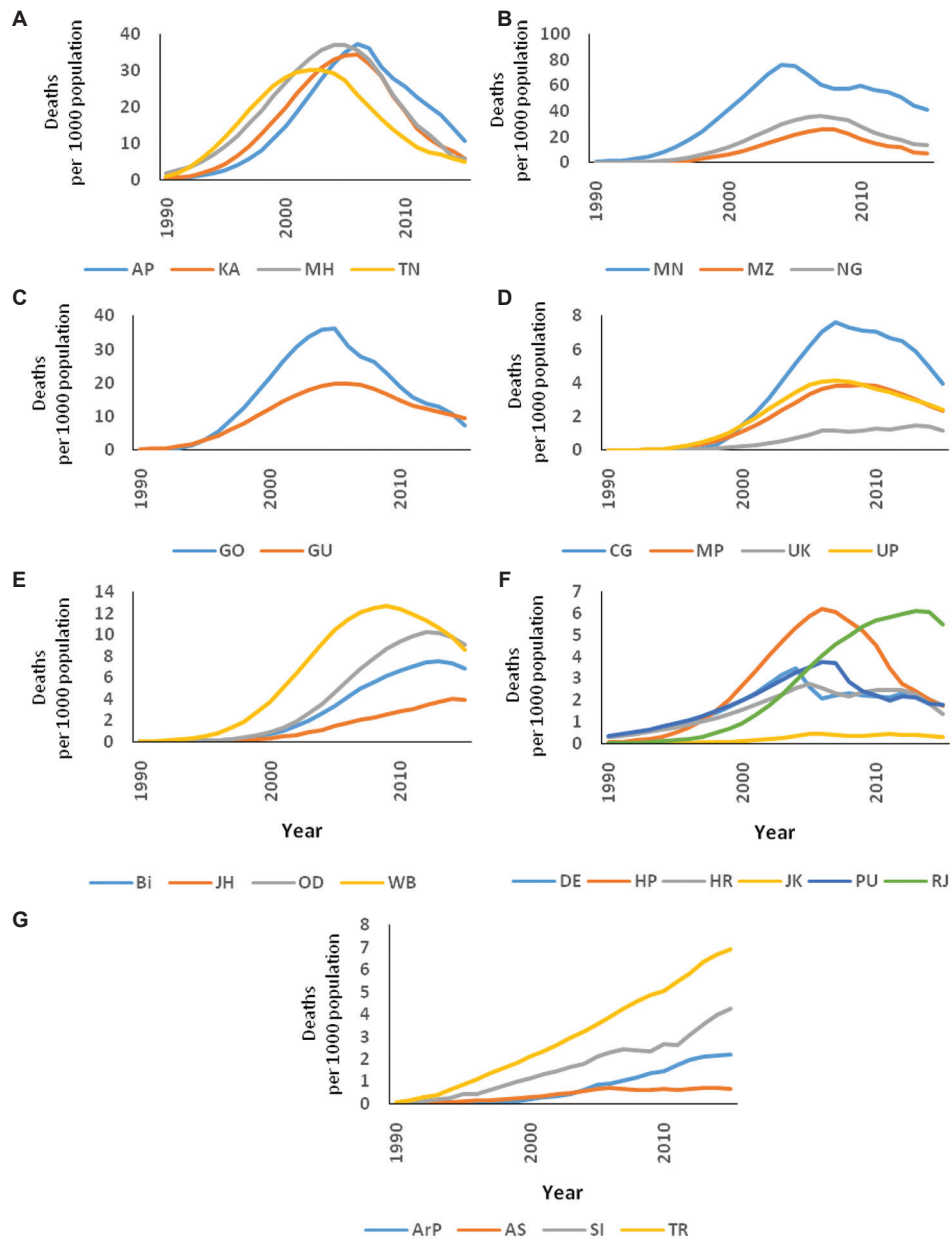


Fig. 5 (A-G). AIDS-related deaths per 100,000 population by States, 1990-2015. Abbreviations as given in Fig. 2.

PMTCT treatment needs. These latest estimates were generated using globally recommended modelling techniques. Key methodological aspects were adapted to the Indian context. In this round, HIV prevalence data collected from the National IBBS survey was used for the first time. This has helped calibrating the unadjusted median prevalence for key populations from HSS that was utilized for relevant years until 2011. A similar method of calibration of HIV prevalence data was employed using prevalence data from the 2006 NFHS-3 to adjust HSS ANC prevalence. Use of IBBS

data for calibration of key population prevalence increased the scientific robustness of HIV estimates because these data were more representative as the survey was conducted in a much larger number of sites, covering over 138,000 respondents, including new sites in northern and central parts of India.

However, these additions did not have a major impact on estimations results for two reasons: first, HIV prevalence from 2014 to 2015 National IBBS across different key populations groups was more or less consistent with prevalence obtained from

HSS conducted in 2011. Second, as key population size estimates were smaller compared with the total population of the country, the resulting key population prevalence translated as additional absolute numbers of HIV-infected people in these groups was relatively insignificant and did not affect the overall estimation results.

Changes in assumptions on HIV mortality among people on ART in Spectrum 5.30 used in this estimation round included modifications of annual probability of HIV-related mortality of people on ART by CD4 count and treatment initiation and duration. The 2012 estimates, instead, used custom ART mortality derived from earlier studies by the International Epidemiological Database to Evaluate AIDS consortium¹⁰.

For India's 2015 HIV estimations, the 'Asia' pattern model¹⁰ was selected for calculation of the annual probability of HIV-related mortality of people on ART. Since Asia-specific HIV-related mortality in the context of ART was half the standard one used in 2012, this change in assumption was expected to improve estimates of the number of people living with HIV. In fact, it caused a notable decline in AIDS-related mortality, and consequently levelled out HIV prevalence and somewhat decreased HIV incidence.

The 2015 HIV estimates corroborated the success of the National AIDS Programme² in rolling back the HIV epidemic at the national level from 2000 onwards. Results are consistent with the earlier round of HIV estimations as well as local epidemic understanding^{1,2}. This was consistent with declining trends in HIV infections observed in most parts of the world¹⁹. In India, nationally, the total number of new annual HIV infections decreased by 66 per cent in 2000-2015, while annual AIDS-related deaths declined by 54 per cent after attaining a peak in 2006. The declining trend in these indicators was found in most States/Union Territories, with certain exceptions. One of the main reasons for the decline in new infections was the integrated use of evidence on the epidemic and the response to inform the large-scale expansion of the HIV prevention programme, particularly in the high-epidemic areas during the early phases of the response^{5,24-26}.

With an estimated 86,000 of new annual HIV infections in 2015 (7 per 100,000 population) and 67,000 AIDS-related deaths (5 per 100,000 population), the progress made in responding to the AIDS epidemic in India was notable. In some States/Union Territories,

HIV infections were still rising, and AIDS-related deaths did not decline as fast as expected. Overall, the epidemic has grown more multi-faceted, and hence a better understanding of the disease burden and epidemic trends in specific geographical areas and key populations is required. Analysis of State-level estimates provided indication of areas where vulnerabilities and risk behaviours were highly prevalent, and further investigation and programme focus are needed.

The new estimates also showed that the epidemic was no longer declining at the same rate as it was earlier. While new HIV infections reduced at a high rate by overall 66 per cent in 2000-2015, the annual rate of decline was slow, especially since 2011. In some States in the northern and central part of the country, where transmission of the virus is driven by a combination of injecting drug use and sexual transmission, the new infections were rising or stabilising (Gujarat, Uttar Pradesh and Punjab). It is in these rising or stabilising epidemic States/Union Territories where programmatic efforts need to be focused, to increase the yield of fast track efforts, to avert new HIV infections, and prevent AIDS-related deaths, so to reach 90-90-90 targets and eliminate the epidemic.

Similarly, while on average AIDS-related mortality declined annually by 9.3 per cent in 2001-2005, 7.4 per cent in 2006-2010, the decline was 3.4 per cent in 2011-2015. If a 'business as usual' approach is maintained, declines in AIDS-related mortality may continue at an annual rate of 3.4 per cent. Similarly, without introducing programmatic innovations and scaling up or at least sustaining prevention efforts, new HIV infections will decline only by roughly 50 per cent by 2030²⁷. Not only is this far from national and global targets, but slow progress in decreasing new HIV infections will also impact on treatment targets and overall burden of the disease.

In the post-2015 era, countries across the world have adopted 17 sustainable development goals (SDGs) that include ending the AIDS epidemic by 2030²⁷. India is one of them. UNAIDS Fast-Track Strategy²⁷ has two core components: the prevention target of reducing the new HIV infections among adults to 200,000 by 2030 (roughly 90% reduction against the current level) and a treatment target of getting 86 per cent of PLHIV on treatment for viral load suppression. Clearly, (i) prevention of new HIV,

infection among various populations, especially key groups at high risk of infection, (ii) earlier diagnosis and detection of HIV, and (iii) rapid enrolment of people diagnosed with HIV in treatment and adherence for suppressed viral load are all critical priorities which need to be promoted.

India's 2015 HIV estimations not only indicated the need for intensifying prevention efforts, but also showed which States required special focus. Gujarat, Uttar Pradesh, Bihar, Andhra Pradesh, West Bengal and Rajasthan were the biggest contributors to HIV incidence. These States need to be targeted as a matter of priority. While the number of people living with HIV in the northeastern part of the country is relatively small, there are high HIV incidence rates in many States and in some of them incidence continues to rise. There is a need to intensify efforts in Tamil Nadu and Chhattisgarh where HIV incidence has not decreased in the recent past. Further strengthening of decentralized planning using local epidemic data will be crucial to tailor HIV/AIDS preventive programmes to the State- and district-level needs. The benefit of a locally tailored response has been suggested by prior research²⁸⁻³⁰.

Provision of ART has helped averting 7.6 million AIDS-related deaths globally²⁸. India has announced, in 2016, its decision to expand treatment eligibility at ≤ 500 CD4 count³¹. To achieve the AIDS-specific SDG goals, the global recommendation²⁷ is to adopt a 'Test and Treat' strategy for all people diagnosed with HIV so as to improve the overall health of people living with HIV, achieve viral suppression and reduce infections transmission²⁷. Once this strategy is adopted, AIDS-related mortality is expected to decline more swiftly.

These new HIV estimates showed that, in addition to expanding early treatment initiation, there was a critical need for intensifying prevention efforts to avert new infections to allow India to end the AIDS epidemic by 2030. The 2015 Global Burden Study³²⁻³⁴ and other research also suggest that there is an urgent need to adopt more innovative prevention strategies in India to reduce HIV incidence at a faster rate³²⁻³⁴.

While the present HIV estimates are robust because these contain the latest demographic, epidemiological and programmatic evidence, these have certain limitations³⁵. Most of these are due to a lack of India-specific data to inform the assumptions underpinning the Spectrum modelling. The most

important assumptions pertain to mother-to-child transmission rates, age-specific fertility ratios for HIV-positive women, female-to-male ratio of adult HIV incidence and AIDS-related mortality (with or without ART). In the absence of context-specific evidence to adjust assumptions to the Indian context, global or regional assumptions are being used which, in future, will need to be adapted to the local setting. As the quality of HIV estimates depends on the assumptions made in the model, it is recommended that at least the main assumptions should be validated by generating new country-specific evidence through research.

Updating HIV estimations on a regular basis is important to monitor the epidemic and evaluate the impact of the response. The present estimates showed that overall, at national level, HIV incidence and AIDS-related mortality continued to decline which confirmed that India's NACP was making a positive impact on the epidemic. However, the estimates suggested that the rate of decline in new HIV infections diminished in the last few years, which calls for an intensification of prevention efforts to fast-track progress. To sustain the success of the programme, in addition to increasing the coverage of its treatment component, there is an urgent need to design and scale up more effective prevention interventions that help avert new HIV infections at a wider scale.

Prevention efforts will have to be strategically tailored to focus on geographical areas and key populations where new infections are still occurring at high rates. The estimates showed pronounced inter-State variations in progress in reversing the epidemic with some States still experiencing rising or stabilizing epidemic trends. The situation in these geographical areas needs to be investigated in depth using the findings of these estimations together with data from other sources to help programme managers in making informed decisions towards ending the AIDS epidemic as a public health threat by 2030.

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