
Responding to surveillance: Methods and software to produce HIV/AIDS estimates in the era of population-based prevalence surveys

Report of a meeting of the UNAIDS Reference Group for
“Estimates, Modelling and Projections” held in Glion, May
10-11th 2004

TECHNICAL REPORT AND RECOMMENDATIONS



UNAIDS

The meeting of the UNAIDS Reference Group on Estimates, Modelling and Projections (the 'Epidemiology Reference Group') was organised for UNAIDS by the UK secretariat of the reference group (<http://www.epidem.org>) based at Imperial College London. Participants of the meeting are listed at the end of this document. The recommendations in this document were arrived at through discussion and review by meeting participants and drafted at the meeting.

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Introduction

The Reference Group

The Joint United Nations Programme on HIV/AIDS (UNAIDS) Reference Group on “Estimates, Modelling and Projections” exists to provide impartial scientific advice to UNAIDS and the World Health Organization (WHO) on global estimates and projections of the prevalence, incidence and impact of HIV/AIDS. The Reference Group acts as an ‘open cohort’ of epidemiologists, demographers, statisticians, and public health experts. It is able to provide timely advice and also address ongoing concerns through both *ad hoc* and regular meetings. The group is co-ordinated by a secretariat based in the Department of Infectious Disease Epidemiology, Imperial College London (www.epidem.org).

Aims of meeting

The primary aim of this ad-hoc meeting was to bring together experts and new data to provide insight into the reasons for discrepancies in estimates of HIV prevalence from recent population based samples and antenatal clinic convenience samples routinely used to estimate adult HIV prevalence in sub-Saharan Africa. This work built on a previous meeting held in Lusaka in 2003 supported by the WHO and UNAIDS (1). Recommendations were sought on how to use this new information to improve HIV estimates in the region, and more generally on the data, standards and analyses required from both antenatal and population-based surveys. The implications of changing surveillance for the software (EPP and Spectrum) used by UNAIDS and national AIDS programmes to produce HIV estimates were also a focus of attention. The meeting additionally provided a forum to present and obtain feedback on the methods used by UNAIDS and WHO to produce HIV estimates for all countries at the end of 2003, including recently derived methods to estimate uncertainty in HIV statistics (2).

Approach

The first day of the meeting was devoted to presentations of recent population-based prevalence survey data and analyses of this data, the relationship between mobility and HIV infection, and the methods and software promoted by UNAIDS to produce HIV estimates (the agenda is reproduced in Appendix II). During the second day two working groups focused on separate issues. The first group discussed population-based prevalence surveys and the relationship with existing surveillance systems, and the second group considered estimation software and the identification of improvements and additional features.

The meeting was attended by 26 experts from 10 countries (see Appendix II for a list of participants). Each contributed, not only data, insights and analysis, but also worked hard to produce a set of recommendations for UNAIDS and WHO, drafted at the meeting. We would like to thank them for their hard work and attendance at the meeting.

The recommendations drafted at Reference Group meetings give UNAIDS and WHO guidance on how best to produce estimates of HIV/AIDS, an opportunity to review

current approaches and also help to identify information needs (earlier reports are published on the Reference Group website www.epidem.org). They are typically drafted with an explicit timeframe for follow-up work that is subsequently reported on by the Reference Group secretariat to ensure a response to all recommendations. This transparent process aims to allow the statistics and reports published by UNAIDS and WHO to be informed by impartial, scientific peer review.

Group I Recommendations: Reconciling ANC and population prevalence surveys

1. What are the major factors driving discrepancies between population and ANC-based surveillance in sub-Saharan Africa and can generalisations be made?

a. Coverage of populations in surveillance systems with different characteristics or locations

There are two potential biases that affect the extent to which HIV prevalence data obtained in ANC sites reflect adult population prevalence 1) the extent to which the selected sites are representative of all pregnant women at ANC across the country and 2) the relationship between ANC prevalence and prevalence in the surrounding community. Most discrepancies between ANC-based estimates and population-based estimates are explained by the first type of bias: rural populations are poorly covered by ANC-based surveillance systems and the bias tends to be in one direction - overestimation. Remote rural populations have a lower probability of being included in surveillance systems and generally such populations have lower HIV prevalence than less remote rural populations.

It is likely that urban ANC clinics provide a better picture of prevalence among all pregnant women in urban areas. However, the location of the urban sites may not be representative of the whole urban population (e.g. in low income area). Also, urban ANC attendees may be less representative of the population living in the catchment area of the clinic, than rural ANC attendees are, because more women attend private health care in urban areas compared to rural.

ANC data are good for analysis of trends and for regional differentials, but not ideally suited for calculating the general population prevalence. It is a proxy and not representative. Still, in countries without a population-based HIV prevalence estimate, it is the primary source of data to derive a national HIV prevalence estimate. Furthermore, ANC data are available on an annual basis while surveys are often one-off events with long intervals in between. Caution should be exercised in the language used to describe results (i.e. ANC should always state "prevalence in pregnant women"). Also, while in most countries the longest time series are available for urban areas, urban trends may be different from rural trends.

Recommendations

Improving the quality of data

- Satellite rural clinics can be used to increase coverage of remotely rural areas (e.g. as done in Ethiopia)

Better documentation of ANC data

- The residence (rural/urban) of individual women in ANC must be collected in surveillance.

- Reporting by age by countries is poor and only improving gradually. There is a need for a big effort to standardize HIV prevalence reporting by age and by clinic, as is done in Cote d'Ivoire, using standard reporting forms.
- Locations (preferably GIS coordinates) of ANC sites and description of their catchment areas and population is important to compare with survey clusters.
- Description of the population that is served by the ANC clinic using a standard typology that allows monitoring of trends over time.

b. Movement/migration and absence from population-based surveys; and refusal to participate in HIV testing in surveys.

Refusal to participate and absence from population based surveys may significantly bias estimates of prevalence in the population. In some but not all cases this appears to be confounded with movement of individuals.

Recommendations

Better documentation of survey metrics

- Ensure that the enumeration areas have up to date household census and document the procedures followed.
- Surveys should be de-facto surveys of those who slept in the household the night before (including visitors), not *de jure* so that we only need to adjust for the usual residents of the household who are absent because they are in institutions (e.g. in migrant worker hostels, prisons, schools, hospitals). EPI cluster sampling methodology should not be used.
- Do not replace households but allow for missing households in the sample size calculation.
- For those absent basic socio-demographic characteristics should be collected as well as minimal information to explore mobility-associated bias: age, marital status (first or remarriage), sex, residence (urban or rural), household characteristics, how long away, and where they are at the time of the survey (temporarily out, living elsewhere, in institution, work vs. private household).

Analyses and reporting of biases

- Surveys should conduct an explicit analysis of the characteristics of refusers and absentees. Based on the results of this analysis, adjustments should be made, as appropriate.
- The most important adjustment of survey data however is in most cases the adjustment for non-response by age and sex since these variables capture the largest variation in HIV prevalence in most surveys. It needs to be documented clearly in the report whether or not the overall prevalence estimate is adjusted for this bias.

c. Testing protocols and sample handling and storage in surveillance and population prevalence surveys

In some countries problems with the specificity of HIV test kits in field conditions has led to overestimates of HIV prevalence. Quality control programmes should aim to pick up on these problems.

Recommendations

Testing protocol

- Where possible, do two HIV tests (one in field and one central or two central). A second test should be done for all positive tests and 10% of negatives, even where prevalence is high (this changes the current recommendation of using a single test where prevalence is above 10%). This is a major issue and should soon be addressed by WHO and UNAIDS, in collaboration with CDC.
- Oral fluid testing: at this time there does not appear to be any advantage to the use of oral fluid. Oral sampling does not appear to improve response rates, is more expensive, does not allow repeat testing, and may generate more erroneous results given the lower concentration of antibodies in oral fluid compared to blood. Hence it is recommended to use blood samples in preference to oral fluid samples.

Sample handling / storage

- Quality control results should be part of ANC surveillance reports, including total eligible ANC clients, the number of blood samples collected, and lab tests done with results of all tests (initial and confirmatory).
- Use dried blood spots, especially if storage of serum samples is problematic.

Analysis and report

- Where possible, compare ANC with prevention of mother-to-child-transmission (PTMCT) programmes' HIV test data.
- A draft table of the results of quality control and how these may affect the overall results should be included in the proposed population-based survey guideline.

General

- In general capacity building in lab and lab data management for better quality control is necessary. Record keeping and lab data management need to be improved.

2. What specific analyses should population surveys do to inform ANC-based estimates?

Recommendations

- Comparisons between antenatal and population survey estimates of HIV prevalence should include: urban ANC with nearby urban survey clusters; rural ANC with nearby rural survey clusters; regional (provinces or states) prevalence level ranking.
- Women in population surveys who delivered in the last 2 years or are currently pregnant should be selected to compare with ANC women.
- HIV prevalence by type of antenatal care facility attended, i.e. hospital, health centre, dispensary, no antenatal care (separately for rural and urban areas). Based on this information an adjustment to ANC derived estimates can be made to account for prevalence in very remote areas where women don't have access to antenatal care (and therefore are not covered in the ANC-

based surveillance), using the number of pregnant women in each of the strata to weight the prevalence.

3. Quality standards and reporting formats for population surveys

When is a population survey useful to measure HIV prevalence?

- Population surveys for the measurement of HIV prevalence are not useful in low-level and concentrated epidemics (where ANC prevalence is below 1% nationally), because in this type of epidemic HIV infections are concentrated in hidden or hard-to-reach populations, including injecting drug users, sex workers, men who have sex with men, and mobile populations. These groups are likely to be missed or underrepresented in household samples.
- In generalised epidemics (where ANC prevalence is over 1% in both urban and rural sites) the HIV prevalence measured in a population survey is likely to be closer to the true population prevalence in countries with high HIV prevalence compared to countries with lower HIV prevalence. In countries with relatively low prevalence of say between 1% and 3%, HIV infections will be more concentrated in hard-to-reach populations than in countries with higher levels of prevalence, and, as for low-level and concentrated epidemics, population surveys may underestimate the true prevalence.

Organization of survey teams is critical for minimizing non-response. Best:

- Same person does interview and collect specimen. Problem if lay interviewers are not permitted to perform specimen collection.
- More male interviewers (since men are more likely to be absent)
- Estimates of non-sampled population size needed (boarding students, prisoners, refugees, institutional residents, workers living in hostels, etc.)

Other recommendations:

- Whenever possible, surveys should link biological data with other data while protecting the identity of the participants.
- Surveys should document and better describe the methodology of selection of households and respondents (characterization of clusters, issues of selection of HH within clusters, populations not covered, any replacement policies, etc.). The proportion of single person households is particularly important, as they are associated with HIV (because of deaths of partner or parents due to AIDS or greater mobility and possibly exposure) and because the non-response rate is likely to be higher (single household more likely to be outdoors, no other household member to make appointment for revisit).
- Procedures (?specifics) should be applied to training and field manuals to reduce bias introduced by the field staff.
- In addition to the generally standard questions in the household schedule - age, sex, place of residence, household size, relationship to the head of the household, it may be considered to add questions on characteristics of absentees: marital status (first or remarriage), household characteristics, how long away, and where they are at the time of the survey (temporarily out, living elsewhere, in institution, work vs. private household). Surveys should report characteristics of non-responders. Adjustments should be considered if absentees have different characteristics than those present (based on sex,

- age, marital status, household size and other characteristics) and if the reason for being absent is associated with higher risk for HIV infection.
- The impact of response rates on the overall estimate of prevalence varies by non-response rate and the chances that HIV prevalence is different among non-responders. If the response rate is below 60% the HIV prevalence estimate should be labelled as highly uncertain. 60-70% as uncertain, 70-80% fairly plausible, 80% and over as plausible.
 - Example reporting format should be included in the proposed population-based survey guideline (based on DHS formats and additional for refusers/absentees). In reports, observed prevalence should be reported and additionally, rates adjusted for age, sex, urban/rural residence and any other factors, as appropriate.

4. How to adjust ANC with information from surveys

The prevalence curves constructed by EPP should be based on ANC data and subsequently estimates should be adjusted using the population survey data. Recommendations were made to allow post-hoc adjustments to the level of the epidemic curve(s) within EPP on the basis of analysis of population based prevalence surveys (where available; see 2. and 3. above) and the location of antenatal clinics (urban/rural and by province; see EPP recommendation *d.*).

5. For age and sex distributions of PLWHA should country-specific data or regional estimates be used?

Several factors need to be considered. Non-response in country's survey and any bias it introduces. One needs to balance the specificity that comes from data of one's own country versus the bigger sample and the summary analysis of regional values (regional values are the basis for defaults in the Spectrum software).

Additional sources of country-specific information on sex ratio of infections such as: blood donors, VCT data, other sites where testing is routinely done, could be considered but none will be as useful, however, as data from population surveys.

6. How to proceed with joint analyses and release of new HIV prevalence estimates based on either ANC surveillance or population-based survey

General population surveys can inform ANC surveillance-based estimates (see 4.) . Reconciliation of both sources into a common epidemiological analysis is desirable. Tabulation standards should be applied to all surveys to increase comparability.

Before (preliminary) survey reports are released, there should be joint review and careful explanation of differences. Characteristics for comparison include:

1. ANC coverage and resulting bias.
2. Survey non-response and resulting bias (focusing on age and sex, and on absence versus refusal).

3. Comparisons between rural/urban in both.
4. Adjustments made as per above recommendations.

The comparisons and adjustments should be made by joint technical teams that comprise representatives involved in the data analysis of each of the two data sources (ANC surveillance and national household surveys). When data become available from a national household survey, the new data should be reconciled with existing HIV estimates based on ANC surveillance, as per above recommendations. Similarly, when new ANC surveillance data become available in a country where a national household survey has been conducted, the information from the national household survey should be used to inform the HIV prevalence estimate, as per above recommendations. This reconciliation will allow for the best possible assessment of the epidemiological situation and estimates for the country, and will avoid confusion in the minds of politicians, decision makers and the public, thereby ensuring greater confidence in the epidemiological assessment and estimates. Communications to press and specific audiences should use the results and estimates of this common analysis.

Comparison of ANC sentinel surveillance with PMTCT program prevalence will also help to validate ANC based estimates in the future.

7. Role of population prevalence surveys for young people estimates

The prevalence among young pregnant women /young people is the primary indicator for monitoring MDG and UNGASS goals. Currently used indicators for young people are:

- 15-24 year olds ANC prevalence, separately reported for capital city, other urban areas, and rural areas;
- 15-24 year olds prevalence in general population from national household surveys, separately reported for women and men.

Recommendations:

- Explore the use of age-specific predicted incidence rather than prevalence information for inputs to Spectrum in order to better estimate prevalence in youth 15-24.
- The 15-24 prevalence indicators are important; specific non-response in this age group is needed in surveys. This should be included in reporting format in proposed population-based survey guideline.
- Further work is needed to improve the estimates for population prevalence 15-24 among men and women based on ANC, and combining such data with population based surveys.

Group II Recommendations: Methods and software for estimates of HIV/AIDS

EPP

EPP is currently under revision with major changes including the implementation of a likelihood-based fitting algorithm that will allow poor fits to be highlighted, and the option of allowing different sites to have different prevalence level parameters that are automatically estimated as part of the epidemic curve fit. These changes respond to recommendations made during the last major reference group meeting in December 2003.

Recommendations

- a. More flexible management of multiple projection sets required
- b. turnover of groups at higher risk, background mortality and what to do with those who quit the groups
 - Keep track of all ex-high risk groups by sex (turnover specified by duration parameter)
 - Additional non-AIDS mortality in groups at higher risk specified by a mortality ratio
 - Assume ex-high risk groups don't have any additional non-AIDS mortality over that in general population
 - If evidence for low risk prevalence not directly dependent on high risk behaviour also include (e.g. fraction of ANC)
- c. Use standard templates and force user to attribute total population from demographic profile of country to risk groups to ensure that all groups at higher risk are included.
- d. Fitting algorithms and goodness of fit measures
 - Allow site-specific level parameters to be estimated during fit and test fit compared to model where all levels the same (cf. previous recommendations)
 - Remove scaling and weighting of prevalence estimates from data entry sheets
 - Allow scaling of 'sub-epidemic' curves (province, urban, rural, etc.) after fit – informed by DHS+ or other population prevalence surveys (enter either adjusted population prevalence or a scaling ratio (default 0.8 for rural, 1.0 for urban)
- e. model behaviour change and treatment effects?
 - Explore impact of allowing r to change at a given time to reflect behaviour change
 - If this gives better/realistic fits then think about making this an EPP option (for some users)
 - test how additional category of HIV positive on ART can be included

Spectrum

Recommendations

- a. change to using force of infection rather than age profile of prevalence?
 - Use fixed pattern of force of infection by age to give age distribution of prevalence over time (cf. recommendations from group 1)
 - Use this as default pattern – allow user to enter alternative patterns and have Spectrum recalculate prevalence either side of this year based on pattern of change over time
- b. treatment effects
 - Await outcome from Tim's results with EPP
- c. other indicators/outputs useful
 - DALYs or another measure related to burden of disease (e.g., HEALYs)
 - Recommend implementation of GOALS in Spectrum

Role of workbooks for concentrated epidemic estimates

- Continue to use where time-series of prevalence data unavailable.

Linking EPP and Spectrum:

Generalised epidemic

- Allow urban and rural curves to feed into separate urban/rural demographic projections in Spectrum
- Allow Spectrum to present indicators split further (e.g. province), but don't automatically do separate demographic projections (this can be done but requires specification of complete demographic models for the provinces/regions)

Concentrated epidemics

- fraction of HIV prevalent infections among (active) IDU passed from EPP to Spectrum along with the non-AIDS mortality relative rate
- inform age distribution of high risk HIV positive population in Spectrum with recent review (Neff Walker, Mary Mahy) (no change over time)

Plausibility bounds

Include algorithms in software (EPP or Spectrum)?

- Spectrum – use heuristics to present range around estimates for fixed year for generalised and concentrated epidemics
- EPP – don't implement other than to indicate when curve fit significantly worse than previous best fit using maximum likelihood method

Timelines for Group II recommendations

- Draft versions of EPP and Spectrum ready for testing by reference group by September
- Testing and comments by October
- Final versions end November (in time for reference group meeting mid-December)

References

1. World Health Organisation & UNAIDS. Reconciling antenatal clinic-based surveillance and population-based survey estimates of HIV prevalence in sub-Saharan Africa. Geneva, WHO, 2003.
2. Grassly, N.C., Morgan, W.M., Walker, N., Garnett, G.P., Stanecki, K.A., Stover, J. et al. Uncertainty in estimates of HIV/AIDS: the estimation and application of plausibility bounds. *Sex. Transm. Infect.* 2004, 80 (suppl 1): i31-i38.(will be available on-line as of 6 July 2004).

Appendix I: Meeting Agenda

Monday 10th

9:00	Welcome and introduction	Peter Ghys
9:10	Aim of this meeting	Geoff Garnett

I. Reconciling population prevalence surveys and ANC estimates

Findings of recent population prevalence surveys

09:15	Overview of findings of DHS+ in Mali, Zambia, Dominican Republic, Kenya, and Ghana	Ann Way
09:30	2002 HSRC and Lovelife survey in South-Africa	Thomas Rehle
09:45	Surveys in Niger, Burundi, Congo, and Sierra Leone	Txema Calleja
10:00	Concordance and discrepancies between surveys and ANC-based estimates	Karen Stanecki
10:15	HIV prevalence and characteristics of pregnant women at ANC	Wolfgang Hladik
10:30	Female: male HIV prevalence ratio in generalised epidemics	Peter Ghys

10:45 *Discussion*

11:00 **Coffee** (15 mins)

Association of mobility with HIV infection

11:15	Overview of past studies	Geoff Garnett
11:30	Manicaland	Dik Habbema
11:50	Effects of mobility on HIV prevalence measurement in cross-sectional surveys – results from Kisesa	Basia Zaba

12:10 *Discussion*

12:30 **Lunch**

Approaches to adjusting survey- and ANC-based HIV prevalence estimates

13:30	Adjusting rural sites in ANC-based estimates	Karen Stanecki
13:45	HIV status according to survey participation in Masaka	Jimmy Whitworth
14:00	HIV status and survey participation in the 4-city study (Ndola, Kisumu)	Ann Buvé
14:15	Adjustment derived from Kisesa	Basia Zaba
14:30	Characteristics of non-responders in Kenya's DHS+	Ann Way
14:45	Result from Kenya meeting	Larry Marum

15:00 *Discussion*

15:15 **Tea/Coffee** (15 mins)

II. Tools for estimates and projections

Intervals about estimates

15:30	Adult HIV prevalence, incidence and AIDS mortality	Nick Grassly
15:45	Child HIV prevalence, incidence and AIDS mortality	Meade Morgan
16:00	Implementation of ranges for 2003 UNAIDS/WHO estimates	Neff Walker

16:15 *Discussion*

16:30 **Coffee/Tea** (15 mins)

Tools

16:45	Overview of previous recommendations for EPP and Spectrum	Geoff Garnett
17:00	New and proposed features of EPP	Tim Brown
17:15	New features of Spectrum	John Stover

17:30 *Discussion*

18:00 End

Tuesday 11th

9:00 Working groups on:

- I. Reconciliation of surveys and ANC-based estimates**
- II. Tools for estimates and projections**

10:00 **Coffee/Tea**

12:30 **Lunch**

13:30 Continue in drafting working group recommendations

14:30 Presentation of group 1 recommendations

15:30 **Coffee/Tea**

16:00 Presentation of group 2 recommendations

17:45 End

Appendix II – List of Participants

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