

Methodology – Understanding the latest estimates

Part one: The data

1. What data do UNAIDS and WHO base their HIV estimates on?

The *precise* numbers of people living with HIV, people who have been newly infected or who have died of AIDS are not known. Achieving 100% certainty about the numbers of people living with HIV globally, for example, would require testing every person in the world for HIV every year—which is logistically impossible and poses ethical problems. But we can estimate those numbers by using other sources of data.

UNAIDS/WHO estimates are based on all pertinent, available data—including surveys of pregnant women attending antenatal clinics, population-based surveys (conducted at the household level), sentinel surveillance among populations at higher risk of HIV infection, case reporting, as well as other surveillance information.

Different sets of data are used to calculate estimates of HIV prevalence for *generalized* (high-level – where HIV is firmly established in the general population and sexual networking is sufficient to sustain an epidemic independent of sub-populations at higher risk of infection) and *concentrated* (low-level – where HIV is concentrated in groups with behaviours that expose them to a high risk of HIV infection) epidemics.

In countries with *generalized* epidemics, estimates of HIV prevalence are primarily based on surveillance among pregnant women attending sentinel antenatal clinics (ANC). Such data are collected on an annual basis and are currently our primary basis for the assessment of trends. Population-based sample surveys that include testing for HIV infection (conducted much less frequently) are used to improve the antenatal clinic data-based estimates. If countries have conducted such a survey, the results are used to calibrate the trend in HIV prevalence. Countries who have not conducted these surveys calibrate their HIV prevalence trends based on the “global default” adjustments derived from the comparison of HIV prevalence between national surveys and ANC surveillance in other countries.

For countries with low-level or *concentrated* epidemics, HIV estimates are based on studies among key populations who are at higher risk of HIV exposure—such as people who inject drugs, sex workers, or men who have sex with men.

Countries with concentrated epidemics sometimes have additional sources of data which can help refine estimates. In countries with high coverage of voluntary counselling and testing programmes, case reports can add to the estimation process and make estimates more precise.

Better data from country surveillance and steady improvements in the modelling methodology are enabling UNAIDS/WHO to develop more accurate estimates.

2. What are the strengths and weaknesses of using antenatal and household surveys in estimating HIV infection levels for generalized epidemics?

Each of these methods has its strengths and weaknesses. Generally, estimates based on antenatal clinic attendees provide a good indication of HIV infection *trends* among 15–49 year-olds over time.

Studies have shown that high proportions of women in most of the highly-affected countries have access to antenatal clinic services. Where possible, estimates derived from antenatal clinic data have been compared at local level with HIV prevalence data acquired in community-based surveys. Such validation exercises have concluded that estimates based on antenatal clinic sentinel surveillance provide a good approximation of HIV prevalence among adults aged 15–49 (men and women combined) in the local community. However, ANC surveillance is limited in that it only

samples pregnant women attending public health services and therefore excludes women who are not pregnant or sexually active and who do not attend public health clinics. The most important limitation is often related to the selection of sentinel antenatal clinics. In general, clinics with larger volumes of pregnant women are included to obtain the minimum required sample size during the few weeks of the annual survey of sentinel clinics. Such clinics are more likely to be in urban areas, and the sample of clinics is often not geographically representative. Remote rural clinics are underrepresented for the most part, although countries are increasingly trying to increase their representation as in-country surveillance efforts are expanding.

National population-based household surveys, on the other hand, can reveal important information about the national prevalence level and about the spread of HIV in a country. These surveys are generally geographically representative and can provide estimates for the general population as well as for different subgroups, such as prevalence in urban and rural areas, men and women, different age groups, and different regions. However, population-based surveys by their nature exclude certain high-risk populations (e.g. people living in hostels, army recruits, etc.) and might therefore underestimate HIV prevalence. Non-response due to absence from households and refusing to participate in these surveys could also lead to bias in the HIV estimates. Current research, however, indicates that in most instances these biases are relatively small.

Population-based surveys are costly, complex undertakings, especially if biological testing is included. Therefore, they are done with long intervals in-between and few countries have done more than one national survey with HIV testing since 2000.

Considered together, the various data sources can yield more accurate estimates of HIV infection levels and the demographic impact of AIDS. However, HIV estimates (whether derived from household surveys or sentinel surveillance data) need to be assessed carefully, and the data and assumptions reviewed continually.

3. Are population-based surveys more accurate than antenatal surveys?

For all diseases a sound population-based sample provides better estimates of disease prevalence than a clinic-based sample. National population-based surveys reveal important information about the national prevalence level and about the spread of HIV, particularly among young people, men and residents in rural areas. If response rates are good (e.g. over 75%) and there is no evidence of systematic biases of exclusion of a large proportion of the population with likely different levels HIV infection, then national estimates that consider data from all sources (surveillance, population-based surveys and if available mortality data) should be close to the true situation.

4. Which are the more accurate sources of data: sentinel surveillance or case reporting?

Case reporting generally tends to substantially underestimate the number of people living with HIV. Most countries that rely on case reporting focus the data collection on specific at-risk groups, often missing other groups. Often, case reporting tends to focus heavily on injecting drug users, and often the data collected reflect trends only among those users who interact with government authorities (for example, by being arrested or attending drug treatment clinics).

However, in countries that have extensive voluntary counselling and testing programmes, case reports may enable more precise estimates to be developed. Nonetheless, case reporting is unlikely to capture people living with HIV who were recently infected, and who therefore present no symptoms of infection. For these reasons, case reports can only indicate the minimum number of people living with HIV.

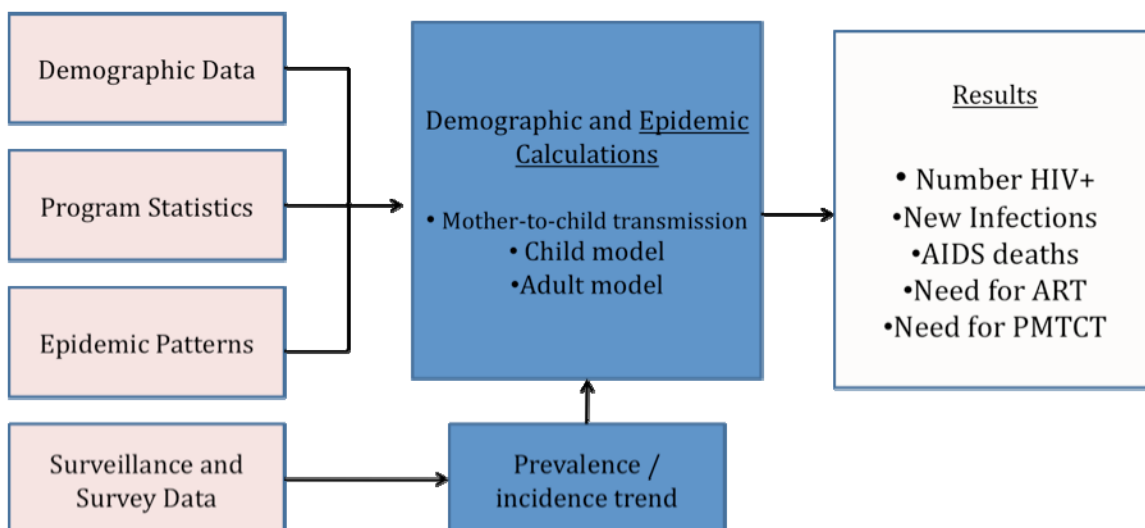
On the other hand, reliance on *sentinel surveillance* of at-risk groups can lead to overestimation of HIV prevalence in these groups. This is because such surveillance in some cases detects HIV infection rates among individuals who are at highest risk of HIV infection. For example, sentinel surveillance among sex workers or their clients often focuses on those who seek treatment at sexually transmitted infection clinics—and who, by definition, have had unprotected sex. However, other sex workers and clients who *do* practice safe sex—and who therefore tend not to present at these clinics with sexually transmitted infections—generally are not captured in this surveillance.

Part Two: From the data to the estimates

5. How are the HIV estimates arrived at?

UNAIDS and WHO, in close consultation with countries, employ the software tool Spectrum to estimate HIV prevalence for men and women. An increasing number of countries have adopted this software tool to develop national estimates.

Estimates for countries and regions are generated with the Spectrum software package, using all pertinent, available data—including surveys of pregnant women attending antenatal clinics, population-based surveys (conducted at the household level), sentinel surveillance among key populations at higher risk of HIV infection, case reporting, information on antiretroviral therapy and on programmes for preventing mother-to-child infection and demographic data.



Between March and June of 2011, UNAIDS and WHO conducted 11 regional workshops, training national personnel/technicians from more than 150 countries responsible for HIV estimates in the specific tools and methodologies used to produce the national estimates in this report. In addition, UNAIDS and WHO have participated in several country-specific consensus meetings on HIV estimates. These methods allow for standardization in measurement methods and allow cross-national comparisons and regional aggregation and estimates.

6. Can the new estimates be compared with those from previous years?

The latest estimates cannot be compared directly with estimates published in previous years. Nor should these latest estimates be compared directly with those UNAIDS/WHO will publish in the years to come. Why not? Because the assumptions, methodologies and data used to produce the estimates are gradually changing as a result of ongoing enhancement of our knowledge of the

epidemic. The data that the countries include in the models increases each year providing a more complete understanding of the epidemic curve. Comparing the latest estimates with those published in previous years is liable to yield misleading conclusions. UNAIDS/WHO re-estimate the trends based on new assumptions and enhancements and include them in their latest publications.

In a nutshell, the latest estimates—for the current year and for past years—will tend to be more accurate and reliable than those produced in previous years, since they are based on improved methods and more data than earlier estimates. This kind of caution is not unusual when dealing with global estimates of disease.

7. Why have UNAIDS and WHO changed the age group ranges?

The new estimates of the number of adults living with HIV (and of adults with new infections and of AIDS mortality) are no longer restricted to those in the 15–49 age group. Historically, UNAIDS and WHO restricted the estimates to this age group to ensure comparability across countries, especially for HIV prevalence. However, it has become evident that a substantial proportion of people living with HIV are 50 years and older, as shown in age distributions of HIV and AIDS case reports, community studies and population-based surveys. Accordingly, UNAIDS and WHO now present estimates of adults living with HIV, new infections and AIDS deaths among adults for all adults '15 years and older'. In addition, we continue to provide estimates of HIV prevalence for 'adults 15–49 years', to continue to allow for comparisons across countries. UNAIDS and WHO also estimate trends among children 'less than 15 years of age'.

8. Why are UNAIDS and WHO publicizing ranges of HIV estimates?

The ranges reflect the degree of uncertainty associated with estimates and define the boundaries within which the actual numbers lie.

UNAIDS/WHO reports point estimates (for example, fixing HIV prevalence in country X at 12.5%). In addition, we also publish the ranges of uncertainty around those point estimates, depending on the quality of the data used to create the estimates. This is done because all estimates are associated with some level of uncertainty.

Because the quality of data varies from country to country, the ranges of uncertainty surrounding the estimates can widen or narrow depending on the country. As well, presenting point estimates might encourage a false sense of precision, notwithstanding the fact that ranges of uncertainty are also provided.

Improved methods, enhanced data and new estimation tools are enabling a better understanding of the degrees of uncertainty that surround HIV and AIDS estimates. This is part of an ongoing process of improving estimates and developing appropriate ranges—all of which are vital for effective HIV planning and programming at national and regional levels.

UNAIDS and WHO are confident that the actual numbers of people living with HIV, people who have been newly infected or who have died of AIDS lie within the reported ranges.

9. If UNAIDS and WHO claim the current estimates are more accurate, why are the ranges for some countries so large?

The ranges reflect the degrees of uncertainty around HIV estimates in particular countries.

Accordingly, the ranges vary, depending on the quality of HIV data available in different countries.

Four factors determine the extent of the ranges around the HIV estimates:

(i) *The HIV prevalence level* – Ranges tend to be smaller when HIV prevalence is higher. Thus the

bounds around the best estimate of adults living with HIV in Zambia would be relatively small compared to a lower prevalence country such as Djibouti where the ranges will be much wider.

(ii) *The quality of the data* – Countries with better quality data have smaller ranges than countries with poorer quality data. The ranges for Asia and the Pacific are comparatively broad—which reflects the fact that HIV surveillance of key populations (such as people who inject drugs, sex workers and men who have sex with men) is relatively poor in most countries in that region, hence resulting in more uncertainty. In general, the ranges for sub-Saharan Africa are narrower, because of recent improvements in the collection and interpretation of HIV data in that region.

Countries in which a national population based survey has been conducted will generally have smaller ranges around estimates than in countries where such surveys have not been conducted. National surveys of HIV infection, which are generally more representative of the general population and of specific sub-groups such as men and women, urban and rural areas, or different regions, will generally reduce the level of uncertainty around estimates of HIV.

(iii) *The number of steps or assumptions used to arrive at an estimate* – The more steps and assumptions, the wider the uncertainty range is likely to be (since each step introduces additional uncertainties). For example, ranges around estimates of adult HIV prevalence are smaller than those around estimates of HIV incidence among children, which require additional data on the probability of mother-to-child HIV transmission. The latter are based on prevalence among pregnant women, the probability of mother-to-child HIV transmission, and estimated survival times for HIV-positive children. There is therefore greater uncertainty in these estimates than for adult prevalence alone.

(iv) *The type of epidemic (generalized or low-level/concentrated)* – Ranges tend to be wider in countries with low-level or concentrated epidemics than in countries with generalized epidemics because in low-level or concentrated epidemics, one needs to estimate both the numbers of people in the groups at higher risk of HIV infection *and* HIV prevalence rates in those groups.

10. How confident are UNAIDS and WHO about the estimates of the number of people who die of AIDS each year?

Estimates of adult AIDS mortality are based on several assumptions and additional sets of data—including estimates of the numbers of adults and children who are HIV-infected, and estimations of survival times from infection with HIV to death for adults and children infected with HIV.

Civil registration systems are the best source to obtain an estimate of the mortality due to AIDS. However, in most countries with generalized epidemics, coverage of civil registration is too low to provide useful information on AIDS mortality. Some countries have local demographic surveillance or general information on adult mortality from censuses and surveys that can help estimate mortality levels due to AIDS.

Estimating mortality in countries with low-level or *concentrated* epidemics is even more difficult. Some at-risk groups are likely to have different background mortality, in other words they are more prone to other causes of death (for example, injecting drug users are vulnerable to fatal drug overdoses and other life-threatening hazards). All this can have substantial effects on patterns of mortality. Unfortunately, country-specific data on mortality and on changes in risk behaviour are seldom available. However, some countries with low-level/concentrated epidemics have well-functioning vital registration systems that include the cause of death.

11. What is being done to improve national HIV estimates?

New and different sources of data, such as national population-based surveys, are enabling more

accurate estimates and more refined understandings of the epidemic's trends. In addition the results from the models are being compared with other sources such as data from demographic surveillance sites, mortality surveys, or early infant diagnosis results to improve the assumptions.

Importantly, the roles of national AIDS programmes have changed significantly since the first set of UNAIDS/WHO country specific estimates was produced in 1997. Initially, countries were requested to comment on provisional estimates. The extent of their involvement has increased subsequently

In the past several years, for example, UNAIDS and WHO, along with their technical partners (including East-West Center, Futures Institute, the US Census Bureau and the US Centers for Disease Control and Prevention) carried out a series of regional training workshops in which epidemiologists from over 150 countries were trained in the HIV estimation process.

Such efforts have led to much greater involvement by national programmes, national statistics offices and other government and academic organizations in the production of estimates. The result has been better quality estimates, due to the use of additional data and the application of local knowledge.

UNAIDS and WHO continue to work with countries, partner organizations and experts to improve data collection. These efforts will ensure that the best possible estimates are available to assist governments, non-governmental organizations and others in gauging the status of the epidemic and monitoring the effectiveness of prevention and care efforts.

Part three: Interpreting the new estimates

12. Is the AIDS epidemic slowing down?

Yes, the epidemic is slowing down globally but not all countries are experiencing a decline in new HIV infections. Globally, the HIV incidence rate (the annual number of new HIV infections as a percent of previously uninfected persons) is believed to have peaked in the late 1990s and to have decreased by 21% through 2010. However, the numbers of people living with HIV have continued to rise, due to population growth and, more recently, the life-prolonging effects of antiretroviral therapy.

13. Has the epidemic peaked in sub-Saharan Africa?

Across most of sub-Saharan Africa (including parts of southern Africa), HIV prevalence among pregnant women attending antenatal clinics has been roughly stable in recent years—albeit at very high levels in southern Africa—and has shown declines in some countries. UNAIDS and WHO analyses over the past six years show that the epidemic in this region overall has peaked and there has been a notable decline in the regional rate of new infections.

The number of people living with HIV in the region rose dramatically in the late 1980s and 1990s, but has stabilized in recent years. This stabilization is a result of a peak in new infections which occurred in the late-1990s and initial indications of a decline in deaths due to increased access to antiretroviral treatment.

13.1 What might be causing the stabilization of HIV prevalence in sub-Saharan Africa?

The balance between new HIV infections and deaths due to AIDS determines the number of people living with HIV. In countries where the number of people who have been newly infected each year roughly equals the number of AIDS deaths, prevalence will be stable. HIV prevalence might therefore appear stable, but it hides a persistently high number of annual, new HIV infections and an equally high number of AIDS deaths.

Declining prevalence in countries could be explained by high numbers of AIDS deaths and decreasing incidence, which could be associated with behaviour change.

On the other hand, as coverage of antiretroviral treatment increases, it is possible that we will see prevalence levels increase as more people infected with HIV live longer. However, in many countries in sub-Saharan Africa, we do not see an increase in prevalence because incidence is decreasing at the same time as people live longer because of ART.

13.2 There is no such thing as the “African” AIDS epidemic?

It is important to remember that there is not one “African” AIDS epidemic. In several countries, adult HIV prevalence is below 2%, while in a few other countries it is over 20%. These extreme differences in prevalence levels fall roughly into geographically separate areas. Nine countries in southern Africa (Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe) have prevalence above 10%. In West Africa, HIV prevalence is much lower with no country having a prevalence above 10% and most having prevalence between one and five percent. Adult prevalence in Central and East Africa falls somewhere between these two groups.

The countries of the region also differ in the time course of their epidemics, with epidemics starting earlier in Central and East Africa and much later in countries in southern Africa. Uganda is an example where adult HIV prevalence peaked in the early 1990s.

14. Is the percentage of women infected with HIV rising globally?

No, this estimate has been roughly the same for the last several years. UNAIDS/WHO estimate that about half of adults aged 15 years and over living with HIV are women. An estimated 80% of all HIV-positive women live in sub-Saharan Africa. Young women are also much more likely to be HIV-infected than young men – a ratio of 3 to 1.

The concentration of HIV-infected children in sub-Saharan Africa reflects the estimate that about 60% of HIV-infected adults in that region are women and that women in Africa have more children than elsewhere in the world. Aside from sub-Saharan Africa, the Caribbean is the only region where the proportion of women and girls living with HIV (53%) is higher than that of men and boys.

15. Are more young people becoming infected with HIV?

UNAIDS estimates that about half of all new HIV infections worldwide are among children and young people aged 15-24.

Additional sources of information

For a technical description of the processes used to arrive at the estimates, please see:

UNAIDS web site

<http://www.unaids.org/en/KnowledgeCentre/HIVData/Epidemiology/epiworkinggrp.asp> and
<http://www.unaids.org/en/KnowledgeCentre/HIVData/Methodology/>

For a detailed description of the methods, software, quality of data and development of ranges, please see a series of articles published in a supplement in the journal *Sexually Transmitted Infections* in July 2010. The articles can be downloaded for free from the website at

<http://sti.bmj.com/>

More information on the advisory group to the estimation process, the UNAIDS Reference Group on Estimates, Modelling and Projections, can be found at www.epidem.org