

# **Technical updates for UNAIDS HIV estimation tools**

Report and recommendations from a meeting of the UNAIDS Reference Group on Estimates, Modelling, and Projections  
17-18<sup>th</sup> June 2021

## **REPORT & RECOMMENDATIONS**



## Abbreviations

|        |   |
|--------|---|
| ANC    | Antenatal clinic                              |
| ART    | Antiretroviral therapy                        |
| CDC    | US Centers for Disease Control and Prevention |
| ECDC   | European Centre for Disease Control           |
| EPP    | Estimation and Projection Package             |
| MTCT   | Mother to child transmission                  |
| PEPFAR | President's Emergency Plan For AIDS Relief    |
| PLHIV  | People living with HIV                        |
| PWID   | People who inject drugs                       |
| SSA    | sub-Saharan Africa                            |
| UNAIDS | Joint United Nations Programme on HIV/AIDS    |
| WHO    | World Health Organization                     |

The meeting of the UNAIDS Reference Group on Estimates, Modelling, and Projections was organised for UNAIDS by the Secretariat of the Reference Group ([www.epidem.org](http://www.epidem.org)), managed at Imperial College London, the University of Cape Town, and Stanford University. Participants of the meeting are listed at the end of this document.

Oli Stevens, July 2021

## Background

### UNAIDS Reference Group on Estimates, Modelling, and Projections

The Joint United Nations Programme on HIV/AIDS (UNAIDS) relies on impartial scientific advice from international experts in relevant subject areas to provide guidance on how to best calculate estimates and projections of the prevalence, incidence, and impact of HIV/AIDS globally. The UNAIDS Reference Group on Estimates, Modelling, and Projections acts as an ‘open cohort’ of epidemiologists, demographers, statisticians, and public health experts to provide scientific guidance to UNAIDS and partner organisations on the development and use of the tools used by countries to generate annual HIV estimates, which are the source for UNAIDS Global HIV epidemic estimates. The group is coordinated by a secretariat hosted at Imperial College London, the University of Cape Town, and Stanford University.

### Meeting Overview

The UNAIDS Reference Group held the virtual thematic meeting on *Technical updates for UNAIDS HIV estimation tools* from 17-18<sup>th</sup> June 2021. The meeting featured presentations and group discussion to generate consensus recommendations. The programme consisted of the following sessions:

1. Care and treatment cascade in Spectrum/EPP
2. Estimating ANC and PMTCT coverage
3. Concentrated epidemic EPP and CSAVR
4. UNAIDS estimates process

This report presents a summary of the meeting presentations and discussions. The presentations are available to meeting participants at [www.epidem.org](http://www.epidem.org) (others, please contact the Secretariat via [epidem@imperial.ac.uk](mailto:epidem@imperial.ac.uk)). The final recommendations can be found at the end of this report.

The recommendations drafted at these meetings provide UNAIDS with guidance on generating HIV estimates, review current approaches, and identify required data to further improve HIV estimates. Previous meeting reports are available at [www.epidem.org](http://www.epidem.org). This transparent process aims to allow the statistics and reports published by UNAIDS and partners to be informed by impartial, scientific peer-review.

The list of participants and meeting agenda are included in Appendix I and Appendix II, respectively.

## Introduction

Mary Mahy presented an overview of the 2021 UNAIDS estimates. 172 countries created HIV estimates, the largest number of participating countries to date. Virtual workshops due to the COVID-19 pandemic increased participation in the process to 1200 people. Video presentations improved and increased access to workshop materials.

The estimated number of global PLHIV and new infections increased slightly compared to previously published UNAIDS 2020 estimates and the estimated number of AIDS deaths during the late 1990s and 2000s increased. Declines in new infections were larger among men than women, whilst AIDS deaths decreased similarly in both sexes. Adult incidence and paediatric prevalence estimates aligned well with the most recent household survey data.

## Session 1 – Care cascade in Spectrum/EPP

John Stover and Rob Glaubius presented possible revisions to the CD4 model and computation timestep in Spectrum:

1. Removing the CD4 category for 200-249 cells/ $\mu$ L.
2. Reducing the number of simulation time steps for HIV disease progression and mortality from 10 per year to 4, 2, or 1 per year.
3. Intercalating new HIV infections at each time step (like EPP) instead of only at the end of each simulation year.

Spectrum tracks the HIV population through seven CD4 categories (>500, 350-500, 250-349, 200-249, 100-199, 50-99, 0-49). The 200-249 category was required as some national guidelines previously recommended initiating all PLHIV with a CD4 count under 250. However, as PLHIV spend on average less than one year in this category, a short timestep for Spectrum's calculations was required. Combining the 200-249 and 250-249 categories would potentially allow a longer timestep and reduce calculation times.

Initial tests suggested that reducing the number of time steps to 2 per year only reduced the Spectrum model simulation time by 20%. However, this was expected to be larger for the models used for inference (EPP, CSAVR, Shiny90), which do not include many of the other Spectrum impact calculations.

Currently, in Spectrum, new HIV infections are added to the HIV population only annually at end-of-year. It was proposed to revise this to insert new infections every

0.1-year time step for consistency EPP and to allow persons to be exposed to diagnosis and treatment in the first year of infection (see Maheu-Giroux, October 2019 UNAIDS Reference Group meeting [1]). Comparing Spectrum results across all countries with new infections added at each timestep with the existing implementation, the trend in AIDS deaths was shifted approximately six months earlier. Adding new infections every 0.1 year time step did not substantially affect the model simulation time. There were large changes in incidence and prevalence in recent years in countries that used EPP to estimate incidence. This was caused by the Spectrum/EPP incidence-prevalence adjustment which is frozen after 2010, leading to a divergence in new infections from 2010 onwards.

### **Key points in discussion**

- Consider stratifying the comparison by EPP-ASM and concentrated epidemic EPP in the timestep analysis to further isolate the reason for difference (Tim Brown).
- Changing Spectrum to a 0.5 year time step had little impact on estimates in the pre-ART era, and a larger impact following 2010. This is likely due to the implementation of on-ART mortality and the loss of the <6 month ART duration category, but is not expected to be difficult to resolve (John Stover).
- Extending the time step and removing the 200-249 compartment would lead to a larger reduction in computation time in EPP-ASM than in Spectrum (Rob Glaubius).

The second topic of the session considered challenges arising for estimating ART coverage during the 2021 UNAIDS estimates process. Ali Feizzadeh presented 2021 estimates of the treatment cascade. Among all PLHIV, 84% knew their status, 73% were on treatment, and 66% were virally suppressed. Reconciling Spectrum estimates with ART programme data was difficult in several countries this year. The reported number on ART was greater than the estimated number of PLHIV among adult women in eSwatini, Peru, Burundi, and Nigeria and among men in adult men in the Democratic Republic of Congo. Lack of modelling strategies for estimating of knowledge of status outside of SSA and among key populations are limitations of the current suite of tools and should be considered for further development.

Jeff Eaton presented proposed methodology for jointly fitting to HIV prevalence and ART coverage data in EPP. Several data sources for treatment coverage exist, including household survey data and ART coverage at antenatal clinic (ANC) HIV testing as used within Naomi. Spectrum estimates of ART coverage aligned with PHIA survey estimates in eSwatini, Zimbabwe, Uganda, Tanzania, and Zambia, but differed in Rwanda, Namibia, Malawi, and Lesotho. Reported ART coverage among pregnant women is typically lower than that of the general population due to a younger age distribution, on average being more recently infected, and under-

reporting of ART and HIV status in routine ANC testing programme data. Eaton proposed that survey ART coverage be incorporated into the EPP likelihood using the same statistical approach implemented for survey HIV prevalence. When jointly fitting to HIV prevalence ART coverage data and in cases when survey ART coverage lies far from ART coverage estimated using programme data, as in Maputo City and Province, HIV prevalence and incidence curves can change considerably (see [Session 2.3](#) [1]). Five recommendations were proposed:

1. In Spectrum, no longer discretely cap displayed results in years where number on ART is inconsistent with PLHIV.
2. Exclude incidence curves in EPP that would lead to prevalence and PLHIV estimates that are smaller than the numbers on treatment
3. Add validation plots for survey ART coverage and ART coverage among pregnant women.
4. Reduce focus on 100% threshold for ‘plausible’ ART coverage.
5. Include survey ART coverage in EPP likelihood to ensure HIV incidence and prevalence trends that are consistent with ART data.

### **Key points in discussion**

- Estimates of PLHIV in eSwatini have remained quite flat since 2016, but numbers on ART have increased considerably. In 2016, Spectrum estimates of ART coverage aligned well with PHIA estimates (John Stover).
- Self-reported ART coverage in surveys may be biased (Mary Mahy), though survey data has been interrogated through the Naomi data review process and found to be consistent with other information (Jeff Eaton).
- Underreporting of ANC ART coverage should be further investigated using ANC-SS data from South Africa and viral load testing from Kenya (Jeff Eaton, Mary Mahy).
- ART coverage by key population is sparse in concentrated epidemic countries using EPP and this will be challenging to include in model fitting (Tim Brown).
- Including paediatric ART coverage in paediatric estimates is challenging because there is no model fitting to paediatric-specific surveillance data (John Stover).

The final topic of the session was potential revisions to the modelling of ART mortality and treatment interruption in Spectrum and related models. For the 2021 estimates, an input editor was added in Spectrum for specifying the number on ART at the end of each month to capture potential impacts of short-term COVID-19 related treatment interruptions. Twenty-six countries entered monthly data which. There was little evidence of sharp short-term disruptions to the number receiving ART and, in most cases, monthly data reflected a roughly linear change in between January and December, consistent with the interpretation made by Spectrum when

entering annual data. The net effect of entering monthly data over annual data was minimal. As the COVID-19 epidemics will continue to affect health systems across the world in 2022, the proposed recommendation is to retain the monthly editor for the 2022 estimates.

The second ART modelling topic was representation of mortality for people on ART for durations longer than one year, presented by John Stover. Spectrum presently stratifies the ART population by CD4 count at initiation and duration on treatment (0-6, 7-12, 12+ months). Crude analysis of the most recent Spectrum analysis implied that half of PLHIV on ART globally may have been on ART for more than 5 years. Previous analysis of leDEA collaboration mortality data found that mortality continued to decline for each year on treatment after the 12+ month duration category. More duration categories could be introduced, or mortality could be the same for PLHIV on treatment for longer than 1 year regardless of CD4 count at initiation.

Christos Tomadakis presented a model of CD4 count following treatment initiation, interruption, and re-initiation fit to East Africa leDEA data (Fig 1). Between initiation and interruption, CD4 count increases nonlinearly based on the time from treatment initiation. Following interruption, CD4 count declines relative to the time since initiation assuming that CD4 counts decline faster from higher CD4 counts. Following re-initiation, CD4 counts increase, relative to the length of disengagement from care. The rate of CD4 increase depends on the baseline CD4 count at initiation/re-initiation.

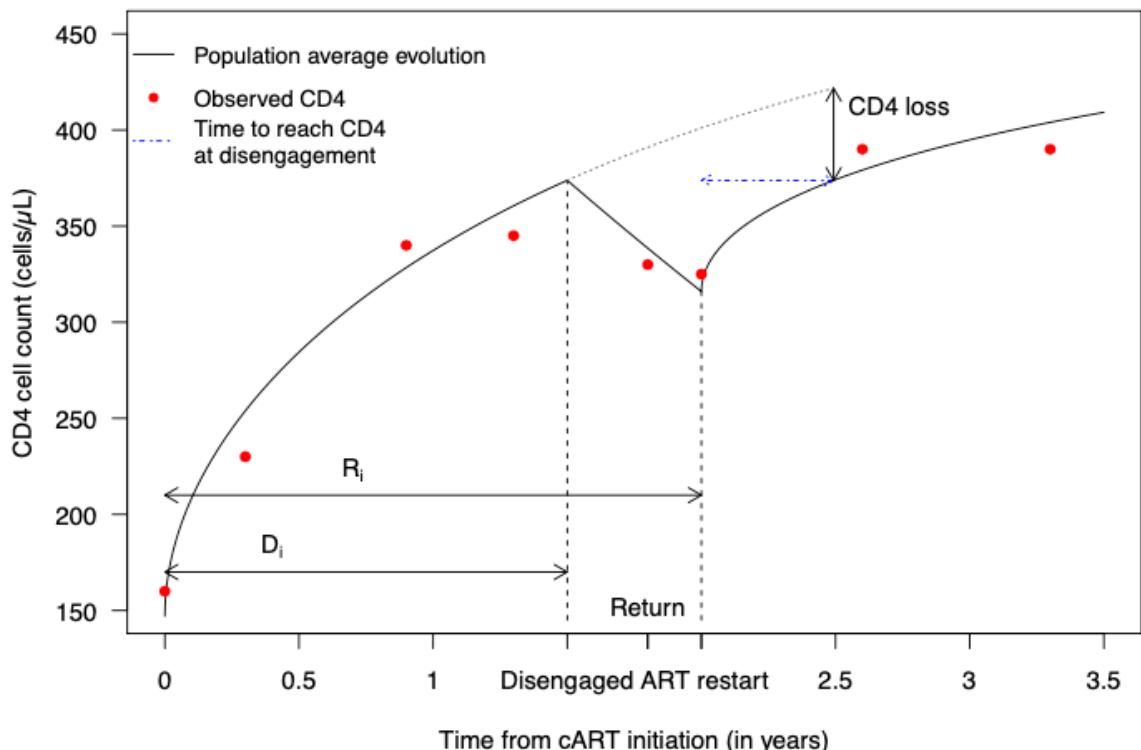


Figure 1: Model schematic of CD4 recovery following treatment initiation, interruption, and re-initiation (Thomadakis)

Giorgos Bakoyannis presented a model to estimate the treatment cascade under incomplete death ascertainment, ‘churn’ of patients interrupting and re-engaging in treatment. The probabilities of individuals being engaged in care, disengaged, or dead over time since initial ART initiation were estimated, informed by tracing studies of a sample of LTFU patients in Kenya in order to ascertain death status. Mortality estimates incorporating tracing data were around five times higher than unadjusted estimates of mortality.

A discussion on priority research areas for the Reference Group for the leDEA Consortium was led by Leigh Johnson. Four requests were raised, to be discussed further by leDEA during 2021:

- Revised ART mortality parameters consistent with the forthcoming Spectrum treatment duration categories.
- Review ART mortality assumptions for EECA and Asia/Pacific.
- Review evidence on effect of dolutegravir transition on ART mortality and whether it is important to model dolutegravir regimens.
- Review evidence of VLS as a determinant of ART mortality.

## **Key points in discussion**

### **On-ART mortality**

- South African data indicate that CD4 count at initiation is still predictive of mortality at >5 year treatment duration, but the gradient in mortality across CD4 categories is substantially attenuated (Leigh Johnson).
- Reducing mortality at long treatment durations could be implemented by modelling increasing CD4 categories over time or by introducing further categories. Introducing further categories is a larger structural change to Spectrum (John Stover).
  - IeDEA can re-analyse 2018 data with revised treatment duration categories (Leigh Johnson).
  - The effect of revised treatment durations can be tested with the EPP-ASM codebase which has already implemented compartments for this (Jeff Eaton).

### **Treatment interruption**

- Estimates relating to treatment interruption are sensitive to the definition of 'lost to follow up' and may be biased by facility transfer and treatment less frequent than the existing two month definition (Leigh Johnson/Christos Thomadakis).
- CD4 declines are likely a biological function and regional defaults could be applied across countries. The length and timing of treatment interruptions, however, would need to be informed by country-specific data (Constantin Yiannoutsos) and the quality and quantity of nationally available data on treatment disengagement requires further investigation (Mary Mahy/Leigh Johnson).

## **Session 2 – Estimating ANC and PMTCT coverage**

Session 2 focused on challenges interpreting and inconsistencies in routine ANC testing data, which are key inputs to fitting HIV incidence trends in EPP and estimating need for and coverage of PMTCT in Spectrum. Athena Pantazis reviewed ANC testing data in Spectrum files across sub-Saharan Africa to identify cases in which the number of ANC clients exceeded the estimated number of births, which is an indication of potentially inconsistent ANC testing programme data. One hypothesised explanation for this is overcounting the number of ANC clients. This can be caused by women visiting multiple clinics and being recorded as a first visit in several places, or by individual clinics recording repeat visits as first visits. Five countries in ESA and six in WCA had the reported number of ANC clients greater

than the modelled number of births or the number of women who received PMTCT greater than the estimated number of HIV positive pregnant women.

For EPP model estimation, there is concern that ANC double counting or failing to record women who are known to be HIV positive at their first ANC visit is leading to an underestimation of HIV prevalence among pregnant women from routine ANC data, and subsequent underestimation of HIV incidence when calibrating to these data in EPP. Sensitivity analyses showed that removing or adjusting ANC-RT HIV prevalence data has a large impact on EPP prevalence curves and that existing HIV incidence estimates in countries with sharply declining ANC prevalence may be biased (Fig 2). This confirmed that inconsistent or incomplete ANC testing data which do not conform to the assumed interpretation is a potential major source of bias for national HIV incidence levels and trends.

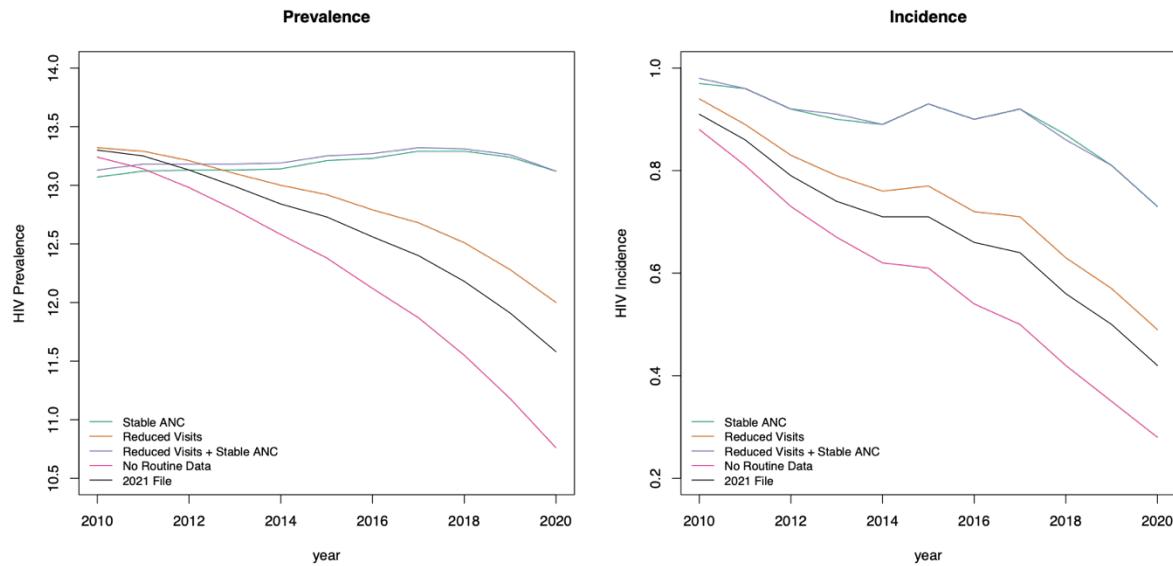


Figure 2: Sensitivity analysis of HIV prevalence and incidence in Namibia conducted by altering ANC-RT prevalence (Pantazis)

Oli Stevens presented a validation analysis of routine ANC client data in Mozambique. The analysis triangulated province-level data on the number of ANC clients, the number of live births in health facilities adjusted by the proportion of women who give birth in facilities in facilities, and Spectrum demographic estimates for the number of births. In all eleven Mozambican provinces the reported number of ANC clients was greater than the Spectrum modelled number of births. When using adjusted births estimates for live births, the ratio of ANC clients to births decreases, but remained above 1.0 in the majority of provinces, indicating that programmatic double counting of ANC clients is likely the cause. Stevens proposed a recommendation to adjust data on the reported ANC clients for overcounting based on the reported proportion of pregnant women attending ANC from the most recent

household survey, and recalculate ANC-RT prevalence with the adjusted number of ANC clients.

### **Key points in discussion**

- There should be a better understanding of whether women are differentially counted by HIV status, and how known positives are recorded at ANC entry (John Stover/Eline Korenromp).
- The number of live births could be validated against the number of EID tests (Katie Battey), and data quality assessments are underway in Uganda for live births and ANC clients (Wilford Kirungi).
- How do we validate estimates from countries with sharply falling ANC prevalence and high PMTCT coverage, and how can we move towards thresholds for excluding estimates? (Mary Mahy).
- Sentinel surveillance activities would be informative to validate routine testing data (Jeff Eaton).

## **Session 3 – Concentrated epidemic EPP and CSAVR**

Keith Sabin described challenges arising for concentrated epidemic paediatric estimates. For countries using CSAVR, estimates of CLHIV were 30% higher in 2021 than in 2018. Estimates from countries using EPP were also higher in 2021, but were less systematic across countries. These changes can be difficult for countries to understand. Paediatric estimates are usually not informed by or calibrated to specific data on paediatric HIV. In many cases, initial paediatric HIV estimates from Spectrum were inconsistent with locally available paediatric HIV programme data. For example, the estimated number of children living with HIV was less than the reported number of children receiving ART coverage in several countries. This was usually resolved by adjusting fertility or the sex ratio of new infections.

Several countries with concentrated epidemics using EPP to develop estimates include ‘prisoners’ as a distinct sub-population. This involves estimating an HIV incidence curve from HIV prevalence observed among prisoners, implicitly assuming that all HIV infections among prisoners occurred while in prison. These infections are then returned to the general population when prisoners ‘turnover’. Sabin proposed that the prisoner sub-population be removed, or turnover disabled within this population. This was because in many cases HIV positive prisoners were infected with HIV before entering prison, not acquired in prison, and returning these cases to the general population through ‘turnover’ likely double counts HIV infections also represented in other population groups where they were initially acquired, especially among people who inject drugs (PWID).

One feature of the concentrated epidemic EPP model is a table of ‘reassigns’ documenting the number of people living with HIV who are reallocated from the each population group to the ‘remaining population’ through population ‘turnover’. This provides information about the source of infection for those with prevalence HIV infection. Sabin requested an additional feature for the EPP software to export the “Reassigns” table in graphical format.

Guy Mahiane presented proposed updates to the CSAVR model approach for estimating incidence rate ratios (IRR) and modelling CD4 count at diagnosis. CSAVR estimates IRRs to sex/age disaggregated AIDS death and/or HIV diagnosis data in countries where they are available. During the 2021 estimates round, it was noted that IRR fitting sometimes produced implausibly large values during and before the data period. Mahiane proposed three changes to the IRR fitting specification to address this: (1) incidence rate ratios are fixed at constant values in the years before age/sex-stratified data data are available, (2) explore further constraints to regularise the age IRRs, and (3) add an option to the model to only fit the sex ratio of incidence but not the age pattern of incidence.

CSAVR outputs of the mean CD4 count at diagnosis were closer to observed values after incorporating the new CD4 progression assumptions, but remained substantially higher. The European Centre for Disease Control (ECDC) model for estimating HIV incidence, which calibrates to CD4 count at diagnosis and new HIV diagnosis data, but does not use AIDS death data, captures CD4 count at diagnosis data well. To explore why CSAVR is unable to reproduce observed patterns of CD4 at diagnoses, Mahiane fitted CSAVR separately to either 1) New diagnoses and CD4 count at diagnosis (similar to the ECDC model) or 2) New diagnosis and AIDS deaths. When excluding AIDS deaths from model fitting, CSAVR results more closely matched the observed distribution of CD4 at diagnosis. Similarly, when data on CD4 at diagnosis were excluded, the model fitted well to deaths and diagnoses. These findings suggested that the model was able to reproduce each data source, but simultaneously reconciling AIDS death and CD4 count at diagnosis was. Adjusting the proportion with CD4>500 at seroconversion as an additional calibration parameter can improve fits, but there was not systematic direction across all countries and there is limited evidence that this should vary substantially across countries.

Rob Glaubius presented an analysis on a method to estimate IRRs in concentrated epidemics using age-stratified data on the number receiving ART. Six countries had ART data by 5-year age groups, of which three used default IRR patterns developed for PWID-driven epidemics and three with non-PWID default IRR patterns. IRR patterns were permitted to vary with age and over time. Fitted IRRs in Nicaragua resulted in estimates that more closely matched age-stratified ART data than the

default Spectrum IRRs, though in some cases the model was not flexible enough to match ART closely (Fig 3). However, the estimated IRRs themselves do not appear credible when projected through time, with peak incidence clustering in the youngest age groups. Further investigation is warranted.

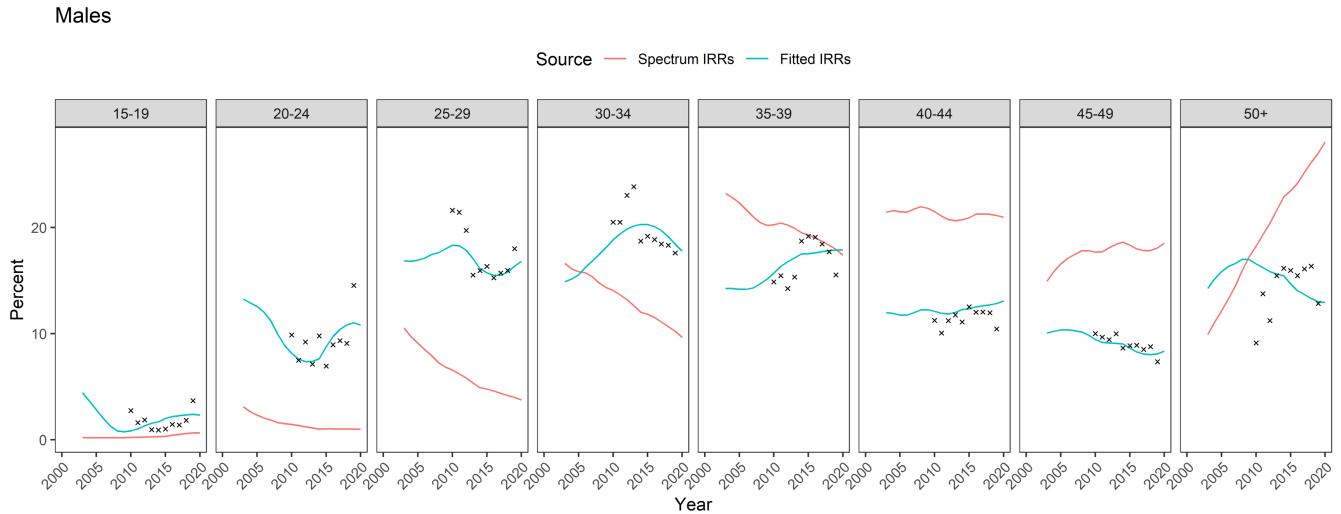


Figure 3: Fitted IRRs (blue) lie closer to ART by age data than Spectrum IRRs (red) in Nicaragua

### Key points in discussion

#### Paediatric estimates in concentrated epidemics

- The Reference Group requested a list of countries where default Spectrum paediatric estimates were not consistent with other available paediatric programme data for further investigation.

#### Application of EPP in concentrated epidemics

- In most countries using a prisoner subpopulation, the prisoner subpopulation with HIV is usually predominately drawn from the PWID population rather than infections occurring in prison. Thus the prisoner population will double count PWID who turnover quickly between the populations (Tim Brown).
- If prisoners are removed as a population, it is important to ensure that other key population size estimates increase in response (Eline Korenromp).

#### CSAVR

- Several countries using CSAVR reported large reductions in new HIV diagnoses during 2020. It is uncertain the extent to which this reflects reductions in new infections or reductions in HIV testing during the COVID-19 pandemic. The impact of these data has not yet been assessed, but is expected to be minimal. This merits further sensitivity analysis excluding 2020 HIV diagnosis data to confirm (Mary Mahy).
- HIV incidence trends can be compared between CSAVR fitting to new HIV diagnoses and CD4 count at distribution with the ECDC model. Deaths before

1996 in the pre-ART era may also be compared (Oli Stevens/Ard van Sighem).

- There may be a systematic missing data on CD4 count at diagnosis among persons diagnosed with AIDS at the time of HIV diagnosis in TESSy (Ard van Sighem).

### **Concentrated epidemic IRRs**

- Decreasing flexibility in the early epidemic and increasing flexibility in recent years may improve fits (Jeff Eaton).
- A more parsimonious model that is an improvement on existing defaults is desirable. More flexible models can be challenging to apply across countries (Jeff Eaton).
- There will be country-specific interpretations to the ART by age data in concentrated epidemics e.g. influenced by criminal justice implications of presenting to treatment (Mary Mahy).

## **Session 4 – UNAIDS estimates process**

Session 4 focused on reviewing the UNAIDS estimates process, usage of the software tools, and proposed developments to enhance the process for the 2022 estimates. Rachel Esra and Jonathan Berry presented a summary of six one-to-one user feedback sessions and focus group discussions conducted to understand usage patterns and challenges experienced with the AIDS Data Repository and Naomi model in the 2021 estimates round. Representatives from 17 of 39 countries that created subnational estimates participated in the sessions. Specific recommendations were synthesised for user workflow, the AIDS Data Repository, and Naomi that will inform model development and implementation of the Estimates Journey Manager tool for the 2022 estimates. The full report of the sessions and recommendations is available in the [meeting background materials](#).

Jonathan Pearson presented proposed Data Quality Standards of Practice for HIV data used within the estimates process. The Standards of Practice were derived following consultation participation in the Mozambique, Zambia, Kenya, Uganda, and Ghana 2021 estimates workshops. The standards aim to increase the role of country teams in the estimates process by strengthening the HIV programme data and the national capacity to interrogate data quality. Further information can be found in the [meeting background materials](#).

Mary Mahy described a proposed new tool, the ‘Estimates Journey Manager’, to be introduced for the 2022 estimates. The tool will guide country users through the

complex HIV tools and model landscape, interfacing with the AIDS Data Repository and modelling tools to ascertain progress and check for common data errors.

### **Key points in discussion**

- Development of the Journey Manager will be focused on the generalised epidemics for the 2022 estimates because of the complexity of the subnational estimation process, but will be expanded to concentrated epidemic countries in future (Mary Mahy).
- Concentrated epidemic EPP countries should be using the ADR for the 2022 estimates (Tim Brown).
- Video resources for the 2021 estimates have allowed a wider and better informed participation in workshops than previous rounds (Chibwe Lwamba/Tobi Saidel).

## References

- [1] UNAIDS Reference Group on Estimates Modelling and Projections, “Technical updates and Naomi model development,” 2019.  
[http://www.epidem.org/sites/default/files/reports/Tech%20Updates%20Report\\_final.pdf](http://www.epidem.org/sites/default/files/reports/Tech%20Updates%20Report_final.pdf).

**UNAIDS Reference Group on Estimates, Modelling, and Projections**  
**Recommendations I June 2021**

| Recommendation   | Lead person(s)  | Timeline   |
|--|---|--|
| <b>Session 1: Care and treatment cascade in EPP/Spectrum</b>   |   |  |
| <u>Spectrum updates - timesteps</u>  |   |  |
| <ul style="list-style-type: none"> <li>Aim to implement Spectrum new infections on same time step as EPP/CSAVR/Shiny90, conditional on satisfactorily addressing prevalence adjustment concerns <ul style="list-style-type: none"> <li>Stratify existing analysis of changes due to new infections timing by EPP concentrated and EPP-ASM</li> <li>EPP provide values by time step in SPT to Spectrum</li> <li>Review whether fixed prevalence adjustment factor from 2010 onwards is still optimal</li> </ul> </li> <li>Revise new infection process in Shiny90 consistent with any change to Spectrum timestep</li> <li>Consider effects of coarser model time step (0.1, 0.2, 0.25, 0.5, 1 year) <ul style="list-style-type: none"> <li>Effect on wide range of model results</li> <li>Implications for computational efficiency</li> <li>Effect of long timesteps on short duration states (e.g. CD4 &lt;50)</li> </ul> </li> </ul>  | Avenir Health<br><br>Avenir Health<br><br>Tim Brown<br><br>Avenir Health<br><br>Mathieu Maheu-Giroux<br><br>Avenir Health / Imperial College / East-West Center / McGill University | October 2021<br><br>October 2021<br><br>November 2021<br><br>October 2021                    |
| <u>Spectrum updates – CD4 compartments</u>   |   |  |
| <ul style="list-style-type: none"> <li>Retain 200-249 CD4 compartment [No action required]</li> </ul>  |   |  |
| <u>Spectrum updates - ART</u>  |   |  |
| <ul style="list-style-type: none"> <li>Retain monthly ART inputs for 2022 estimates [No action required]</li> </ul>  |   |  |
| <u>Resolving ART coverage in excess of 100%</u>  |   |  |
| <ul style="list-style-type: none"> <li>Remove capping in Spectrum results displays if #ART greater than #PLHIV; display a warning in Spectrum or in the Estimates Journey Manager</li> <li>Add validation displays in Spectrum <ul style="list-style-type: none"> <li>Spectrum ART coverage vs. household survey ART coverage estimates</li> <li>Spectrum outputs for ART coverage among pregnant women vs. observed ART coverage from ANC testing data</li> </ul> </li> <li>Implement input editors in EPP for optional ART-related inputs by subpopulation: <ul style="list-style-type: none"> <li>Number on ART by sex</li> <li>Survey ART coverage</li> <li>Routine ANC ART coverage</li> </ul> </li> <li>Add likelihood for survey ART coverage in EPP-ASM</li> <li>Recommend further review of evidence on underreporting of ANC ART usage at first ANC before including in EPP-ASM likelihood <ul style="list-style-type: none"> <li>South Africa ANC-SS</li> </ul> </li> </ul> | Avenir Health<br><br>Avenir Health<br><br>East-West Center<br><br>Jeff Eaton / East-West Center<br><br>Jeff Eaton / UNAIDS / Leigh Johnson  | October 2021<br><br>October 2021<br><br>October 2021<br><br>October 2021<br><br>October 2021 |

|  |                      |                         |                |
|--|----------------------|-------------------------|----------------|
| <ul style="list-style-type: none"> <li>○ Kenya VL testing at first ANC</li> </ul>  |                      |                         |                |
| <ul style="list-style-type: none"> <li>• Develop guidance or case studies for addressing discrepancies in ART number, population, prevalence, and ART coverage data</li> </ul>   | TBD                  |                         | 2022 estimates |
| <ul style="list-style-type: none"> <li>• Review consistency of ART by age inputs in Spectrum with Spectrum results for ART by age</li> </ul>   | UNAIDS               |                         | August 2021    |
| <ul style="list-style-type: none"> <li>• Consider how better to use ART data for PLHIV estimates in concentrated epidemics and paediatric estimates           <ul style="list-style-type: none"> <li>○ Review Stover 2019 analysis on fitting paediatric parameters</li> </ul> </li> </ul> | TBD<br>Avenir Health | Ongoing<br>October 2021 |                |

#### Treatment interruption

- Validate current Spectrum assumption about CD4 decline among persons interrupted treatment with Thomadakis estimates from leDEA data

leDEA-EA / Avenir Health

October 2021

#### Mortality at long treatment durations

- Extend Spectrum treatment duration compartments:
  - Propose 5 duration categories: 0-5 months, 6-11 months, 12-23 months, 24-47 months, 48+ months
  - Consider removing stratification by baseline CD4 count after 48+ months
- Refine assumptions around LTFU at each duration category
- Conduct exploratory analysis with EPP-ASM codebase for impact on estimates
- Improve LTFU and new ART initiator data inputs in Spectrum
  - Review quantity and quality of new initiator data
  - Validate new initiator data vs LTFU inputs
- Revise ART mortality parameter estimates consistent with updated Spectrum
  - Additional ART duration categories
  - Continuous age
- Review ART mortality assumptions for EECA and AP region
- Review evidence on effect of DTG transition on ART mortality & whether evidence important to model DTG regimen
- Review evidence on VLS as a determinant of ART mortality (over time, across locations)

Avenir Health / Imperial College / East-West Center

October 2021

TBD

October 2021

Imperial College / Avenir Health

August 2021

UNAIDS

2022 estimates

leDEA, ART-CC

October 2021

Avenir Health / East-West Center / leDEA

October 2021

leDEA

TBD

leDEA

TBD

#### **Session 2 – ANC and PMTCT coverage**

- Review evidence from national data quality exercises

TBD

August 2021

|   |                                  |                |
|---|----------------------------------|----------------|
| <ul style="list-style-type: none"> <li>○ Chart review and UID in mother-and-baby pairs in Namibia [CDC Namibia]</li> <li>○ Delivery quality assessment and ANC DQA [MoH Uganda]</li> </ul>  |                                  |                |
| <ul style="list-style-type: none"> <li>● Conduct further triangulation exercises <ul style="list-style-type: none"> <li>○ Number of ANC visits in DHS with repeat testing recorded in health information systems [all countries]</li> </ul> </li> </ul> | TBD                              | October 2021   |
| <ul style="list-style-type: none"> <li>● Test adjustment factor to women needing PMTCT/ANC clients using survey reported ANC coverage</li> </ul>  | Imperial College / Avenir Health | September 2021 |
| <ul style="list-style-type: none"> <li>● Conduct exploratory analyses to determine a threshold to exclude ANC-RT prevalence data from EPP</li> </ul>  | TBD                              | October 2021   |

### Session 3 – Concentrated epidemic EPP and CSAVR

|   |                           |                |
|---|---------------------------|----------------|
| <ul style="list-style-type: none"> <li>● Compare CSAVR fits with and without 2020 HIV diagnoses data to assess impacts of reduced number of diagnoses recorded in 2020 due to COVID-19</li> </ul>   | UNAIDS                    | October 2021   |
| <ul style="list-style-type: none"> <li>● In countries using concentrated epidemic EPP, recommend removing the prisoner subpopulation as these are often reflective of PWID population, not infections occurring in prison <ul style="list-style-type: none"> <li>○ If strong desire to retain prisoner subpopulation, turnover should be disabled</li> <li>○ In settings where appropriate, based on knowledge of local epidemiology, users may consider using prison HIV testing data to calibrate estimates for PWID population. But any application should consider whether prisoner population represents higher risk sub-group of PWID population and is therefore not representative</li> <li>○ Ensure total national prevalence is not impacted by omitting the prisoner subpopulation and any PWID population size estimates are appropriately adjusted to include prisoners</li> </ul> </li> </ul> | UNAIDS / East-West Center | 2022 estimates |
| <ul style="list-style-type: none"> <li>● EPP to produce a graphical view of the ‘reassigns table’ of former key population PLHIV in the remaining population</li> </ul>   | East-West Center          | October 2021   |
| <ul style="list-style-type: none"> <li>● Develop guidance for countries to reconcile cases where <ul style="list-style-type: none"> <li>○ Number of children on ART exceeds number of children living with HIV</li> <li>○ Paediatric estimates change significantly from year to year</li> </ul> </li> </ul>  | UNAIDS                    | October 2021   |
| <ul style="list-style-type: none"> <li>● Provide list of concentrated epidemic countries where paediatric mortality or programme data are inconsistent with default Spectrum estimates for further investigation</li> </ul>   | UNAIDS                    | July 2021      |
| <ul style="list-style-type: none"> <li>● Create editor to input age-stratified inputs on immigrant CLHIV and paediatric nosocomial infections</li> </ul>  | Avenir Health             | October 2021   |

#### CSAVR – IRRs

|   |             |              |
|---|-------------|--------------|
| <ul style="list-style-type: none"> <li>● Impose constant IRRs before data are available and explore further constraints on age IRRs to prevent implausible fitted values</li> </ul> | Guy Mahiane | October 2021 |
| <ul style="list-style-type: none"> <li>● Provide list of priority countries for testing more constrained CSAVR IRR models</li> </ul>  | UNAIDS      | July 2021    |
| <ul style="list-style-type: none"> <li>● Users should be able to fit sex IRRs separately to age IRRs</li> </ul>   | Guy Mahiane | October 2021 |

#### CSAVR – CD4 model

|  |                             |              |
|--|-----------------------------|--------------|
| <ul style="list-style-type: none"> <li>● Compare CSAVR model results and ECDC model <ul style="list-style-type: none"> <li>○ HIV incidence trends</li> </ul> </li> </ul> | Guy Mahiane, Ard van Sighem | October 2021 |
|--|-----------------------------|--------------|

|  |               |                |
|--|---------------|----------------|
| <ul style="list-style-type: none"> <li>○ Deaths before 1996</li> <li>○ Relative diagnosis rates by CD4 category</li> </ul>   |               |                |
| • Consider revision to assumptions about relative diagnosis rate by CD4 category, or estimating these parameters, to improve consistency with observed CD4 at diagnosis distribution | Guy Mahiane   | October 2021   |
| • Investigate systematic omission of CD4 counts at diagnosis in those with simultaneous HIV and clinical AIDS diagnoses in TESSy   | TBD           | October 2021   |
| <b><u>CSAVR - interface</u></b>  |               |                |
| • Consolidate feedback on incidence model option interface   | UNAIDS        | July 2021      |
| • Ensure age-sex IRRs in AIM reflect those fitted in CSAVR   | Avenir Health | 2022 estimates |
| • Ensure incidence options remain the same between closing and re-opening the CSAVR interface  | Avenir Health | 2022 estimates |
| • Prevent running national fit before training fits are completed  | Avenir Health | 2022 estimates |
| <b><u>Fitting IRRs to ART by age data</u></b>  |               |                |
| • Recommend the development of a separate fitting tool with a parsimonious model that can accept ART data by 5-year age group and by GAM age groups                                  | Rob Glaubius  | October 2021   |
| <b><u>Session 4 – UNAIDS estimates processes</u></b>   |               |                |
| • Develop Estimates Journey Manager tool   | UNAIDS        | November 2022  |
| • Consider whether components of ADR and Estimates Journey Manager approach can be extended to concentrated epidemic countries   | UNAIDS        | TBC            |