

Technical Consultation on Methods for Generating Sub-National Estimates of HIV Epidemiology to Support Country Programme Planning and Evaluation

**Nairobi, Kenya
24-25 March 2014**

Organised by: HIV Modelling Consortium, UNAIDS Reference Group of Estimates, Modelling and Projections and UNAIDS Hotspot Taskforce.

Summary Report

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Background

In response to these developments, UNAIDS convened a meeting in July 2013 to bring together relevant stakeholders to review the field and to identify ways in which it could move forward. A forthcoming UNAIDS report will emphasize that countries should increasingly seek to leverage available data to identify areas of remaining high HIV transmission ('epidemic strongholds') and to fit programs to the local needs of populations. At the meeting, it became clear that many technical questions remain open about how to synthesize available data to provide a robust description of sub-national epidemiology. In particular, how much data is sufficient to make useful inferences on sub-national epidemiological patterns; how should data from different surveys be incorporated together; how fine should the scale of inference be.

Subsequent to that convening, UNAIDS commissioned a task force to advance this agenda and the HIV Modelling Consortium has been asked to investigate these technical challenges. In a related development, USAID has funded a group to review how data is used within countries to form programming decisions, and as part of that maps of key indicators (HIV prevalence, new infections, ART coverage, etc.) will be developed. Any recommendations from this Modelling Consortium project will feed directly into that USAID-funded work, as well as into the UNAIDS Reference Group on Estimates, Modelling and Projections (www.epidem.org), which oversees the development of methods to compute the global AIDS statistics.

The Central Question

How should countries develop sub-national estimates relating to their HIV epidemics?

Aims

This consultation aimed to:

- Review proposed modelling methods for generating sub-national estimates of HIV epidemiology;
- Reach agreement on whether to proceed with development of the recommended method, and if so, how to do this; and
- Develop a research agenda based on data and analysis needs identified during discussions.

Meeting 24 – 25 March 2014, Nairobi, Kenya

The Secretariat convened a meeting in Nairobi, 24 – 25 March 2014 for the modelling groups, representatives from UNAIDS, the Health Policy Project, and representatives from country program teams to discuss the utility of sub-national estimates of HIV epidemiology and review the proposed methods.

In total seven modelling groups agreed to participate in the exercise:

- Sarah-Jane Anderson, Imperial College London
- Samir Bhatt and Peter Gething, University of Oxford
- Diego Caudros, Weill Cornell Medical School Qatar
- Ngianga-Bakwin Kandala, University of Warwick
- Joseph Larmarange, CEPED & University of KwaZulu-Natal
- Samuel Manda, South Africa Medical Research Council
- Imelda Moise, Ezekiel Kalipeni and Leo Zulu, University of Illinois

In advance of the meeting the HIV Modelling Consortium Secretariat collected data from a variety of sources, which the modelling groups could use to develop their method (GPS and HIV data from DHS, ANC, land cover, population density etc.). Data sources were provided (rather than allowing individuals to use any available data) to first ensure that it was possible to compare the model performance and to ensure that the methods were developed based on widely available data. The models were asked to apply their methods to 6 African countries (in the following order) that vary in regards to the epidemic and data availability: Malawi, Tanzania, Ghana, Uganda, Cote d'Ivoire, Kenya.

Table 1: Summary of methods

	Run time	Data intensity	Software	Training needs
Larmarange / PrevR	10 min	Low Only DHS	Open-source: R package (PrevR)	Low Easy to implement
Cuadros	1 day	High Addition data needs customisation and geographical harmonising	ArcGIS	High
Bhatt & Gething / Oxford	3 days	High Data driven; customisation and geographical harmonising of covariates	Open-source: R, MET lab, Inla, WinBUGS	High Complex and computationally demanding method; Understanding Bayesian framework
Moise / US	1-2 h	Medium DHS and ANC, population density, syphilis, land cover	Open-source: R, GeoDa	Medium Regression kriging
Manda		Low DHS and ANC	Open-source: WinBUGS	Medium Bayesian smoothing of district level estimates
Kandala		Low Only DHS	Open-source: BayesX	Medium Bayesian geo-additive mixed models

Three of the seven models developed methods sufficiently in advance of the meeting for comparative analysis to be conducted: Bhatt, Oxford; Cuadros, Weill Cornell Medical Centre; Larmarange, CEPED.

Joseph Larmarange: Mapping HIV prevalence from DHSs using kernel density with adaptive bandwidths (PrevR)

- Based on kernel density estimates to smooth between DHS clusters
- Kernels use adaptive bandwidths based on a fixed number of observations

Diego Cuadros: Optimal spatial sampling design to obtain sub-national estimates of HIV prevalence (Cuadros)

- Mapping relevant covariates
- Regression analysis to account for covariates
- Adding spatial autocorrelation to residuals

Samir Bhatt: Integrated model-based geostatistical approaches for geospatial prediction of HIV prevalence (Oxford)

- Bayesian model-based geostatistical models to predict posterior distributions of HIV prevalence

The performance of the methods in predicting the pattern of prevalence was compared using the following validation methods:

Internal validation:

- Leave Out One Cross Validation (LOOCV) whereby each data point is held back in turn, the estimation is re-computed and the prediction compared with the data at the relevant measured location.
- Partitioned Data Holdback is analogous to LOOCV, except a percentage of the data is held back (here 10%) instead of each point individually. The metric used to quantify the quality of the model

prediction is the Root Mean Squared Error (RMSE), which uses the difference between observed (O) and predicted points (E) for each of the data points being held back (of which there are N).

External validation:

Compare the estimated surfaces (where applicable) for one year (Y), with that which was measured by different set of clusters in a previous year (Y-T), where T is between 4 and 6 in the countries we have been working with. The comparison aims to demonstrate the acceptable performance of the methods rather than as a direct way to compare the performance of the different methods. This approach is confounded by real changes in the level and spatial distribution of HIV prevalence, the likely extent of which will be assessed post-hoc and potentially with reference to ancillary data sources.

Each of the models was deemed to have similar predictive ability and perform well (demonstrated by comparable RMSE values), however none of the methods produced perfect estimates. The model developed by the Oxford Group consistently produced marginally better results for the validation exercises. The correlation between observed and modelled data was also comparable between all models; but the Oxford model again gave the strongest result with the highest correlation between predicted and observed data in both Tanzania and Kenya.

Recommendations

Based on discussions over the 2 days of the meeting, participants at the consultation proposed the following recommendations:

1. Generation of sub-national level HIV estimates, in particular at a second sub-national level, would be useful to respond to the urgent need for countries to be able to describe their epidemic at a sub-national level and inform programming. Sub-national estimates better reflect differences in the HIV epidemic within a country. It should be possible to combine these estimates with other data (i.e. programme data).
2. The key elements identified that should be present in the ideal method for generating sub-national HIV estimates are:
 - Uncertainty;
 - Inference on associated statistics, such as HIV incidence, ART coverage, etc.
 - Ability to leverage geographically-specific ancillary information; and
 - Country ownership.
3. A short-term and medium-term courses of action are recommended (see Figure 1):
 In the medium-term, it is recommended that participants from Oxford University (*Oxford Group*) further develop the model proposed during the meeting, to be finalized by Q1 2015. This model allows estimates, and measures of the associated uncertainty, to be robustly inferred from the data. This method also performed the best in the internal and external validation exercise. Further development should consider the estimation of incidence and ART coverage, account for age structure, and assess the scope for scalability of the method (i.e. many countries applying this model every year). The level of precision of the estimates to be generated through this method will need to be investigated. It may be possible for a finalized model to be fully aligned with the models currently used for statistical estimation (Spectrum/EPP).

The urgent need for countries to understand sub-national variations in HIV epidemiology was noted. In the short-term, countries will be advised that, in many cases, data from DHS permits the direct generation of province-level estimates of HIV prevalence. However, if a country requires approximations for HIV prevalence at the second-administrative level (i.e. district level) a data visualization resource will be made available for time-limited use by countries.

This resource will be distributed as a UNAIDS product and will be based on the PrevR model presented by Joseph Larmarange. Larmarange will apply the model to all countries with DHS/AIS from 2008 onwards (displacement was restricted to avoid crossing borders in surveys starting in 2008) that included HIV testing, using the most recent survey for each country. No formal quantification of the uncertainty can be generated for computed estimates for HIV prevalence. However, a useful scale for the reliability of computed estimate will be represented with a “traffic light” system that will reflect the number of observations used to generate the estimate, and the distance from which points were drawn to compile the estimate, and the extent to which these were from other districts.

Reports will be produced for each country containing:

- a. Visualization of the surfaces of HIV prevalence and the number of people living with HIV (15-49 and 15+);
- b. A visualization of quality of estimates, based on the traffic-light scheme;
- c. Data table of district-level HIV prevalence estimates and number of people living with HIV (15-49 and 15+), with the indication of quality of the estimate based on the traffic-light scheme.

Each report will be accompanied by a short guidance document providing information on the method applied, assumptions made, limitations of the method, and guidance on interpretation of results.

The reports will be made available through a website. This method may also be recommended for immediate use in selected countries as part of the HPP technical assistance process in preparation for New Funding Model applications to The Global Fund.

4. Accompanying guidance to be developed on generating sub-national estimates should include recommendations around confidentiality of data, and geo-data in particular.
5. The validation exercise and analysis will be repeated incorporating methods not included in the analysis presented at the meeting, as well as for the district-level estimates produced by each model.
6. A policy paper will be written to document the decision-making process leading to meeting recommendations. It will touch on the rationale (i.e. the need for the more localized data to inform programming and help management), the methods presented as well as the analysis of the validation of methods proposed by the various groups.
7. In terms of data needs, it was noted that PEPFAR countries are being supported to generate geo-located master facility lists for all national services. Master facility lists are also being developed specifically for PEPFAR services. Other partners providing services in countries should be encouraged to also produce or contribute to national master facility lists of their services.
8. Countries should be encouraged to make their survey, surveillance and programme data publicly available.

Next Two Years



	Q2 2014	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016
Country teams	Use readily-available short-term method				(Possible) Use new methods(?) as per recommendations of Reference Group			
HPP	Assist countries in the use of // Insert short-term method here //							
DHS	Developing methods to deliver selected indicators (not HIV prevalence)		Developing methods to deliver further indicators (to include HIV prevalence?)					
UNAIDS Reference Group	Assist in development of guidance around short-term method	Work with Oxford group to develop methods further			(Possible) Revision to national and international estimation process			
Oxford Group	Develop methods further to allow estimation of incidence, ART coverage; age structure etc.; and to assess scope for scalability.				(Possible) Continue model development, supporting of countries etc.			

Figure 1: Agreed activities for coming two years. All timings are indicative.

Agenda

Day 1 – Monday 24 March

Time	Presentation	Speaker
09:00	Introductions, meeting aims and objectives	Tim Hallett
09:15	Summary of Health Policy Project activities: <ul style="list-style-type: none"> • Goal: build capacity of countries to assess, analyse and use data for high-impact program planning and development of strategies to address HIV disease burden • Overview of work with USAID, PEPFAR and Global Fund • Concepts for data use in countries to be modelled in Consortium exercise 	Ian Wanyeki
10:00	UNAIDS HIV prevalence estimation process: <ul style="list-style-type: none"> • Requirement for sub-national estimates of HIV prevalence • Experience applying EPP-Spectrum sub-nationally 	Peter Ghys
10:30	Coffee break	
11:00	HIV Modelling Consortium planned approach: <ul style="list-style-type: none"> • Development and validation of methods for generating sub-national estimates of HIV epidemiology • Geographical targeting of HIV/AIDS interventions and value of survey information <ul style="list-style-type: none"> ○ Value of heterogeneity ○ Value of obtaining more precise estimates of epidemiological data to reduce decision uncertainty 	Tim Hallett
11:30	Presentations from country representatives* (<i>10 min presentation and 2 minutes discussion per country</i>) <ul style="list-style-type: none"> • Malawi <ul style="list-style-type: none"> ○ Andreas Jahn • Ghana <ul style="list-style-type: none"> ○ Isaiah Doe Kwao ○ Cynthia Adobea Asante • Cote d'Ivoire <ul style="list-style-type: none"> ○ Kadio Aka Janvier • Kenya <ul style="list-style-type: none"> ○ Andrea Kim ○ Joyce Njeri Wamicwe • Zimbabwe <ul style="list-style-type: none"> ○ Janet Dzangare 	Discussion chaired by Tim Hallett
12:45	Lunch	
13:45	Presentations from groups on chosen approach and methodology† <ul style="list-style-type: none"> • Joseph Larmarange • Imelda Moise, Ezekiel Kalipeni and Leo Zulu • Samir Bhatt and Peter Gething • Sarah-Jane Anderson 	Discussion chaired by Frank Tanse
17:00	Meeting Close	
18:00	Drinks reception and dinner	



Day 2 - Tuesday 25 March

Time	Presentation	Speaker
09:30	Presentations from groups on chosen approach and methodology† <ul style="list-style-type: none">• Samuel Manda• Ngianga-Bakwin Kandala• Diego Caudros	Discussion chaired by Frank Tanser
11:45	Coffee break	
12:15	Comparative session reviewing methods following external validation exercises <ul style="list-style-type: none">• Comparison of estimated surfaces (for methods where appropriate)	Daniela Fecht
13:15	Lunch	
14:15	Roundtable discussion: <ul style="list-style-type: none">• Further discussion to review performance of methods following comparative validation exercises• Further work / next steps	All, facilitated by Tim Hallett
15:45	Closing remarks	Tim Hallett
16:15	Meeting close	
16:15	Coffee break	



Meeting Participants

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