

## Sex, money and ideas: two decades of battling AIDS in India

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**Has India stopped the 'tsunami of AIDS' that so many predicted? If so, what has worked? Was the epidemic over-estimated from the start? What lies ahead? The author describes the two-decade long struggle against HIV in India, both as an epidemiologist, with the invariable fascination with numbers and graphs, but also as an eyewitness to an important chapter in public health history. This history is by no means complete; the author's purpose here is, as dispassionately as possible, to convey what has been learned, and how it can help India and other countries battle the great epidemic of HIV.**

I first visited the brothels of Bombay (now Mumbai) on a hot, humid day in mid-September 1997. I had just been asked to design the World Bank's second national HIV/AIDS control programme. First stop was the Kamathipura area of Mumbai. Kamathipura was set up by as a red light area for British soldiers during colonial times. In 1997, it was the hot-spot for HIV in India. Already over one in three of female sex workers tested in Mumbai were infected with the virus. I asked Frank Plummer, a noted HIV researcher from Nairobi, to join me. We spent several hours talking to the sex workers and some of the NGOs working with them. Towards the end, Frank, who had been working in Kenya since 1982,

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remarked casually, 'this looks like Nairobi in 1985'. My face fell at that remark, and upon travelling to Kenya a few months later to see first hand the devastation that the AIDS epidemic had already brought, my distress deepened. A couple of months later, Frank and Nico Nagelkerke (a brilliant mathematician) and I did some simulations about HIV growth, and we came up with some shocking scenarios: over 20 million Indians might be infected by the year 2010.

I could not fathom the thought of so many people dying unnecessarily. These numbers were not mere statistics: the faces of the young women in Kamathipura were in front of me. Each of these women had struggled and suffered to depths that defy description. And yet, in all their misery, each woman's undefeatable desire to live was as real as the humidity of those days.

Nearly a decade later, I sat next to India's dynamic Health Minister, Dr Anbumani Ramadoss, and his officials in a hotel in New Delhi, as he announced to the world that India's official estimates of the number of people who were infected with HIV was being cut in half from 5.1 million to 2.6 million. The hundreds of reporters, diplomats and other officials in the room looked stunned. Various experts, including me, were bombarded with questions. Most of us agreed that India's HIV epidemic was more modest than previously estimated, that the predicted massive toll of AIDS deaths was unlikely to happen, and that the epidemic was coming under control in parts of India.

### So what has happened along the way?

At the outset, let me state three conclusions: First, focused efforts to educate female sex workers and to provide them condoms and community support have been chiefly responsible for the notable declines in HIV in South India. Second, future control of HIV in India will depend on the extent to which sex work interventions are implemented throughout all of India. Third, India's main challenge for the next decade

or two will be to sustain what has worked in preventing new infections, but do so everywhere in India at low cost. Lastly, much of the past control effort was based on anecdote. The success of future control relies on the generation and use of robust epidemiological evidence on the spread and consequences of HIV infection as well as independent evaluation of past and ongoing control efforts.

This paper is in five parts. First, I describe the recent situation of HIV/AIDS in India. Second, I turn to the question of what drives India's epidemic, and what this means for control programmes. Third, I provide a history of India's response to the epidemic and also deal with controversies about revising HIV/AIDS estimates in India. Fourth, I ask if India's response has worked, and provide new evidence about the declines in HIV in South India. Finally, I look to what lies ahead.

## 1. The uneven epidemic of HIV in India

Currently, the official National AIDS Control Organization (NACO) estimates suggest that as of 2006, 2.6 million adults are infected (with a best guess that this is as low as 2.1 million or as high as 3.1 million). The prevalence is estimated at just below 0.4 per cent of the adult (15–49 years). The estimated prevalence is roughly double this figure in the 'Southern' states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu, and the North-eastern states of Nagaland and Manipur. Together these states comprise over 75 per cent of all infections, even though they have about 30 per cent of the adult population. Nationally, about 1.6 million men and one million women are estimated to be infected [1].

Figure 1 shows the estimates of HIV infection in the 600 or so districts of India. Districts are the administrative areas of each state, and typically have about two million people. The prevalence shown is based on anonymous testing of pregnant women attending a government antenatal clinic (ANC). An obvious caveat: usually only about 400 women are tested each year in these sites, so even a few more women who test positive or who test negative results in huge variations year to year. The good news is that the number of districts without data has fallen from 387 in 2003 to 148 in 2006. The number of districts showing at least one per cent ANC prevalence has gone up from 79 in 2003 to 83 in 2006, but this mainly reflects expanded testing. The number of districts with ANC prevalence below one per cent was 133 in 2003 and 368 in 2006.

Note the marked variation across districts within any particular state between 2003 and 2006. It is possible to point out 'focal hot spots', meaning districts that have consistently shown infection rates above 1 per cent between 2003 and 2006. A few areas stand out:

- ✦ The Mumbai–Karnataka corridor, comprising about 6–7 districts on the road from Mumbai to Bangalore
- ✦ Eastern districts along the coastal highway of Andhra Pradesh
- ✦ Specific districts of the North-east states of Manipur and Nagaland, which is driven mostly by injecting drug use

The reasons for particular hot spots in the Southern states are not well understood, but probably reflect differences in sexual patterns of adults and other factors. Males in South India report a higher number of non-regular partners and more multi-partner sex [2] (as described below). Hot-spot districts might also have more in- or out-migration of young males who are users of female sex work. Finally, the percentage of men who are circumcised might also be important (circumcision is usually only among Muslim men, who represent 12 per cent of the overall population of men in India).

## 2. The importance of prostitution to India's HIV epidemic

### The maths of HIV sexual transmission

Most infections in India arise from heterosexual contact. I describe the details of how transmission occurs for two reasons. First, such understanding is central to design of control programmes, as well as the choice of interventions, and to monitoring reductions or increases in the levels of HIV. Second, this basic understanding was one of the few pieces of evidence that we had in designing the second national HIV/AIDS control programme back in 1997.

For those who are not interested in the more mathematical concepts, the following section can be skipped. The key message is simple: the few people who have many sexual partners (such as female sex workers, male truck drivers etc) contribute *much more* to the spread of HIV than do the much larger number of people who have only a few lifetime sexual partners. If public health efforts at stopping new infections focus on this central fact, control is possible. To paraphrase Winston Churchill: 'never in the history of infection, have so few given so much to so many'. Control of HIV is possible if interventions that decrease spread from those with high numbers of sex partners are done seriously [3].

**Some details on the maths:** Unlike height or blood pressure, sexual behaviour is not evenly distributed in the population. For height and blood pressure, we can imagine a 'bell curve' which shows that people are evenly below or above the average, with a simple, predictable distribution at the ends. But sexual contacts are much more like a skewed curve: most people have a few partners but a few have many. These core groups of highly sexually active people are central to HIV epidemics. The spread of infection from one person to another can be described in elegant, and surprisingly simple, mathematics [4, 5]. The basic reproductive rate,  $R_0$ , is the average number of infectious contacts by one infected individual. An infectious contact is a person who would transmit the infection if his/her partner is uninfected. For an epidemic to occur, each infected individual must on an average make infectious contacts with more than one individual ( $R_0$  must exceed one). The  $R_0$  must be reduced to lower the prevalence of HIV infection, and brought below one to eradicate it from a population. In turn,  $R_0$  can be estimated by multiplying three factors:

✦ transmissibility ( $\beta$ )    ✦ rate of partner change ( $C$ )    ✦ duration of infection ( $D$ ).

Each of these factors in turn depends on physiological and sociological events. The transmissibility,  $\beta$ , for HIV is actually quite low (perhaps only one in 1,000 of sexual acts with an infected partner will lead to HIV infection). However, co-existing other infections (say with herpes) raises this risk of spreading HIV per sex act considerably. The rate of partner change,  $C$ , is dependent on the average number of unprotected partners. The average rate of sexual contacts in the population is not high enough to sustain HIV epidemics. However,  $C$  can be high enough in vulnerable groups to increase the epidemic above an  $R_0$  of 1.

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Importantly, the contribution of each individual to the value of  $R_0$  is not proportional to his/her number of (unprotected) sex partners but to the approximate square of that number. Why? First, those who have multiple partners have a much greater (i.e. non-linear) risk of contacting an infected partner than we would expect based simply on their number of partners. Second, imagine a country of 10,000 adults. Of these, 9,900 adults only have one or two lifetime sex partners, and these are

with their own low-risk group. The remaining 100 adults have high numbers of sexual partners, but they only have sex with each other, and not with the low-risk group. HIV infection would grow rapidly but only in the high-risk group. However, this segmentation does not occur in real life, and as a result a high variability of sexual partners also means that higher risk of spread.

Historically, there is little doubt that 'core transmitters' are central to the epidemiology of any sexually-transmitted infections (STIs) including HIV. This is not always well understood, and occasions much debate about the importance of such vulnerable groups, especially at high levels of the epidemic. But the central point (supported by our recent research in Africa [6]) suggests that core groups are important at every level of the epidemic.

The maths also enables us to define how control interventions work. Interventions *directed at  $\beta$*  enhance resistance to infection or decrease susceptibility. Barrier methods such as condoms, treatment of co-existent STIs, antiretrovirals that decrease transmission, male circumcision and HIV vaccines would reduce  $\beta$ . Similarly, interventions *directed at  $C$*  aim to alter sexual behaviour, including decreasing the rate of partner change, decreasing concurrency (more than one partner at once), lengthening the time gap between serial partners,

increasing the age of initiation of sexual activity, or decreasing high-risk behaviour. Finally, interventions *directed at D* aim to reduce the period of infectivity, by the use of antimicrobials and antiretrovirals or via contact tracing or partner notification.

### Some real data on sexual spread of HIV in India

In 1997, we had only the above broad mathematical knowledge and some limited field experience from Africa and Thailand about how to reduce the spread of HIV. Robust epidemiological studies in India had not yet been published. Two important sets of studies have appeared since and throw light on the above theory.

Several studies in India have examined the differences among those who were HIV infected and those who were not. Most of these were conducted among high-risk populations such as truck drivers or those attending STI clinics. We have recently conducted 'meta-analyses' or summary analyses of all these studies. We examined a total of seven studies with about 4,000 adults [7]. A few risk factors (that is those factors which are more common in HIV infected adults versus the uninfected) stood out (Figure 2). Paid sex contacts were associated with nearly a five-fold higher probability of being HIV infected. (This probably is expressed as an odds ratio (OR) of 4.7 with 95 per cent confidence intervals (CI, meaning that 95 per cent of the time, this OR could be as low as 2.7 or as high as 8.2). The OR for presence of genital ulcer disease (GUD) was 3.6 (CI 2.5–5.0), and that for lack of male circumcision was 2.1 (CI 1.3–3.5). Put differently, we can examine how much the risk of HIV infection would be reduced by removing these factors. We find that removing paid sex, history of and/or existing genital ulcers, lack of male circumcision, and alcohol use would reduce HIV infections by 71 per cent, 48 per cent, 47 per cent and 25 per cent, respectively. Note that because there are several ways to avoid infection, these factors can total more than 100 per cent.

Indirect evidence of differences in male sexual behaviour, most commonly from use of sex work, can be found in the results of two rounds of national surveys of sexual behaviour. The first, conducted in 2001, studied about 85,000 adults aged 15–49 years [2]. It found that men in the South reported more non-regular sex partners in the last year than similar men in the North (Figure 3): 13 per cent of men in the South reported a non-regular partner in the past year, versus 8 per cent of men in the North. Moreover, of those men reporting a non-regular partner, about 59 per cent in the South reported more than one partner, whereas in the North, only 45 per cent reported more than one partner. Only about four per cent of women in the South reported a non-regular partner in the past year, versus one per cent in the North; only 30 per cent of these women in both regions reported more than one non-regular partner. Although men may over-report – and women under-report – sexual partners, the most plausible explanation for such differences is male use of female sex work.

The wide variation across districts in the South, and over time in HIV levels, is shown in Figure 1. Indeed, the variation in patterns of use of sex work by males may well be the reason for such wide variation in HIV levels over time and across the districts – especially in the South. The wider dispersion of numbers of sexual partners among males (and, to a lesser extent, among females) in the southern states suggests that HIV should be more likely to spread rapidly in these states (note the above point that the more variable or dispersed sexual behaviour is, the greater that growth of HIV. Note also that networks involving males having sex with males might also have a role in explaining why HIV is more common in the South. Male-male sexual contacts are not well studied, but reported prevalence is probably too low to account for the differences between males and females in reported sex contacts [8].

There are no direct estimates of what proportion of new HIV infections are due to sex work. Indirect estimates, based on assumptions derived from our previous work (of condom use, number of contacts, infectivity and overall HIV infections) suggest that somewhere between 60 per cent to 95 per cent of all new infection are due to sex work [7, 9].

To summarise, the mathematical evidence plus the direct field data support the idea that most new infections in the India (in both South and North) are due to first- or second-generation spread through female sex workers and their male clients. The next section describes how this evidence was turned into a national response.

### 3. The response

HIV was first detected in 1986 in a female sex worker in Tamil Nadu, Chennai. Within a year, HIV was detected in over 140 people in blood banks in all Southern states and in injecting drug users in the North-eastern. Reactions were, in retrospect, predictable, and similar to those in the United States. Among these were denial that AIDS was in India, or the labelling of AIDS as only a 'gay disease' [10]. These reactions occurred despite the fact that heterosexual transmission was clear from the outset as the major way of spread. Second, the early temptation was to focus narrowly on blood safety issues, again denying that sex was the driving reason behind HIV. There was even a backlash against foreigners, partly because the first infected female might have had a foreign male client. Calls came to screen all foreigners on entry to India (ignoring the fact that tests then available could not detect HIV infection for several months after it began in the body). One senior Government of India official proposed having a police man assigned to each foreign man to ensure that they did not have sex with an Indian. It was pointed out to him that it would be easy to pay off the policeman, or that even some might accept pay for sex.

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A National AIDS Control Programme was established in 1987, and the National AIDS Control Organization (NACO) started in 1992. NACO was set up in part via a World Bank credit of US\$100 million that ran from 1992-1999. The First Phase established NACO and state-level AIDS co-ordinating bodies (the State AIDS Control Societies), developed capacity for surveys of HIV, and helped India

to expand its programme of preventive activities and improve blood screening. The project began, as many new efforts do, slowly, with limited attention to sexual transmission. It was heavily criticised in the press for various reasons [11]. AIDS was dismissed as an agenda of the Western agencies, spending was too slow and there was too narrow a focus on blood safety over other methods to decrease HIV spread.

I joined the World Bank in 1995. In July 1996, David Ho announced at the World AIDS Conference that he had developed combination drugs that could dramatically reduce death rates among those with AIDS. This news created a buzz, the first sense was that treatment would be a mainstay of future AIDS programmes. The World Bank was also releasing a major report on AIDS, which argued for a focus on prevention. HIV/AIDS in India had, by then, become a hugely visible agenda. UNAIDS, headed by renowned scientist Peter Piot, had asked for a strong role in the design of the Second World Bank AIDS project in India, which was to start in 1999. People from President Clinton's AIDS team had expressed interest, and the media were already bombarding the Bank with questions on AIDS in India. I worked on India's National Malaria project and on tobacco control globally, and was only marginally involved in the HIV/AIDS discussions. I had observed that some of these criticisms were unfair, and others deserved, but my clearest sense was that of the overwhelming gaps were in the lack of knowledge on how HIV was being measured.

Then in spring 1997, Richard Skolnik, then chief of the Health Department of the India Department at the World Bank, asked me to take over the design of India's Second National HIV/AIDS programme. This was a coveted position, but I said yes to the task mostly out of curiosity (as a naïve epidemiologist). I could not appreciate at the time how political the project would become. I found the competing messages about what to do on AIDS confusing and contradictory. In contrast, the design of the malaria project had pretty much followed the WHO expert panel recommendations. However, there was no such consensus on what to do about HIV/AIDS. I consulted the books, and contacted Frank Plummer, who had first taught me about HIV/AIDS in 1984 while I was in medical school, and when he had just started his research in Kenya. Frank was outspoken about the poor quality of the fractured response to HIV/AIDS, and said that what mattered were core groups. I went back and read some more and quickly concluded that the key task was in preventing new infections that arose from female sex workers and their clients in India.

In India, a new dynamic head of the NACO had just been appointed – an Administrative Officer named Prasada Rao. I met Prasada alone in his offices in New Delhi in September 1997 and asked what he wanted from the project. We quickly concluded that the key pillars needed to be moving HIV from awareness to behaviour change, and

that a focus on core groups was central to the success of the programme. The heart of the programme was to be 'targeted interventions' or peer-based outreach programmes (usually led by NGOs or CBOs) that reach female sex workers, provide education, condoms, negotiating skills and access to basic health services. No specific new technologies would be required. Sex workers were to be identified using participatory mapping efforts.

Other parts such as blood safety and broad education would need to continue their funding, but these were not nearly as important. We agreed also that a major social mobilisation was needed to get the states of India to understand that the challenges were for preventing HIV and to prepare their project plans. An experienced team of five was hired to go around to the states and began work almost immediately. (Only later did I learn that my hiring this team to work directly on a Government of India project was against some rules of the World Bank.)

Prasada and I got along very well, and I could sense in him the desire to make a real difference. I recall pushing him only on one point – that it was unacceptable that India did not have prevalence data on HIV from all states. At dinner one evening I told Prasada bluntly that I would not recommend the Bank project proceed until we had data from at least one round of testing among pregnant women (then the recommended strategy by the World Health Organization to track changes in HIV) from all major states, and that I wanted the raw data sheets to verify myself that the work was legitimate. He agreed. We got a rude shock when the testing from Andhra Pradesh, a state of 75 million people, showed that over two per cent of the women tested in several clinics were HIV positive. Immediately, Frank, Ram Ramasundaram (one of the crack team we'd hired to work on the project) and I flew to Hyderabad to meet the Chief Minister, N Chandrababu Naidu. We spent an hour with him telling him that he had a problem, and that he needed to act. He asked what to do and we advised focusing on female sex workers.

The Second National HIV/AIDS Project was a US\$200 million World Bank credit that had about US\$50 million for targeted interventions with high-risk groups, including female sex workers, men who have sex with men, and injecting drug users explicitly named along with truck drivers and migrant labourers. The rest of the project dealt with prevention in lower-risk populations and capacity building. At the time the project was considered a bit of a risky move, especially a focus on marginalised, high-risk groups [12].

The project kicked off Phase II of the National Program. The project was controversial from the start. An NGO criticised the focus on prostitution. In retrospect, this was a good thing as it raised the profile of sex work through public debate. I left the project in late 1999 to join the World Health Organization in Geneva. But by then, the core elements of the project were set. The project ran until 2006, and as with all development projects had a mixed record. Some of the states did well – particularly Tamil Nadu – whereas other states did very little. There was some very nice mobilisation of community groups in some settings, such as by NGOs in Gujarat. There was criticism for too much spending on nice offices and meetings in posh hotels [13]. And more recently, the World Bank audit found that there was corruption. But those who know development accept that implementation is never perfect, but what does matter is if the overall direction is right. Independent reviews by the arms-length evaluation department of the World Bank confirmed that the project had been successful, with the obvious caveats in wide variation in what states had done [14].

Around 2001, the Bill and Melinda Gates Foundation started to explore options of what to do to help reduce HIV in India. Frank Plummer and I went to Seattle and presented a set of ideas and a draft US\$110 million proposal, called the 'HIV/AIDS Prevention Now'. The idea was simple: achieve 100 per cent coverage of sex work interventions in all 115 of the districts in South India, and build local capacity to monitor the epidemic. The Gates Foundation listened, said thank you and then about a year later turned the project over to McKinsey, a management consulting firm. The head of their office in India, Ashok Alexander, stepped forward and became the director of the India Avahan programme. Avahan has now grown to a US\$287 million programme from 2004 to 2009, and covers some 260,000 sex workers and other high-risk populations in about 75 districts of South states and the North-east.

**Table 1. Goals of Phase III of the National AIDS Control Programme**

Intervention	Current	Goal
Total sex workers in programmes	0.5 M	2.0 M
Condoms distributed/year	1 Billion	3.5 billion
Voluntary HIV testing per year	3 million	22 million/year
Total people on antiretroviral treatment	75 thousand	300 thousand

In July 2007, the Government of India announced the funding and design of the Phase III of its National AIDS Control Program. It has a total of US\$2.5 billion funding or a four-fold increase over Phase II. Nearly 75 per cent of the funds are for prevention and about one-third of this with high risk groups. The strategic focus is on saturating high-risk groups through comprehensive targeted interventions, as well as community mobilisation. The programme plans a major scale-up also in testing and treatment and in investments to improve management and evidence-based decision making. Table 1 shows some of the key interventions and coverage goals.

### The controversy over AIDS numbers in 2007

The Government of India's halving its estimates of HIV infected from 5.1 to 2.6 million has been sharply criticised in the media, and is also not well understood. Naturally, any sharp revision will breed suspicion. I like to state (somewhat glibly) that the sharp drop in numbers were due more to a computer program than to the control programme.

To understand how difficult it is to guess how many people are infected with HIV, think of a blind person who has tub full of water. The water level represents the number of people in India infected with HIV. The blind person can estimate, crudely, how much water is in the tub but cannot measure it directly. From the below evidence, the 'tap' of new infections is slowing (at least in South India). So the person can hear the tap running slower. Similarly, listening to the drain lets the person know that the water is not draining any faster than usual. The number of AIDS deaths in India (represented by the drain) has not slowed much, simply because the total number of people on life-prolonging AIDS drugs is only 75,000 as of 2006. So, this person can guess very broadly that the tub must be less full than previously imagined.

Unfortunately, ANC data have been used to estimate overall prevalence, despite questionable validity of this method. NACO has developed, with support from UNAIDS, a method to extrapolate the ANC data to HIV levels for the general population and use the numbers from STI clinics to estimate HIV levels among the high-risk population. But this is dodgy: ANC data do not always accurately reflect HIV prevalence in the community: in Tamil Nadu, one study found adult female prevalence in 1998 to be twice (two per cent) that reported in ANC sites (1 per cent [15]) whereas another found adult female prevalence in urban (1.4 per cent) and rural (0.66 per cent) areas to be comparable with ANC prevalence [16]. Another criticism based on one study in one district in Andhra Pradesh [16] found that women with higher HIV prevalence were *over-represented* in public ANC sites. However, our analyses of a national survey (the National Family Health Survey-3 or NHFS-3 [18]) finds the opposite [19].

The NHFS-3 tested about 100,000 adults and found lower HIV levels (0.28 per cent at ages 15–49 for adults) than among women of comparable ages at ANCs (0.60 per cent). India consequently conducted 'hybrid' analyses of ANC data with the NHFS-3, and halved its estimate of HIV infected to 2.6 million.

However, the revised estimate of 2.6 million, based primarily on the NHFS-3, is thus also uncertain. The NHFS-3 also has design problems, including the under-representation of high risk groups [7]. More reliable estimation of prevalence will demand combination of various sources of data, plus additional information on AIDS mortality [20]. The key point to note is that while it is likely that the prevalence of HIV is lower than previously estimated, what we can state more comfortably is that ANC data are most valid for examining trends. Moreover, the important question, is *if and why* new infections have declined in India. I turn to this in the next section

#### 4. Has control worked?

HIV appears to have been controlled in South India and has not yet increased markedly in North India. These are the conclusions of our analyses of testing among pregnant women who attend government clinics, data from men attending STI clinics, and from behavioural surveys. I deal with each in turn.

##### Pregnant women

India like most developing countries uses unlinked, anonymous HIV testing of pregnant women attending antenatal clinics (ANC) to monitor trends in the general population. ANC data provide a large and expanding pool of young pregnant women, whose characteristics stay relatively constant. In India, over 91 per cent of women are cohabiting with their husbands by age 25 [18], and should thus represent a reliable group to monitor changes in HIV incidence. The trend in new or incident infections, particularly in the young who have recently become sexually active, is the most sensitive marker to track the course of the epidemic. Unfortunately, incidence is hard to measure directly, but prevalence among young women (age 15-24) is an indirect but useful proxy.

We analysed the results among 331,668 women age 15-24 tested nationally (Figure 4). This updates our analyses published in 2004 [8] in the *Lancet*. The proportion of women infected fell from about two per cent to one per cent, or by about 50 per cent from 2000-6 in the 'southern' high prevalence states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu, with no significant increase or decrease in North India, where HIV is less prevalent. These declines in new HIV infections are statistically significant. Moreover, the results are similar if we exclude Tamil Nadu, or we restrict the analyses to continuous sites, do the analyses for individual states or split the analyses into individual age groups. Thus a halving of new HIV infections in South India appears to be real.

Of course, women who go to government public hospitals are different than those who do not in education, residence, migration and other factors. However these characteristics have not changed much from year to year, so that they are unlikely to explain the declines seen in the South. Several groups pointed out some problems in our initial analyses of 2004, but others who have gone back to look at their own data have also found declines in new HIV infections in young women [21]. Finally, increased deaths among young women might be expected to remove HIV infected women from antenatal clinic testing. But we have found that mortality is not an explanation for these declines [8].

##### Men attending STI clinics

We observed a significant decline the prevalence of HIV among men aged 20-29 attending STI clinics in the South. These young men are a reasonable proxy for men who have recently used sex workers, or have other high risk sexual contacts. Among these men, prevalence fell 21 per cent to 11 per cent from 2000 to 2006, with this decline also being highly significant. Declines were similar in the subset of men who reported ulcerative STIs. As with ANC, levels in the North were lower: there was a non-significant decrease seen among male STI clinic attendees. Trends were similar in the sites that were open continuously from 2000 to 2006.

Of course, the traits of males using STI clinics are expected to vary even more from year to year than those among pregnant women. However, we found no major change from year to year in age structure, education level, co-infection with syphilis and migrant status [8].

##### Behavioural surveillance in general populations

NACO carried out two behaviour surveys in the general population in all the major states in 2001 and 2006 [2, 22]. These show that that among males, the proportion of men who had a non-regular partner in the last year fell from nearly 13 per cent to below 6 per cent in South India, and from 8 per cent to below 3 per cent in the North of India. As noted earlier, much of these non-regular partner contacts by men represent male use of female sex work.



Among women, the prevalence of non-regular partner fell from four per cent to three per cent in South India, and was similar at about one per cent in North India. These data are obviously subject to the people telling the interviewers what they think the interviewers want to hear. Nonetheless, more detailed examination of the other NACO behavioural surveys of female sex workers and their clients finds that the age of clients has risen, that far more in North and South report condom use with the last sexual contact, and many more of them have had an AIDS test. Other surveys of high-risk groups done in the various southern states also report a marked increase in use of condoms with last contact, condom use over the last few months, and in other indicators. Thus, behaviour change around sex work and clients appears to have occurred, most notably in South India.

**Table 2. Prevalence of self-reported non-regular partner in the past 12 months, by gender and region, 2001 and 2006**

	Male			Female		
	South*	North East <sup>^</sup>	Rest of India	South*	North East <sup>^</sup>	Rest of India
2001	12.9	2.6	7.9	4.4	0.5	1.1
2006	5.7	1.6	2.6	3.3	0.4	0.9

\* South includes AP, KN, MH, TN

<sup>^</sup> North East includes Mizoram, Nagaland, Manipur

Source: ref 2, 22

The combination of all these data show a powerful story: India's HIV epidemic was and continues to be very much based on male use of female sex work. India took sex work seriously in the late 1990s, put significant money into the programme (some of which was imperfectly spent), and has continued a simple system to monitor HIV changes. New HIV infections have been halved in South India. This means that HIV is on its way to being controlled in South India.

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The declines in HIV should be viewed sceptically, of course. There might be other reasons for the decline in new HIV infections: HIV may have peaked naturally and these declines would have occurred without programmes in place. Even in the South, no district has achieved 100 per cent coverage of the estimated population of female sex work. However, the most plausible explanation is that of a change in sex work in India, particularly in the South. Clients appear now to be older and condom use is far

more likely to be reported by either the sex worker or the male client. I add anecdotal evidence that one benefit of the control programmes for sex workers in the South was to network them to each other. Like any other peer group, sex workers have communicated the importance of using condoms and of safe sex to each other. This word-of-mouth communication of basic knowledge is hard to measure, but is in my opinion a key reason for the reported increases in condom use even in districts where active interventions for sex work are not occurring.

## 5. The future of HIV in India

### Predicting what will work

The programmatic directions for Phase III of the National Program have been set, and are described above. These are probably the right priorities, given what has worked in the past. A more formal way of testing these priorities is to put alternative interventions into what is called a 'dynamic compartment model'. This is simply a way of simulating the growth of HIV infection and then seeing what happens if some interventions are done. We have recently updated some earlier work by Nico Nagelkerke [5], and the model presented in 2005 [7]. These test how much of the future growth of HIV (which is more modest than previously projected)

could be avoided with various interventions. The results are shown in Table 3. Further details of the model, including the results of sensitivity analyses, will be published shortly.

The most effective strategy would be, of course, to have no commercial sex work at all. This would avoid 90 per cent of future HIV infections. However, increases in consistent condom use can achieve between 40 and 60 per cent reduction in HIV growth over the next few decades. Such strategies are widely practicable.

**Table 3. Percentage of new HIV-1 infections avoided in India with various interventions until 2035**

Interventions	% reductions in HIV infections
<i>Preventive interventions</i>	
75% consistent condom use by female sex worker (FSW)	-59
30% reduction in the transmission of STIs	-39
40% reduction in female sex work by 15-year-olds entering the adult population	-30
Hypothetical: no commercial sex work	-90
<i>Hypothetical HIV-1 vaccine with 50% effectiveness, 95% coverage of</i>	
General population with no adverse behaviour change	-42
FSW with no adverse behaviour change	-58
General population with full adverse behaviour change	+28 (worse)
<i>Treatment: antiretrovirals with 50% coverage in the general population</i>	
No adverse behaviour change	-19
Full adverse behaviour change	+9 (worse)

Source: Author

The second most practicable strategy would be to accelerate increase in STI treatment, especially for GUD in India. Bacterial STIs are easily treatable. Trends in bacterial GUD or ulcerative herpes simplex virus (HSV-2) in India are not well understood. Some African data suggest, for example, that a high prevalence of herpes might account for a substantial proportion of HIV infection [23].

A 'Uganda' type intervention that changes young people's sexual behaviour is unlikely to be achieved through education alone. Careful reviews have concluded that intensive education programmes tend to raise awareness but not change behaviour among youth [3]. Moreover, such a strategy may be applicable only in advanced AIDS epidemics where many people are dying from AIDS, and this provides an important information signal to the uninfected. Such a strategy would be as effective as an STI strategy in our model.

Similarly, even with a hypothetical HIV vaccine, it can be seen that targeting such a vaccine to female sex work might be as effective as to the general population (in both about 60 per cent of the HIV growth is avoided). However, widespread use of a vaccine leading to behavioural disinhibition and a reduction in male condom use with female sex workers could offset the potential benefits of a vaccine and the epidemic could worsen. Thus, even with an HIV vaccine programme, strategies to reach commercial sex workers and intervene using peer-based education programmes will be needed.

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Antiretrovirals are effective at reducing mother-to-child transmission, but the overall reduction in HIV levels is only modest as the infected children do not pass the infection to others. Antiretrovirals for adult populations have a dramatic short-term impact on mortality, but as resistance appears, their overall effectiveness is limited (about 19 per cent reduction in HIV growth). Moreover, the assumption in the model that there is no adverse behaviour change due to the use of antiretrovirals is an optimistic one.

### From promise to success: what India must do right

The chief determinant of India's epidemic appears to be spread from sex work networks, involving use by mobile males of female sex workers and secondary infection of the regular partners of these males. Thus the most effective and widely practicable strategies to reduce the growth of HIV infection in India are to ensure

*The most effective and widely practicable strategies to reduce the growth of HIV infection in India are to ensure high rates of consistent condom use among female sex workers and their clients, and to increase access to simple treatment of STIs for the general population.*

high rates of consistent condom use among female sex workers and their clients, and to increase access to simple treatment of STIs for the general population. Thankfully, these two strategies are the cornerstone of any response to control AIDS in India. Also, India has adopted the correct and humane goals of extending access to all those who need antiretrovirals. But these drugs are only to help the few hundreds of thousands who are already infected and who need treatment. The real battle is to keep millions of Indians from becoming infected. India certainly has sufficient funding on the table to so achieve these goals.

The challenge will be to spend this well and to ensure that what is left behind is a well functioning, low-cost and sustainable system. A few items are worth mentioning:

- ✦ First, effective monitoring through routine, robust, reliable, low-cost and long-term epidemiological studies and surveillance of HIV and STIs risk behaviours are required in India. Ensuring that the results are widely available to media and academics and NGOs is central. In a democracy like India, such access to information that is accessible and credible is particularly important.
- ✦ Second, we all know we can't ask doctors (like me) to judge our own work. So it is with the control programmes. A fully independent, arms-length and accessible review of what has worked and what has not is needed. In particular the Avahan programme requires an independent review.
- ✦ Third, the Northern states should not be lulled into a sense of complacency. The chief ministers of these states must seize the fact that they can keep HIV under control. The tools, money and know-how are all there. But ensuring good implementation, and leaving public health officials to do their job is the main challenge.

Battling AIDS is not simply a technocratic matter. The haunting faces of those now vanished and gone that I have seen in India's AIDS wards, and also the sorrow of family members who had to endure the death of a loved one, have changed me forever. But the tragedies of these families are preventable, and it will be up to Indians and all their global friends to act more before declaring victory.

India's opportunity is unique. A sharply reduced HIV epidemic would constitute among the greatest public health victories that the world has ever known. 

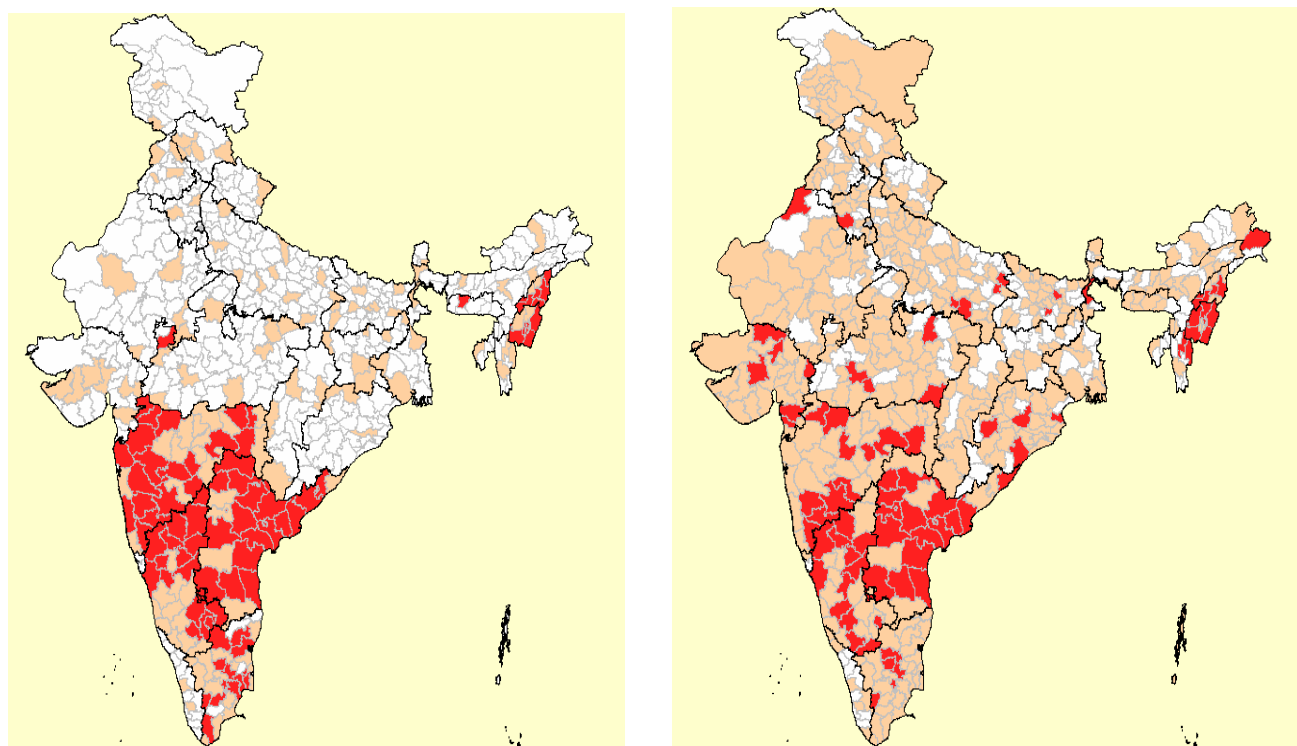
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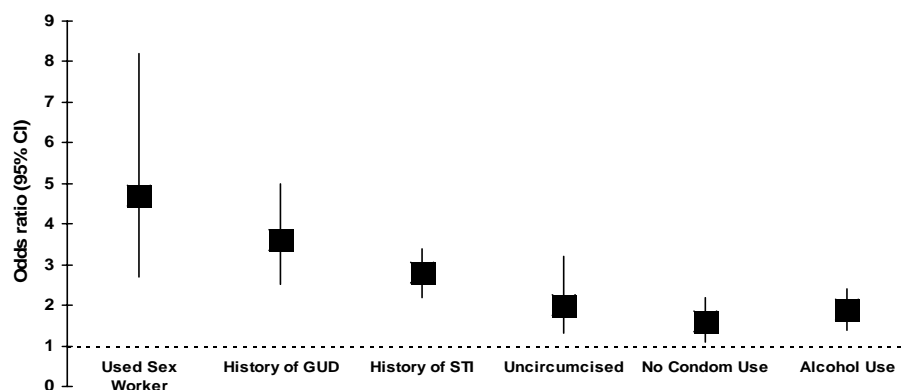
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Figure 1: HIV prevalence in pregnant women by district, 2003 and 2006



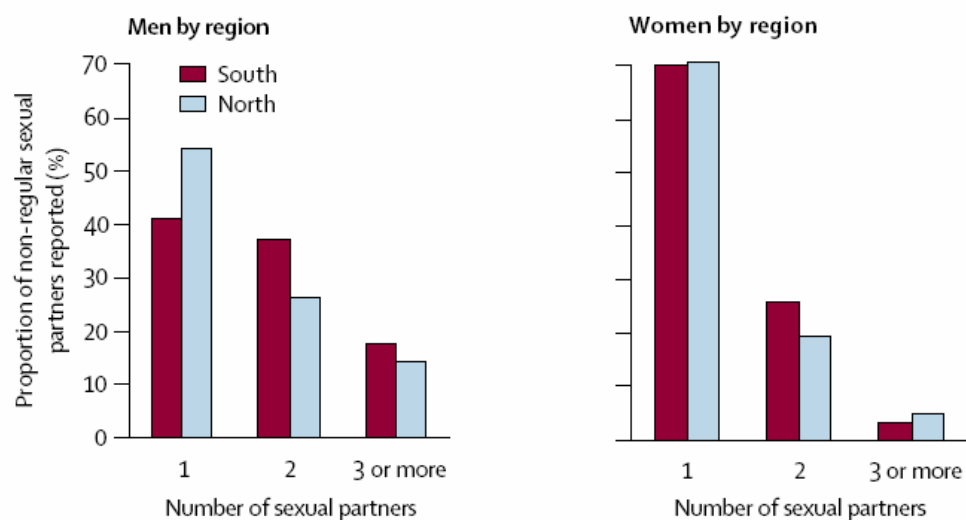
Red: Prevalence >1%; Beige: Prevalence below 1%, White: no data  
Source: NACO, 2008

Figure 2: Meta-analysis of risk factors for HIV-1 among high-risk groups



GUD: genital ulcer disease  
 Source: Author

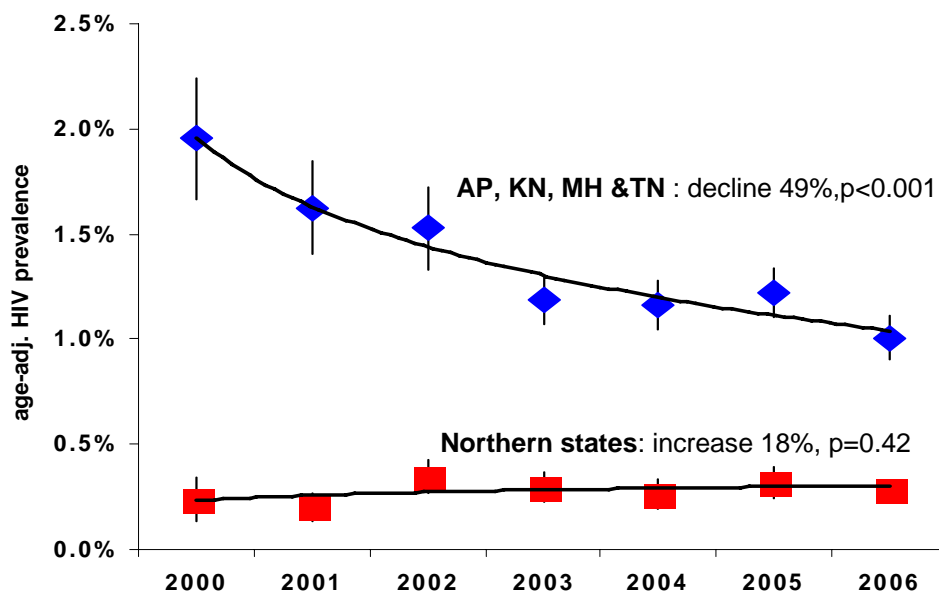
Figure 3: Male and female non-regular partners in the last year by region



	None	Any	1	2	3 or more	None	Any	1	2	3 or more
<b>South</b>	n 6686	991	407	370	174	7322	340	238	88	11
	% 87.1%	12.9%	41.1%	37.3%	17.6%	95.6%	4.4%	70.0%	25.9%	3.2%
<b>North</b>	n 29487	2534	1374	665	364	32609	365	259	71	18
	% 92.1%	7.9%	54.2%	26.2%	14.4%	98.9%	1.1%	71.0%	19.5%	4.9%

Source: Author, reference 8

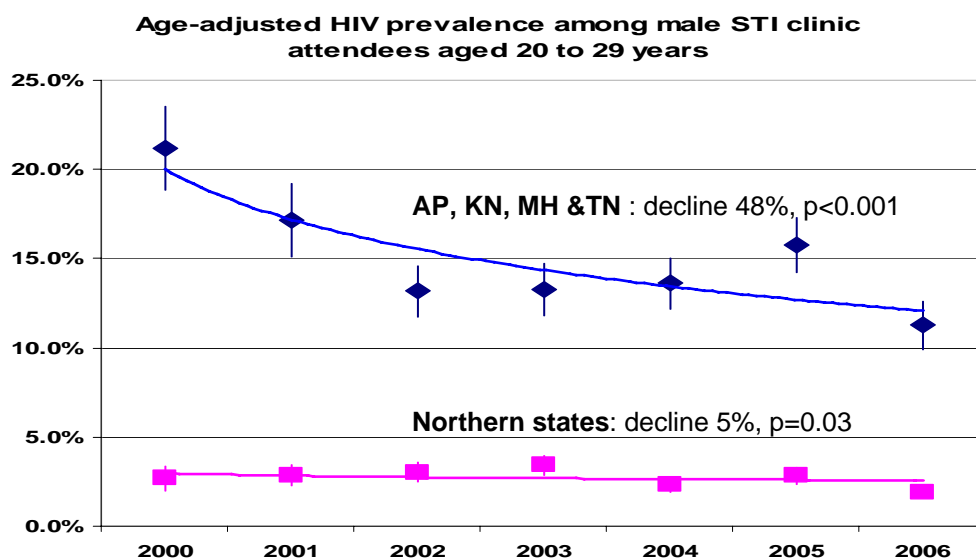
Figure 4: Trends in HIV among pregnant women aged 15-24 by region



Source: Author, reference 19

Note: AP=Andhra Pradesh, KN=Karnataka, MH=Maharashtra, TN=Tamil Nadu

Figure 5: Trends in HIV among males aged 20-29 attending STI clinics by region



Source: Author

Note: AP=Andhra Pradesh, KN=Karnataka, MH=Maharashtra, TN=Tamil Nadu