

## ESTIMATION OF HIV INFECTIONS, AIDS CASES/DEATHS AND OTHER STI

The under-reporting of HIV/AIDS and STI is well-recognized. Therefore, the estimated data of HIV/AIDS and STI is an important measure of the extent of these infections. HIV/AIDS/STI estimates serve as basis for policy development, resource mobilization or allocation, programme planning and monitoring time trends and focusing interventions efforts to control the spread of infections.

This article describes the general methods used for estimating the prevalence and/or incidence of HIV infections, AIDS cases, AIDS deaths, and common STI.

### ESTIMATION OF HIV INFECTION AND AIDS CASES/DEATHS

Prior to effective drug therapy to delay or prevent the progression of HIV infection to the development of AIDS, reporting of AIDS cases was considered to be sufficiently reliable for estimating HIV prevalence by using a *back-calculation method*. The back-calculation method used annual progression rates from HIV infection to AIDS and reported annual AIDS cases (usually after adjustments for incomplete and delayed reports) to calculate how many annual HIV infections would have been needed to generate the estimated annual number of AIDS cases.

In the late 1980s and early 1990s, a *ratio method* using an estimated ratio of prevalent HIV infections to prevalent AIDS cases estimated HIV prevalence. Like the back-calculation method, the ratio method required reliable estimates of AIDS cases. In addition, the ratio of prevalent HIV infection to prevalent AIDS cases changes rapidly over time (from many thousands to one during the first few years of an HIV epidemic. This decline occurs whether HIV incidence increases or decreases because in the absence of effective treatment virtually all HIV-infected individuals progress to AIDS. Thus, at the start of any HIV epidemic, there are virtually no AIDS cases. The HIV to AIDS case ratio is almost all HIV and no or few AIDS cases. As the HIV epidemic continues, almost all HIV infections will progress to AIDS and the HIV to AIDS case ratio gradually decreases. In a hypothetical situation, where all HIV transmission is stopped, the HIV to AIDS case ratio will decrease to almost 1:1 because virtually all HIV infections eventually progress to AIDS. Thus, after a decade, the ratio may be less than 10 to one.

A simple and useful method to estimate current HIV prevalence in a mature HIV epidemic (i.e. one that has been in progress for about 10 years or longer) is the *multiplication of the estimated annual AIDS cases by 20*. If the median period for HIV infection to the development of AIDS is assumed to be 10 years, then about 10 years after the start of an HIV epidemic, about 5% of prevalent HIV infections will develop into AIDS on an annual basis. For example, if the estimated annual number of AIDS cases is 5 000, then the estimated HIV prevalence would be about 100 000 (5 000 multiplied by 20). Conversely, if HIV prevalence is estimated to be 100 000, then by taking 5% of the HIV prevalence one can rapidly calculate the expected annual number of AIDS cases to be about 5 000. This is a quick check and balance method to see if the national estimate of HIV prevalence is compatible with the estimated annual number of AIDS cases and if the estimated annual number of AIDS cases is consistent with the estimated national HIV prevalence.

In the absence of reliable AIDS case estimates or data, epidemiologists have estimated HIV prevalence by using the *results of serological surveys and extrapolating these data to the total 15–49 year-old population*. This has been, and continues to be, the primary method used in developing countries to estimate HIV prevalence.

As of 2001, no uniform process and/or methods have been developed and distributed by UNAIDS or WHO to national AIDS programmes. As a result, many epidemiologists have developed their own methods, assumptions and biases for *using the available HIV serological data to derive a seroprevalence estimate*. Although HIV sentinel surveillance (HSS) systems were not designed to provide data for making HIV prevalence estimates, they have been widely used for this purpose. HIV prevalence in the 15-49 year old population has been calculated according to the following general formulae:

1. The number of HIV infections in each of the major high-risk groups is equal to the estimated HIV seroprevalence rate (from HSS data) multiplied by the estimated number of the HIV-risk group (estimated for a specific population or a province); and
2. The number of HIV infections in the 15-49 year-old population is equal to the estimated HIV seroprevalence rate in antenatal women in the province (from HSS data) multiplied by the estimated number of 15-49 year-olds in the province (from the census estimates).

Some potential errors with this method result from: the quality of data collection; representation of the sentinel surveillance system (selection of sentinel sites and groups, sampling); estimation of population sizes (risk groups, 15-49 year-olds); and the lack of consideration of the male to female ratio or urban-rural differential of HIV infection.

For the estimation/projections of AIDS cases, a simple *scenario/modelling approach* was developed during the late 1980s by the Surveillance, Forecasting, and Impact Assessment (SFI) unit of the former Global Programme on AIDS (GPA) of WHO. This approach was designed to provide working estimates and short-term projections (i.e. less than five years) of AIDS cases and deaths. A scenario is an outline for any series of events that can be made up or constructed with or without models to "fit" the observed HIV/AIDS data and trends. The following is an outline of the general methods used in this approach:

1. Assemble and analyse available HIV seroprevalence data to estimate the most recent pattern(s), prevalence and trends of HIV infection for a specific population.
2. Based on these data and other epidemiological observations, different HIV patterns and prevalence levels (i.e. scenarios) can be constructed with some confidence to the year 2005 for specific countries/populations.
3. An AIDS model can be used to derive annual and cumulative estimates and projection of AIDS cases/deaths and other HIV-related conditions, based on the general HIV scenario(s) constructed.

**EPIMODEL** is a simple microcomputer programme developed by WHO in the late 1980s to estimate past, current, and short-term projections of AIDS cases and deaths in areas where AIDS case reporting was largely incomplete and unreliable. EPIMODEL is still used widely for this specific task. Most problems encountered by users of EPIMODEL are associated with its misuse. The basic module of EPIMODEL uses estimates of HIV prevalence and distributes this prevalence by annual HIV-infected cohorts back to the estimated start of the HIV epidemic along a selected epidemic curve. EPIMODEL then applies annual progression rates from HIV infection to the development of AIDS to each of the annual cohorts to calculate annual numbers of adult AIDS cases and deaths.

In 2001, new software was developed to model the course of HIV/AIDS around the world and to further enhance the quality of estimates of HIV/AIDS prevalence and impact. As a result, the UNAIDS/WHO estimates of 2001 incorporate

new knowledge and assumptions about survival times for adults and children living with HIV/AIDS.

Recently, the *Asian Epidemic Model* (AEM) was developed. This model has been able to fit 10 years of epidemiological and behavioral data in Thailand. This model uses behavioral inputs to model HIV prevalence trends over time. The AEM was recently applied to the time series of epidemiological and behavioural data in Cambodia.

The model contains six major population sub-groups: general population males and females, male clients of sex workers, direct and indirect sex workers, and injecting drug users. The size of each population and behavioural time trends (condom use, frequency of intercourse, etc.) will be determined from analysis of existing behavioural studies in the country. The transmission parameters (e.g. HIV transmission probabilities, STD cofactors, circumcision co-factors) will then be adjusted to fit to time trends in epidemiological HIV data in the country. This model will then produce estimates of new infections that would be more consistent with observed behavioural trends. However this model requires available and reliable biological and behavioural data., and it's not easy to obtain these data in most developing countries.

#### ESTIMATION OF COMMON SEXUALLY TRANSMITTED INFECTIONS (STI)

STI are a major global cause of acute illness, infertility, long term disability and death, with severe medical and psychological consequences for millions of men, women and infants. A number of STI have been identified as facilitating the spread of HIV. Although STI surveillance is done in many countries, data on the prevalence and incidence of STI and their complication are limited and underestimate the burden of these infections.

In 1990, based on a modified *Delphi technique*, WHO estimated that over 250 million new cases of STI occurred globally that year. This method was chosen due to the limited information on incidence and prevalence of STI available at that time. The Delphi method was also used for projecting HIV. Essentially, the Delphi method obtains educated guesses from selected experts in a reiterative fashion, and then uses the average and range of the Delphi responses as projections. Major advantages of the Delphi method are speed and low cost. However, it is difficult to select truly knowledgeable experts to develop reliable estimates or projections. Furthermore, estimates and projections made by the Delphi method may have extremely wide ranges.

In 1995, using a *revised methodology* outlined below, the number of new cases of STI was estimated to be 333 million:

1. Collection and compilation of database of published and unpublished prevalence data.
2. Regional prevalence estimates for gonorrhea, chlamydia and syphilis was calculated using the median prevalence rate from all countries in the region and mid year UN population estimates for adults of 15-49 years of age.
3. Regional prevalence estimates for trichomoniasis in women was calculated as being two times the chlamydia prevalence. For men it was calculated to be one tenth of the prevalence in women.
4. Regional incidence estimates were calculated by dividing prevalence by the duration of disease.
5. Estimates for duration of infection were made for symptomatic, asymptomatic, treated and untreated adjusted for sex and region.

In 1999, using the same methodology as that of 1995, WHO estimated that 340 million new cases of syphilis, gonorrhea, chlamydia and trichomoniasis occurred throughout the world among men and women aged 15-49 years. Data for the estimates were collected by searching published and unpublished information on prevalence and incidence, in the literature in the WHO country files for STI.

At the population level, the spread of an STI depends upon the average number of new cases of infection generated by an infected person. This can be described in terms of the basic or case-reproduction ratio ( $R_0$ ) which, for an STI, depends upon the efficiency of transmission ( $b$ ), the mean

rate of sexual partners change ( $c$ ) and the average duration of infectiousness ( $D$ ) as expressed in the form:  
 **$R_0 = b*c*D$ .**

The higher the value of  $R_0$ , the greater the potential for the spread of the infection.

WHO estimates, although based on a comprehensive survey of the available information, are affected by the quantity and quality of prevalence and incidence data from the different regions and knowledge of the duration of the infection. Interpreting the data from prevalence studies and comparing results are further complicated by the nature of the populations studied. Few studies are community-based and the majority of data come from studies carried out in specific populations, such as STI or antenatal clinic attendees. Other limitations are the small sample sizes, the different diagnostic approaches and the study designs used.

Data from epidemiological surveys show that within countries and among countries in the same region, the prevalence and incidence of STI may vary widely between urban and rural population, and even within similar population groups. These differences reflect a variety of social, cultural, and economic factors, as illustrated by the HIV epidemic, and also differences in access to appropriate treatment. In general, the prevalence of STI tends to be higher in urban residents, unmarried individuals, and young adults. STI tend to occur at a younger age in females than males, which may be explained by differences in patterns of sexual activity and in the relative rates of transmission from one sex to the other.

Despite the limitation, data and methodology used to derive STI estimates by WHO provide useful baseline data for monitoring global and regional changes in STI prevalence in incidence and the effects of public health interventions.

#### References:

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3. MOH/WHO/FHI. *Consensus report on STI, HIV and AIDS epidemiology in Cambodia, April 2001.*
4. UNAIDS/WHO. *AIDS Epidemic Update, December 2001.*
5. A.C. Gerbase et al. *Global Prevalence and Incidence estimates of selected curable STDs. Sex Transm Inf, 74 (Suppl): S12-S16, 1998.*

**Table 1. HIV/AIDS Estimation in the Western Pacific Region, 2001**

Country	Population 15-49 y.o.	Number of HIV Positive					HIV Prev % (15-49 y.o.)	Children orphaned by AIDS	Estimated AIDS death (adults and children)
		Men (15-49 y.o.)	Women (15-49 y.o.)	Sub-total adults (15-49 y.o.)	Children (0-15 y.o.)	Total (adults and children)			
Cambodia	6 314 000	86 000	74 000	160 000	12 000	170 000	2.7	55 000	12 000
Papua New Guinea	2 491 000	11 900	4 100	16 000	500	17 000	0.7	4,200	880
Malaysia	11 868 000	30 000	11 000	41 000	770	42 000	0.4	14 000	2500
Viet Nam	43 343 000	95 000	35 000	130 000	2500	130 000	0.3	22 000	6600
Singapore	2 324 000	2 540	860	3400	<100	3400	0.2	-	140
Australia	9 933 000	11 200	800	12 000	140	12 000	0.1	-	<100
China	726 031 000	630 000	220 000	850 000	2000	850 000	0.1	76 000	30 000
New Zealand	1 911 000	1 020	180	1200	<100	1200	0.1	-	<100
Fiji	443 000	-	<100	300	-	300	0.1	-0	-
Hong Kong, China	4 134 000	1 940	660	2600	<100	2600	0.1	-0	-
Lao PDR	2 542 000	1 050	350	1400	<100	1300	<0.1	-	<150
Philippines	39 600 000	6900	2500	9400	<10	9400	<0.1	4100	720
Japan	59 109 000	5400	6600	12 000	110	12 000	<0.1	2000	430
Rep of Korea	27 558 000	3041	960	4000	<100	4000	<0.1	1000	220
Mongolia	1416 000	-	-	<100	-	<100	<0.1	-0	-
Brunei Darussalam	187 000	-	-	-	-	-	-	-	-
Other Pacific Islands	1300 000	-	-	-	-	-	-	-	-
<b>Total</b>	<b>940 540 000</b>	<b>886 290</b>	<b>357 010</b>	<b>1 243 300</b>	<b>18 020</b>	<b>1 255 200</b>		<b>178 300</b>	<b>53 490</b>

Source: UNAIDS/WHO working group, Report on the Global HIV/AIDS epidemic

Population: 2001 (UNPOP)

**Table 2. Estimated Prevalence and Annual Incidence of Curable STI by Region**

Region (million)	Population 15-49 (million)	Prevalence (million)	Prevalence per/1000	Annual Incidence (million)
North America	156	3	19	14
Western Europe	203	4	20	17
North Africa & Middle East	165	3.5	21	10
Eastern Europe & Central Asia	205	6	29	22
Sub Saharan Africa	269	32	119	69
South and South East Asia	955	48	50	151
East Asia & Pacific	815	6	7	18
Australia & New Zealand	11	0.3	27	1
Latin America & Caribbean	260	18.5	71	38
<b>Total</b>	<b>3040</b>	<b>116.5</b>		<b>340</b>