



# AIM

A Spectrum Module for Creating HIV/AIDS Projections and  
Examining the Demographic and Social Impacts of AIDS

**Spectrum System of Policy Models**

An analytical tool developed to support policy  
decisions concerning public health and  
accompanying research



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Examining the Demographic and Social Impacts of AIDS

## **Spectrum System of Policy Models**

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### **Developed by Futures Institute with support from:**

*USAID / Health Policy project  
Bill & Melinda Gates Foundation  
Johns Hopkins  
United States Fund for UNICEF  
UNAIDS  
World Health Organization  
UNICEF  
GWA  
United Nations Population Fund*

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# 1 Introduction



A Spectrum Module for Creating HIV/AIDS Projections and  
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## Spectrum System of Policy Models

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## 1.1 Description of modules

### Impact Modules

- 
**DemProj:** *Demography.* DemProj projects the population for an entire country or region by age and sex, based on assumptions about fertility, mortality, and migration. A full set of demographic indicators can be displayed for up to 100 years into the future. Urban and rural projections can also be prepared. Default data needed to make a population projection is provided from the estimates produced by the Population Division of the United Nations. DemProj is a required module for all projections created in Spectrum since its population projection is utilized by most of the calculations in the other modules.
  - 
**FamPlan:** *Family Planning.* FamPlan projects family planning requirements needed to reach national goals for addressing unmet need or achieving desired fertility. It can be used to set realistic goals, to plan for the service expansion required to meet program objectives, and to evaluate alternative methods of achieving goals. The program uses assumptions about the proximate determinants of fertility and the characteristics of the family planning program (method mix, source mix, discontinuation rates) to calculate the cost and the number of users and acceptors of different methods by source.
  - 
**AIM:** *AIDS Impact Model.* AIM projects the consequences of the HIV epidemic, including the number of people living with HIV, new infections, and AIDS deaths by age and sex; as well as the new cases of tuberculosis and AIDS orphans. AIM is used by UNAIDS to make the national and regional estimates it releases every two years.
  - 
**Goals:** The Goals Model helps efforts to respond to the HIV/AIDS epidemic by showing how the amount and allocation of funding is related to the achievement of national goals, such as the reduction of HIV prevalence and expansion of care and support. This model explores also the impact of potential HIV vaccines on the epidemic.
  - 
**LiST:** *Lives Saved Tool (LiST- Child Survival).* A program to project the changes in child survival in accordance with changes in coverage of different child health interventions.
  - 
**RAPID:** *Resources for the Awareness of Population Impacts on Development.* RAPID projects the social and economic consequences of high fertility and rapid population growth for such sectors as labor, education, health, urbanization, and agriculture. This program is used to raise policymakers' awareness of the importance of fertility and population growth as factors in social and economic development.
  - 
**RNM:** *Resource Needs Model.* This model is used to calculate the funding required for an expanded response to HIV/AIDS at the national level. It estimates the costs of implementing an HIV/AIDS program, including costs for care and treatment, prevention programs, and policy and program support.
  - 
**TB:** This model projects the consequences of incident TB, including the number of cases notified for treatment, the number of multiple-drug resistant cases and the number of deaths due to TB. It further projects deaths averted in accordance with increasing case detection.
  - 
**NCD:** The non-communicable disease impact module calculates the populations affected by, and the impact of scaling up interventions on cardiovascular and respiratory disease, diabetes, cancer, and mental health, neurological, and substance abuse disorders.
-

## OneHealth Tool Modules

-  **OneHealth - Configuration:** The OneHealth Configuration allows for the configuration of elements used within multiple OneHealth modules, such as interventions, staff, facilities, currency, and exchange rate.
-  **Human Resources:** The Human Resources module allows the costing of salaries, benefits, and incentives for health service providers and health management and support personnel as well as pre-service training and non-specific in-service training.
-  **Infrastructure:** All facilities providing medical interventions, as well as most facilities offering support functions, are planned for and costed within the Infrastructure module. The Infrastructure module also includes planning functions for equipment, furniture, vehicles, and communication.
-  **Budget Mapping:** The Budget Mapping module can be used to allocate intervention and health system costs across budget categories established by the user, in order to match country or international institution cost categories.
-  **Governance:** The governance module includes costing templates for assessing the costs of governance activities.
-  **Logistics:** The Logistics module allows for the planning of warehouses and vehicles needed to move commodities/drugs and supplies from central warehouses to the endpoints of a logistics system. It is also where planning for commodities/drugs and supplies that are not included in the Intervention costing module is done.
-  **Health Financing:** The Health Financing module is used to estimate the costs of implementing health financing programs such as vouchers, subsidies, or cash transfers.
-  **Financial Space:** The Financial Space module is used to analyze the financial space within which health plans are expected to be executed.
-  **Health Information Systems:** The Health Information Systems (HIS) module includes costing templates for assessing the costs of implementing a health information system..

## 1.2 Software options

### Language

Changes the application strings to the selected language. This will also initiate a prompt to download (Internet connection required) a language specific help file if needed and available. If help is not available in the selected language, Spectrum will use the English version of help.

### Editor/display font

Determines which font is used in the input editors and result displays. You may want to change from the default font if characters are not showing correctly with the selected language.

## **Enable OneHealth Layout**

Spectrum and the OneHealth Tool use a common code base. When checked, the OneHealth Tool layout is applied to the interface.

## **Color scheme**

Select color scheme of your choice.

## **Hint duration**

Determines the amount of time in seconds a hint or hover text will appear on the screen when active. Moving the slider to right most position will invoke a setting of infinite which is useful for reading larger hints. Under any setting, mouse movement or a key press will close the hint box. Hints are activated by positioning the mouse pointer over a display element and holding. This is most applicable in the input editors when comments are used to describe cell contents.

## **Show welcome tab**

Determines if the welcome tab is shown when Spectrum starts.

## **Prompt before re-projection**

If checked, Spectrum will prompt before re-projecting. This is primarily a debugging tool and is recommended to be left unchecked.

## **Save projection manager defaults**

When checked, the latest settings in projection manager will become the defaults for the next visit. Useful when creating multiple projections which have similar characteristics, such as projecting years and country.

## **Copy editor values with full precision**

Values in the input editors are formatted to a specified precision for display readability. When checked, the unformatted (full precision) values are copied to clipboard. This is useful when copying values internally between editors since the calculation routines use the full precision numbers saved from the editors which may differ slightly from the formatted value.

## **Copy result values with full precision**

Values in the result tables are formatted to a specified precision for display readability. When checked, the unformatted (full precision) values are copied to clipboard. Since results are primarily copied to an external application such as Excel, the recommended setting is unchecked to preserve the data format

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and readability of the values.

## 1.3 Uses of the policy models

Policy models are designed to answer a number of "what if" questions relevant to entities as small as local providers of primary health care services and as large as international development assistance agencies. The "what if" refers to factors that can be changed or influenced by public policy.

Models are commonly computerized when analysts need to see the likely result of two or more forces that might be brought to bear on an outcome, such as a population's illness level or its degree of urbanization. Whenever at least three variables are involved (such as two forces and one outcome), a computerized model can both reduce the burden of manipulating those variables and present the results in an accessible way.

### Policy issues commonly addressed by the Spectrum set of models

- The utility of taking actions earlier rather than later. Modeling shows that little in a country stands still while policy decisions are stalled, and that many negative outcomes can accumulate during a period of policy stasis.
- The evaluation of the costs vs. the benefits of a course of action. Modeling can show the economic efficiency of a set of actions (i.e., whether certain outcomes are achieved more effectively than under a different set of actions), or simply whether the cost of a single set of actions is acceptable for the benefits gained.
- The recognition of interrelatedness. Modeling can show how making a change in one area of population dynamics (such as migration rates) may necessitate changes in a number of other areas (such as marriage rates, timing of childbearing, etc.).
- The need to discard monolithic explanations and policy initiatives. Modeling can demonstrate that simplistic explanations may bear little relationship to how the "real world" operates.
- The utility of "door openers." A set of policies under consideration may not be acceptable to all stakeholders. Modeling can concentrate on favored goals and objectives and demonstrate how they are assisted by the proposed policies.
- That few things in life operate in a linear fashion. A straight line rarely describes social or physical behavior. Most particularly, population growth, being exponential, is so far from linear that its results are startling. Modeling shows that all social sectors based on the size of population groups are heavily influenced by the exponential nature of growth over time.
- That a population's composition greatly influences its needs and its well being. How a population is composed in terms of its age and sex distribution - has broad-ranging consequences for social welfare, crime rates, disease transmission, political stability, etc. Modeling demonstrates the degree to which a change in age and sex distribution can affect a range of social indicators.
- The effort required to "swim against the current." A number of factors can make the success of a particular program harder to achieve; for example, the waning of breastfeeding in a population

increases the need for contraceptive coverage. Modeling can illustrate the need for extra effort - even if simply to keep running in place.

## 1.4 More information



### **Spectrum Install File and Manuals:**

Click the Health Policy Project or Futures Institute link below in order to download the latest Spectrum install file or detailed documentation in several languages:

[Health Policy Project website](#)

[Futures Institute website](#)

Follow Spectrum on Twitter and YouTube:



### **LiST: The Lives Saved Tool:**

Specific information pertaining to LiST can be found at the following link:

[Institute of International Programs at the Johns Hopkins Bloomberg School](#)



### **OHT: OneHealth Tool:**

Specific information pertaining to OHT can be found at the following link:

[International Health Partnership](#)



### **Futures Institute:**

For general questions, information or application support, please contact Futures Institute using either of the links below:

[Futures Institute website](#)

[ModelSupport@futuresinstitute.org](mailto:ModelSupport@futuresinstitute.org)

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## 1.5 Software support

To view the online Knowledge Base - Wiki for Spectrum click the following link:

[Online Knowledge Base](#)

Use the following link to submit a request for support:

[Submit a request](#)

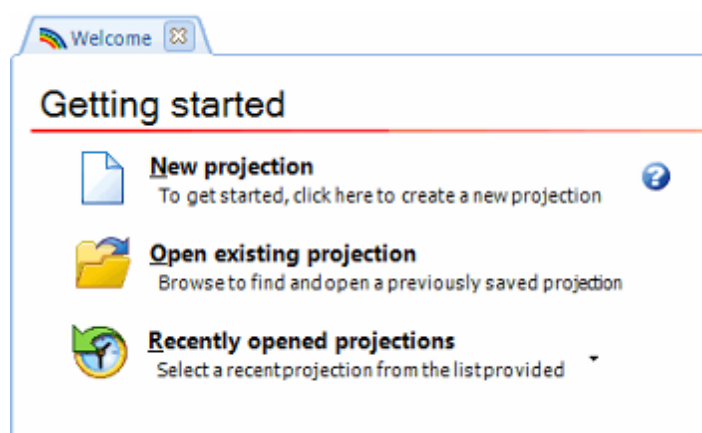
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## 2 Using Projections

### 2.1 Create a new projection

In Spectrum, a projection is defined as a group of modules linked together for the purpose of integrated calculations and display results. You can create a new projection in two ways.

1. When Spectrum is open you can click on "New projection" under **Getting started** on the **Welcome** tab.



2. Select the **Home** tab, click on "New".



In both cases you will see the **Projection manager** dialogue box.

---

Projection manager

Please set all parameters below in order to create your projection.

**Set a name and folder location for your projection data**

Projection file name: C:\Users\tpodkowiak\Desktop\Test1.FJNZ

**Set year boundaries for your projection**

First year: 1970 Final year: 2020

**Activate modules for use in your projection**

Sectors: OneHealth

☒ Demographic Projection (DemProj) ☐ HIV Incidence (Goals)

☐ AIDS (AIM) ☐ Resource Needs Model (RNM)

☐ Lives Saved Tool (LIST) ☐ RAPID

☐ LIST Costing

☐ Family Planning (FamPlan)

☐ TB ☐ Non-communicable diseases

**Select a country or global region from which to retrieve demographic and other default data**

Default data: Micronesia (Fed. States of)

☐ Subnational projection

Ok Cancel Help

The following information is displayed:

- *Projection file name*: This is the name and path for the data files associated with this projection. This name is also used to identify the projection across the Spectrum user interface.
- *First year*: This is the first year of the projection.
- *Final year*: This is the final year of the projection.
- *Active modules*: The check boxes let you select other modules that will be used with the population projection.
- *Country data*: This is where you can select the country associated with default data for active modules.

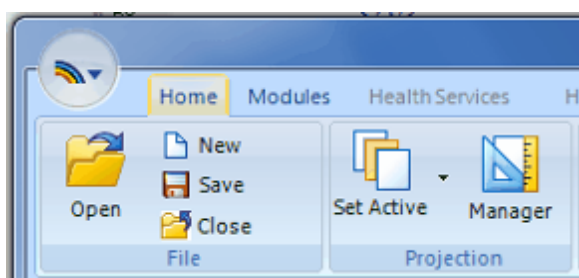
### Sample set-up process:

1. In the Projection manager dialogue box, click the "Projection file name" button, enter a file name for the projection, then click "Save". Enter the first year of the projection and the last year of the projection.
2. Activate modules of your choice by checking the appropriate box. Some modules are dependent on others such as Goals dependency on AIM. Projection Manager will ensure that dependent modules are activated by automatically selecting dependents as needed. Demproj is a required module and cannot be unselected.

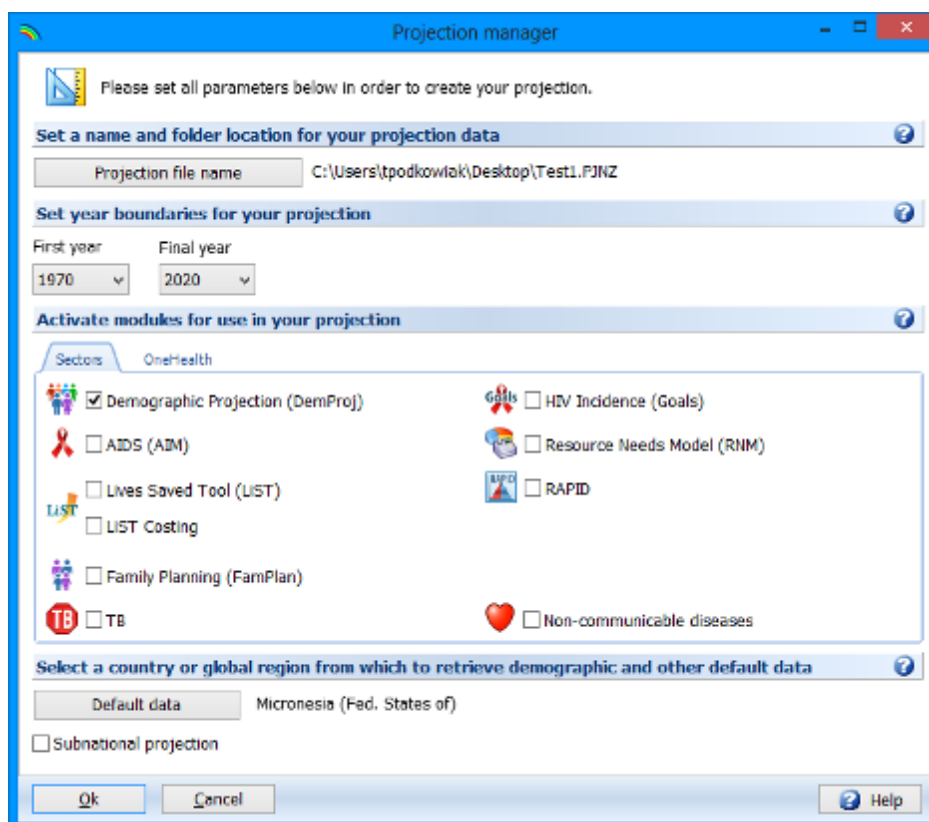
3. Click the "Default data" button and select your country or global region from the list. If your country is not shown, additional countries may be downloaded using the download button. An Internet connection is required for this process.
4. Once you click "Ok" from Projection Manager, Spectrum will create the projection and load any default data available.

## 2.2 Edit an existing projection

Adding or deleting of modules in a specific projection occurs in the Projection Manager. To edit a projection, click on the **Home** tab on the top menu, and then click "Projection Manager".



When the **Projection manager** dialogue box appears, changes to the projection can be made. Click "Ok" to save changes, click "Cancel" to exit without changes.



## 2.3 Reload country specific default data for an existing projection

At times it is necessary to reload specific default data in order to reset the projection. Note: this will delete previously entered data in favor of the defaults.

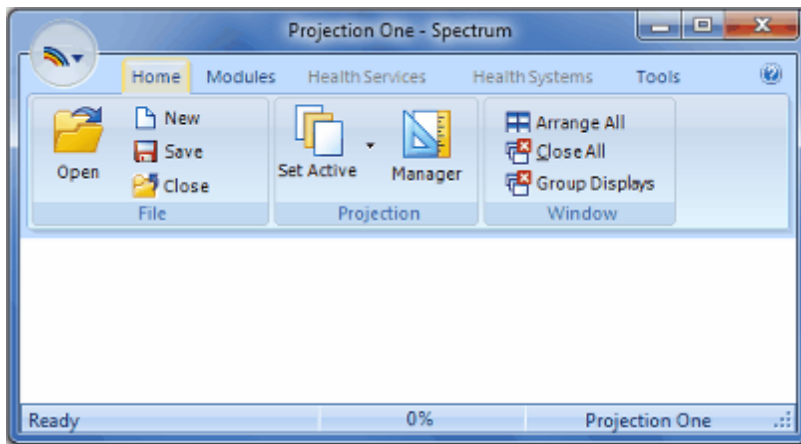
Click the **Home** tab on the top menu, click "Projection Manager", then click "Default data".



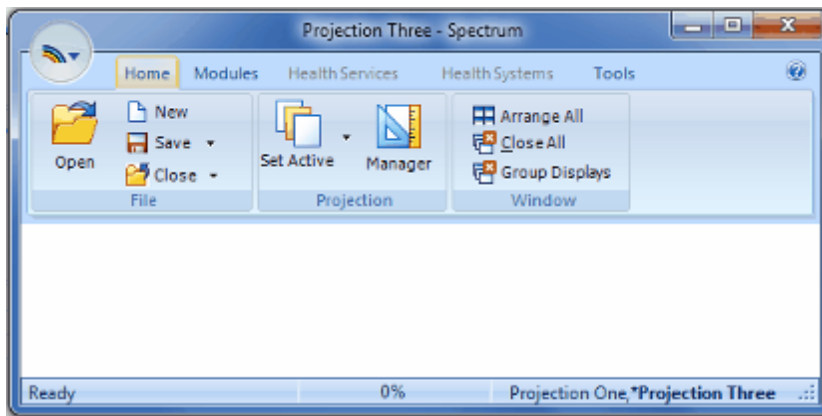
The selected country is highlighted in blue. In this case the selected country is Benin. The checkboxes on the bottom left indicate which selected modules have country specific data available. To reload the country specific data for a particular module, check that module. In this case, FamPlan and LiST have been checked indicating data for those modules will be reloaded for this projection. Click "Ok" and again in Projection Manager to reload the default data and save all changes.

## 2.4 Set active projection

You can determine if a particular projection is active by looking at the top of the Spectrum window. The file name of the active projection will be displayed above the menu bar. In this case *ProjectionOne* is the active projection. If you only have one projection open it is automatically the active projection. To determine how many projections are open look at the very bottom of the Spectrum window. In this case, *ProjectionOne*, is the only projection open.



If you have more than one projection open, all projection file names will be displayed at the bottom of the Spectrum window as shown in the picture below. To determine which projection is active, look at the top of the Spectrum window. The active projection file name will be displayed. The active projection file name will also be in bold and have a \* next to it in the file list at the bottom of the window. In this case, *ProjectionThree* is the active projection.



To select another projection to be set as active, use the **Set Active** button in the menu bar or click on the appropriate file name in the status bar.

## 2.5 Set a projection file name

Select and set a name and folder location for your projection data. The projection files will be saved in your chosen location with a '.pjnz' extension.

## 2.6 Set year boundaries

### Spectrum Layout/Mode

The first year of a Spectrum projection can fall anywhere between 1970 and the current year, inclusive, and defaults to 1970. The final year of a Spectrum projection can fall anywhere between the year after the selected first year and 2070, inclusive, and defaults to 2020.

#### When using AIM/GOALS

AIM must start its calculation prior to the first year (1970) of the epidemic in order to model the epidemic properly. The Spectrum will use an internal base year for Demproj, AIM and Goals of 1970 when AIM or Goals is active regardless of what the user selects for the first year of the projection. This allows Spectrum to calculate all necessary data from before the start of the epidemic (1970) to the first year selected by the user, which can then be used for all years projecting forward.

## OneHealth Tool Layout/Mode

The first year (of the OneHealth modules) for a OneHealth projection can fall anywhere between 1970 and the current year, inclusive, and defaults to the current year. The final year (of the costing modules) for a OneHealth projection can fall anywhere between the year after the selected first year and 2070, inclusive, and defaults to five years after the current year. The user can extend the final year of health systems modules by checking the "Extend final year for health systems modules" checkbox and changing the year dropdown that becomes enabled. The final year of the health systems modules cannot be less than the final year of the costing modules. The first year of the impact modules is automatically set to the same year as OneHealth. The base year for demographic data defaults to 1970 regardless of what the user selects for the first year of the projection. The final year of the impact modules is automatically set to the final year of the health systems modules.

## 2.7 Activate modules

Activate the modules you would like to use in your projection. Selected modules will be enabled for this projection. If multiple projections are open they must have the same modules.

[Click here for more information on each module.](#)

### AIM Module

AIM must start its calculations prior to the first year of the epidemic in order to model the HIV progression properly. For standard AIM or GOALS (which requires AIM) projections, it is recommended to use a First Year setting of 1970. Since this requirement presents an unnecessary burden on other modules when used in conjunction with AIM, Spectrum allows a first year setting greater than 1970. In this case, Spectrum internally sets AIM and Demproj, along with Goals and FamPlan if active to 1970, but allows other active modules (such as LiST or OHT modules) to use the selected first year. This aids in calculation efficiency along with editor and result display simplicity.

### Goals Module

In addition to the AIM requirement above, Goals must use a first year of 1970 in order to load pre-calibrated Goals data for select countries.

## 2.8 Select a country

Select a country from which to retrieve demographic and other default data.

### Country specific data

Choosing a country populates the projection with country specific data. Demographic (DemProj) data is based on estimates and projections of the United Nations Population Division, and is available for all countries shown. LiST data is collected by Child Health Epidemiology Reference Group (CHERG) but is not

available for all countries. FamPlan data are the latest DHS for each selected country, it is also not available for all countries. In addition Spectrum now will load data on HIV incidence, and number of people receiving ART, cotrimoxazole and PMTCT services based on data published by UNAIDS and WHO.

It is important that users compare these inputs with their program data and make any revisions that might be necessary. In particular, the data provided on PMTCT services should be reviewed. If your country is not shown in the selection dialog, additional countries may be downloaded using the download button. An Internet connection is required for this process.

## **Subnational projections**

Check the "Subnational projection" checkbox if you would like to implement a subnational region analysis. Once checked, you will be offered the option to specify a subnational region name. This name is a useful identifier for particular outputs such as the Extract tool. Although there is no subnational default data, it is also recommended that you select a country in order to load national default data. This will create a working projection which is more easily tailored to your specific regional needs.

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## 3 File Management

### 3.1 Add a module to an existing projection

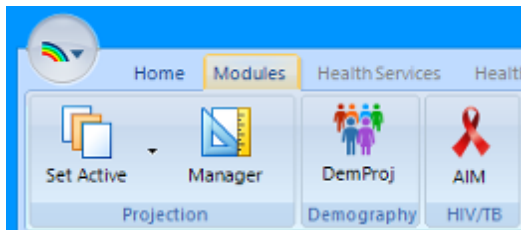
This example will show how to add modules to a previously prepared demographic projection:

1. If the projection is not currently loaded, you will need to select the projection file from the "Open" dialogue box and press "Ok."
  2. Once the projection is open, select "Manager" on the Projection group of the Spectrum menu.
  3. You will see the Projection manager dialogue box where you can activate modules of your choice. Default data for the newly added modules will be loaded automatically. Existing module will not reload default data by default. These options can be modified in the default data selection dialog.
  4. Click "Ok" to complete the set-up process.
  5. You can then go to the Modules tab of the Spectrum menu and begin working in newly activated modules.
-

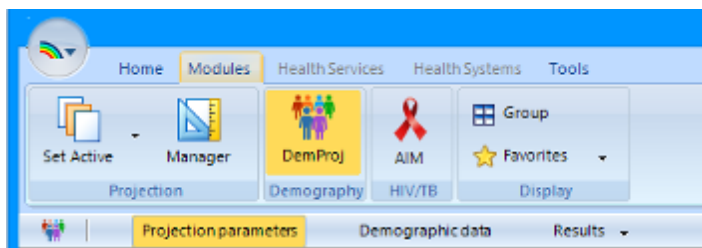
## 4 Using Modules

### 4.1 Edit module data

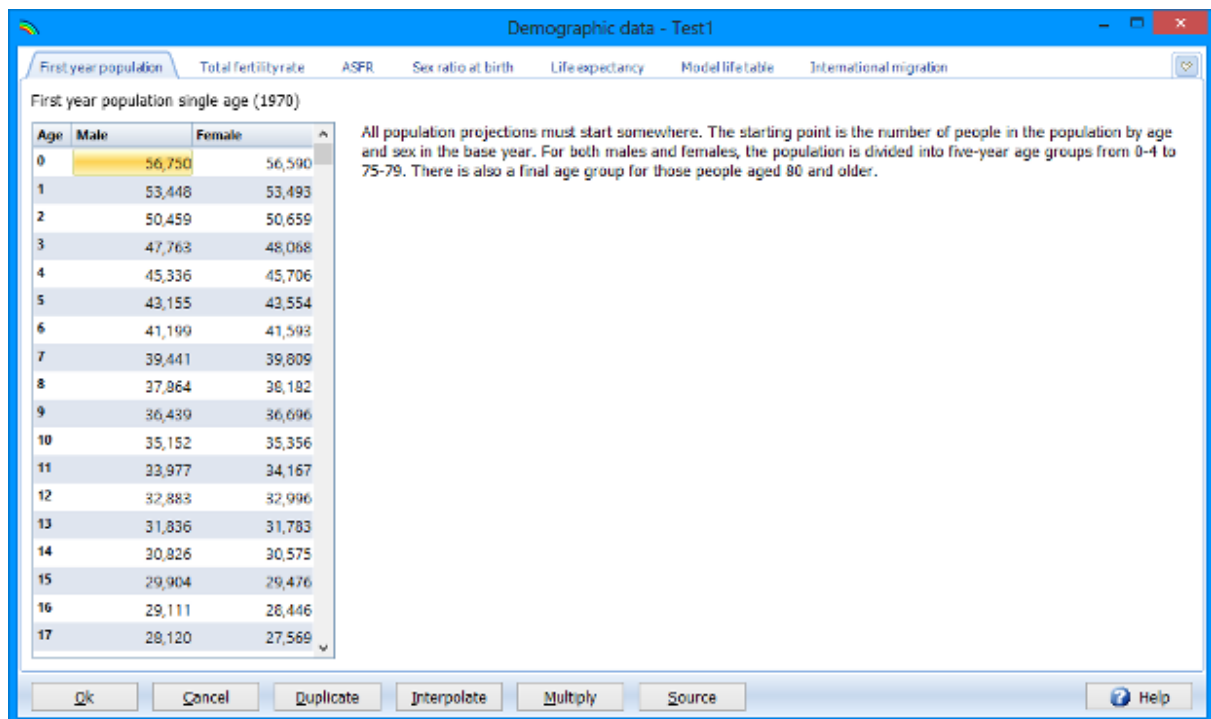
To edit a module in a projection, click the "Modules" tab on the menu bar. All active modules will be shown. In this case Demproj and AIM are the active modules.



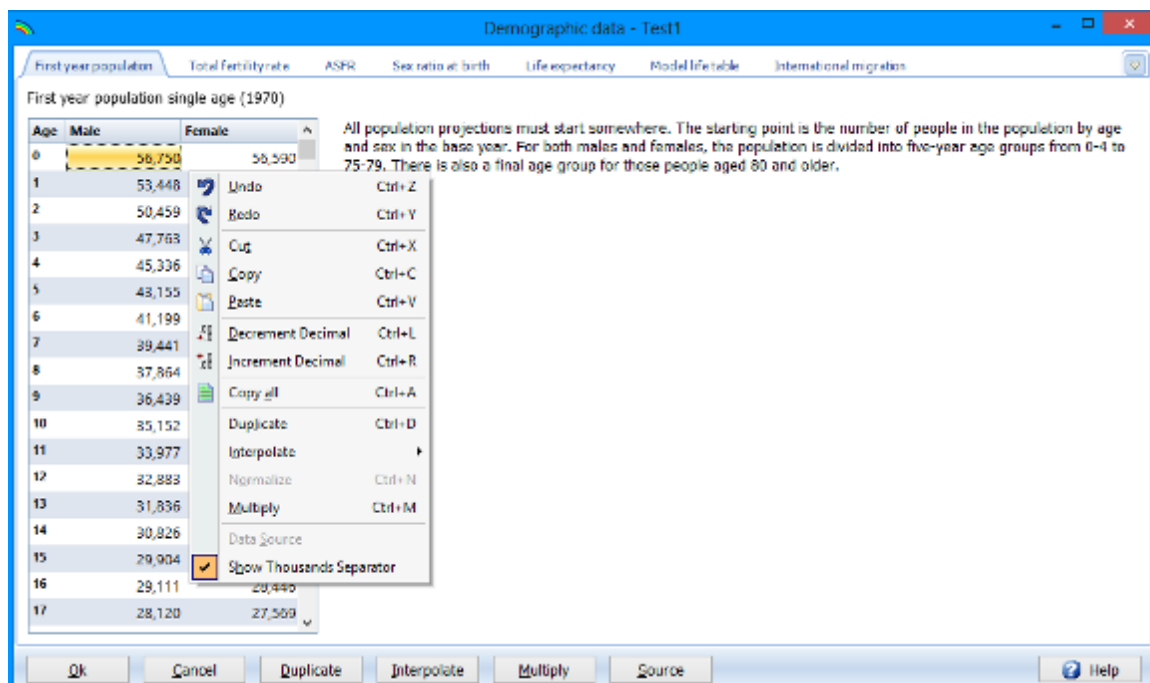
To edit a specific module's data, click that module in the menu bar. The edit menus and results menu will be displayed in a menu bar directly below the module names. In this case DemProj was selected. There are similar editor/results menu bars for each module.



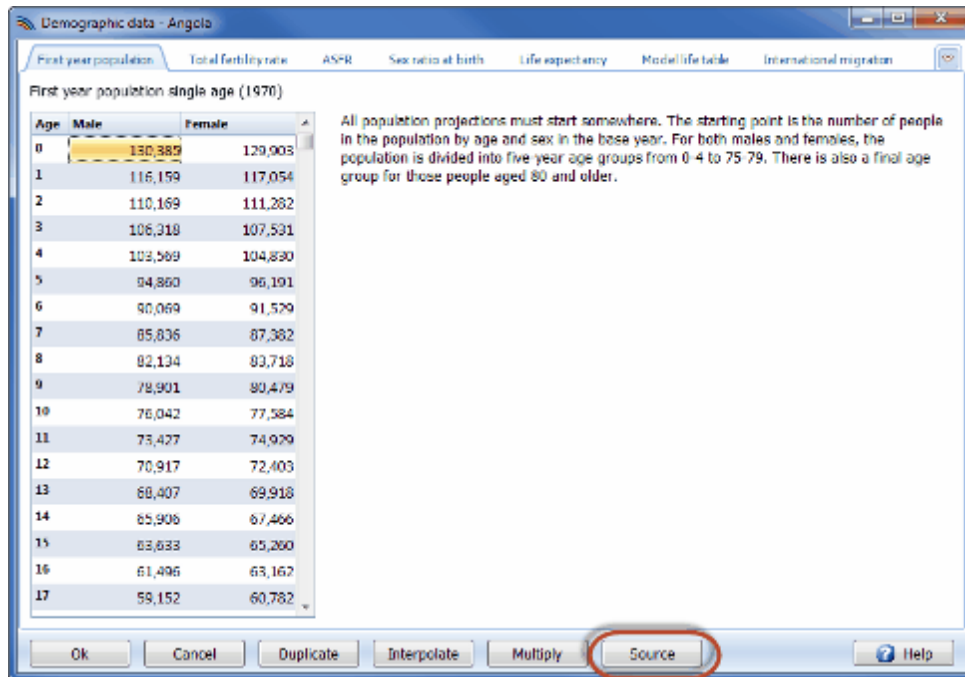
Once you click on one of the menu items, the corresponding editor will be displayed. Below is the DemProj editor for "Demographic data".



If you "Right click" on an editor you will see edit options as shown in the picture below.



## 4.2 Source button



### To use the "Source" button

1. Click on the "Source" button to view default source information regarding the data contained in the editor. Once the source window is open, you can add your specific notes by clicking on the window.
2. Enter the source of the data and make any special comments about the assumptions.
3. Click on "Close" to return to the editor.

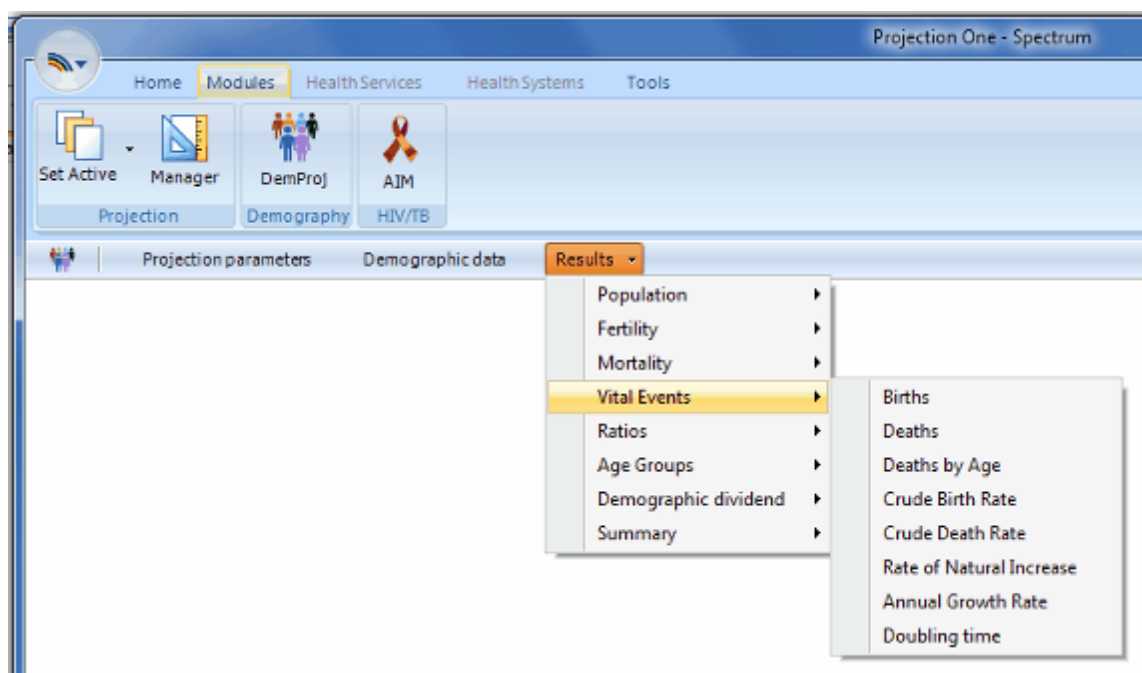
The "Source" feature allows you to keep a record of the data sources and assumptions as you make the projections. This source information will be maintained with the data file. It is **strongly** recommended that you use this feature to avoid later confusion.

## 4.3 Calculate the projection

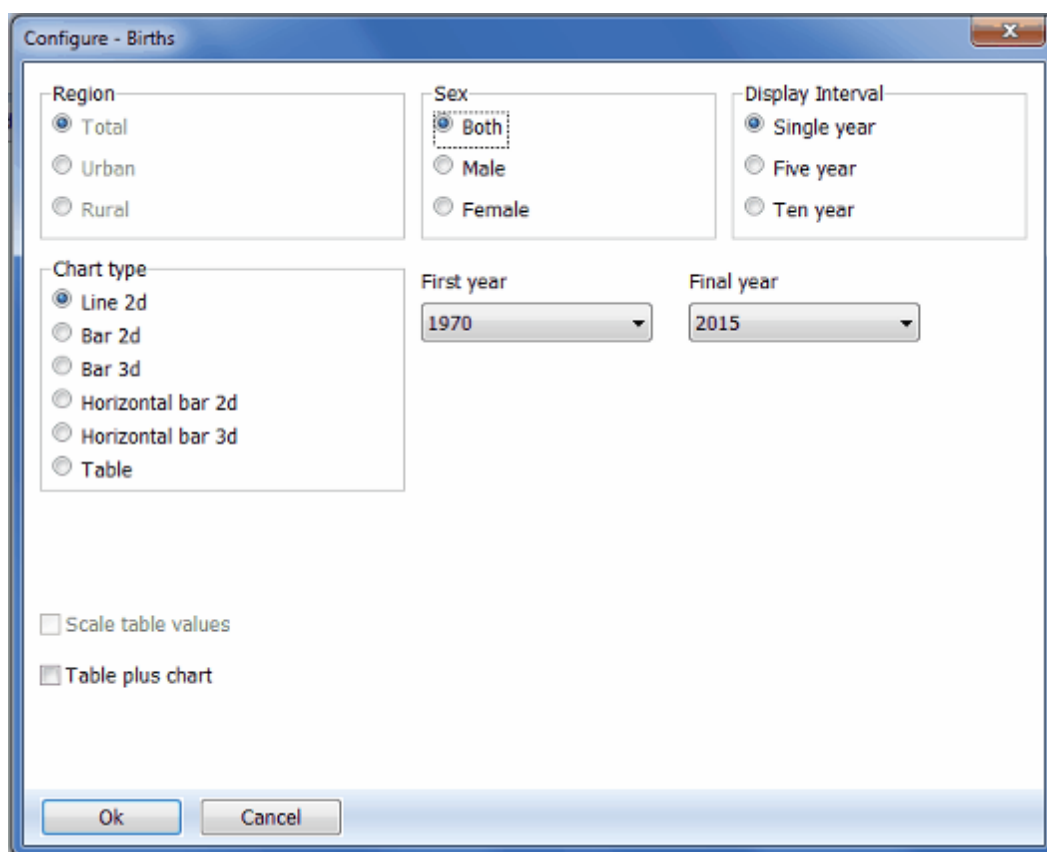
Spectrum keeps track of the validity of a projection depending on changed data or assumption of a loaded projection. Should a calculation be necessary it will occur before a result is displayed. Calculations may take only a few seconds if you are making only a population projection, or could take somewhat longer if you have additional modules activated. The calculation will only occur as needed depending on when data was changed. Under Spectrum Options, you will find a selection to ask Spectrum to prompt the user for confirmation before each calculation.

## 4.4 Display module data

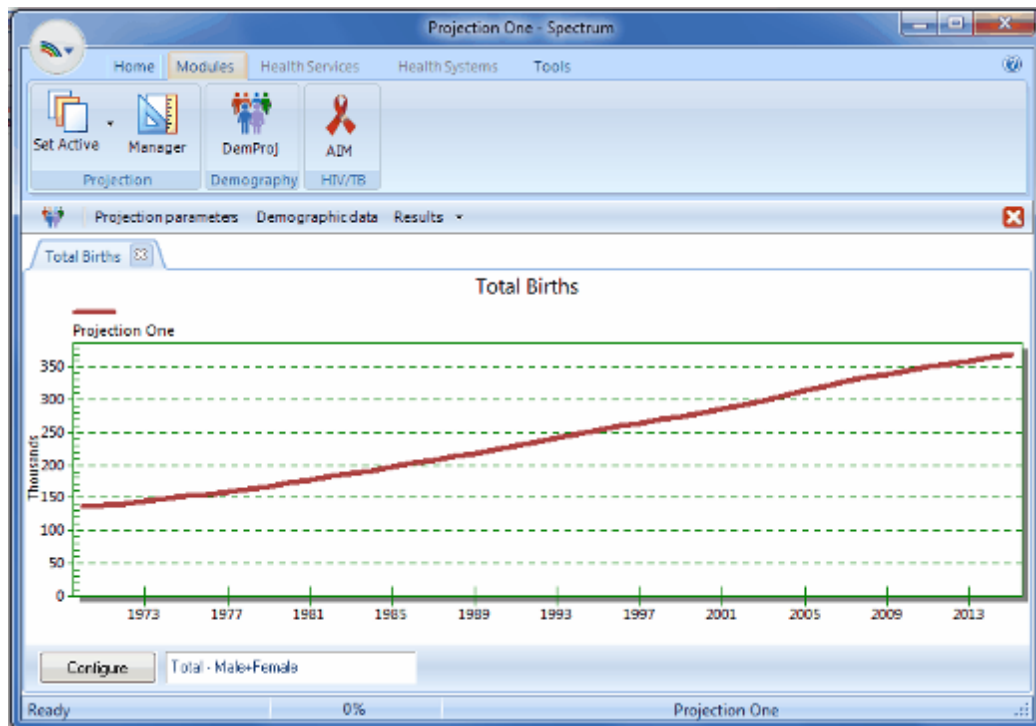
To display data for a module in a projection, choose the "Modules" tab and select one of the active modules, such as DemProj. Click "Results" in the menu shown directly below the module names. A drop down menu appears showing available indicators.



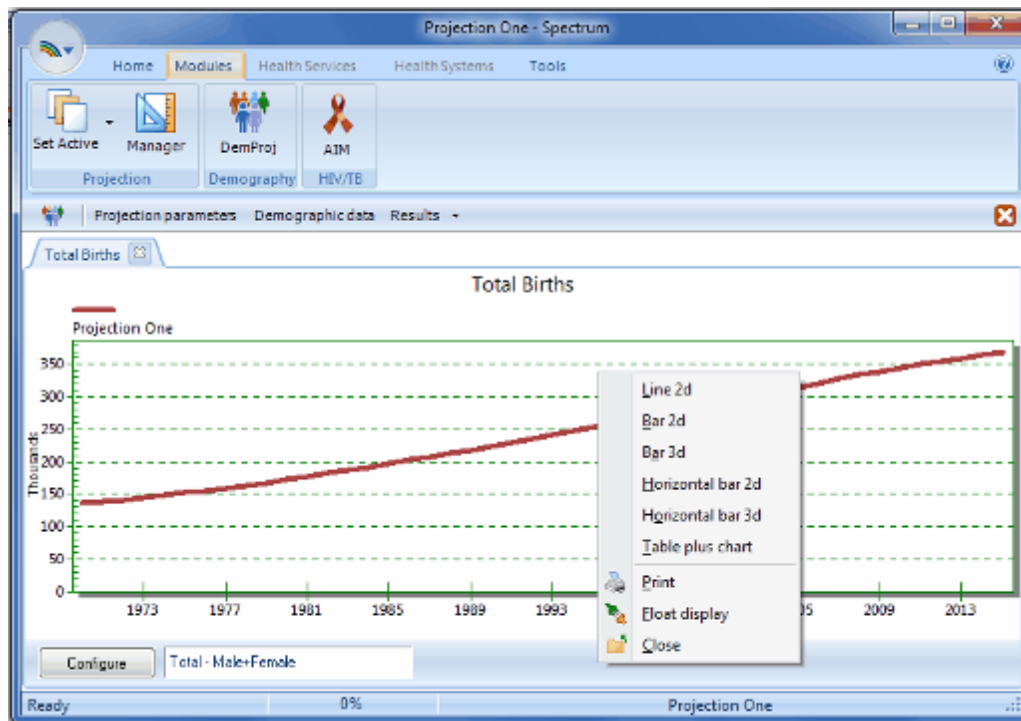
After an indicator is selected, the **Configure** dialogue box appears, it provides several choices on how the data is to be displayed. In this case the dialogue box is shown for Results --> Vital Events --> Births.



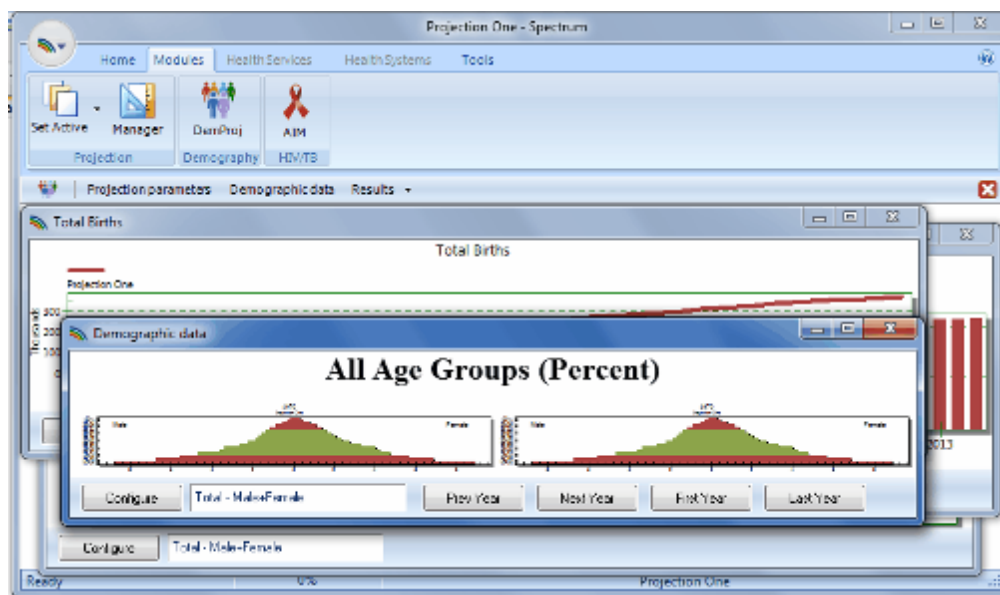
Once the options are selected on the **Configure** dialogue box, click "Ok" and the data will be displayed. To change the configuration, click on "Configure" and the **Configure** dialogue box will appear so you can make desired changes.



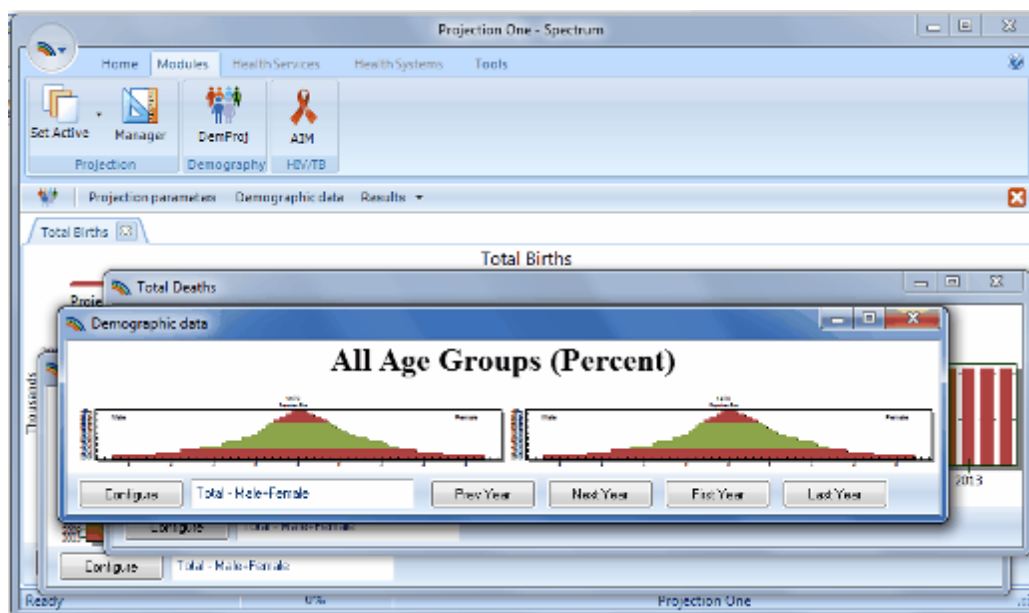
If you "Right click" on a display, you will see the options shown in the picture below.



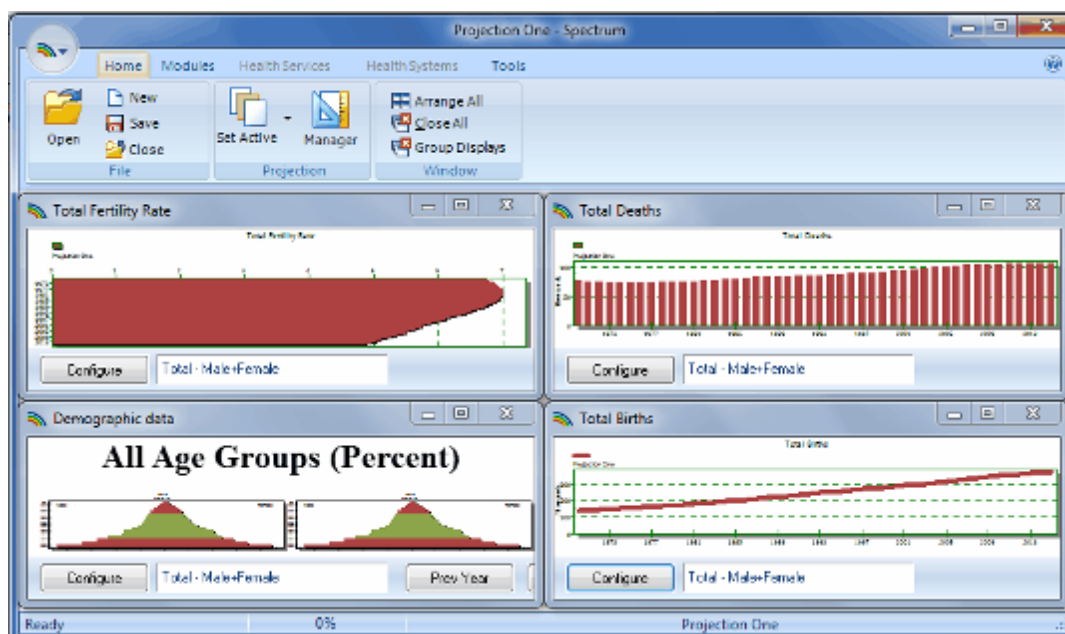
One of the options is "Float display". Float frees the displayed graph/chart/table so that it is separated from the Spectrum window and can be moved anywhere on the computer's desktop. Below is an example of four displays that have been floated.



A display can also be docked back to the Spectrum window. If you "Right click" on a floating display you will see that "Dock display" has been added to the options. In the picture below, one of the floating displays from the above example has been docked.



To make it easier to view all of the displays, you can arrange all of the floating displays in an organized manner, by clicking the "Arrange All" button on the **Home** tab. Once you are finished with the displayed data, you can close each display individually or you can click the "Close All" button on the **Home** tab.



## 4.5 Configure results

The 'Configure - Births' dialog box is shown. It contains the following settings:

- Region:** ☒ Total, ☐ Urban, ☐ Rural
- Sex:** ☒ Both, ☐ Male, ☐ Female
- Display Interval:** ☒ Single year, ☐ Five year, ☐ Ten year
- Chart type:** ☒ Line 2d, ☐ Bar 2d, ☐ Bar 3d, ☐ Horizontal bar 2d, ☐ Horizontal bar 3d, ☐ Table
- First year:** 1970
- Final year:** 2015
- ☐ Scale table values
- ☐ Table plus chart

Buttons at the bottom: 'Ok' and 'Cancel'.

1. The exact display choices available will depend on the indicator you have selected. The display will normally be in single years but you can change it to display every five or ten years if desired. The chart type is also set through this dialogue box. Click on the button next to the type of display you



want. For LiST, you may also select the age cohort to display for some indicators, by using the drop-down menu for "Select age cohort to display".

2. If you want to see only part of the projection (for example, results beginning only in the first year of intervention coverage), you can change the first year or final year through the "First Year" and "Final Year" drop down boxes.
3. To copy the charts you may press "Print Screen" on your keyboard, and then "Ctrl and V" to paste into Paint, Word, or Powerpoint. To export data from a screen, mouse over the top left corner of any table, right click to copy all, and then press "Ctrl and V" to paste into Excel.

## Graphs and bar charts

Spectrum will display a variety of graphs and bar charts, including:

- Line charts
- Two- and three-dimensional bar charts (column charts)
- Two- and three-dimensional horizontal bar charts
- Two- and three-dimensional overlap bar charts (bars for multiple projections are shown on top of each other)
- Three-dimensional perspective bar charts

## Tables

Spectrum will also display data in the form of tables. In tables, each projection that is in use will be displayed in a separate column. You can scroll through the table to see all the years using the PgUp and PgDn keys or the mouse.

To print a table, right click with the mouse and select 'Print'.

You can change the decimal precision on tables by selecting a group of cells and then clicking the right mouse button and selecting 'Increment decimals' or 'Decrement decimals'.

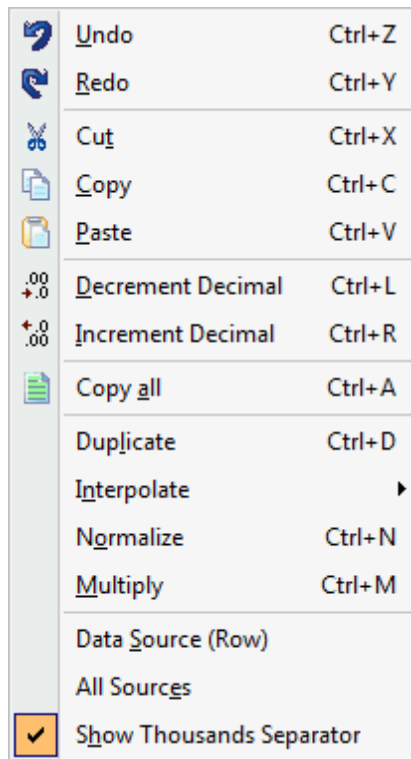
You can copy all the data in a table to Excel or Word by selecting 'Edit' and 'Copy All' and then moving to Excel or Word and pasting the data.

## Summary tables

The final display available in several modules is a summary table showing all the indicators. You can scroll through this page to see all the output. If you have more than one projection loaded, the indicators for the second projection will immediately follow the first.

## 4.6 Right click on an editor or result

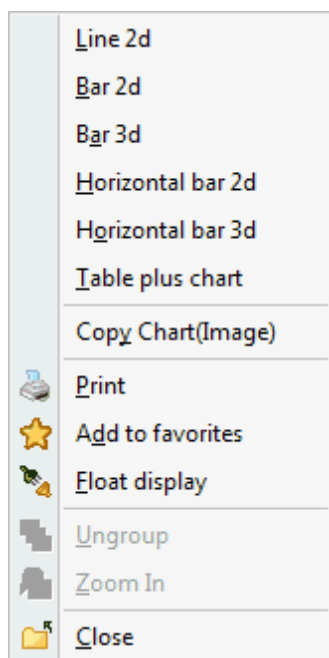
When you hover over an **editor** and right click, the following options appear. Only options that are available for the specific editor will be enabled.



- **Copy all** can be used to copy the entire contents of an editor into Excel, including the editor name, and column and row headings.
- **Duplicate** allows you to copy information from one cell, column or row to another. To use the Duplicate function, highlight (select with the mouse) the range (column, row or cells to be affected). The first cell in the range should be the value you want to copy. Extend the range to the last year by using the mouse (hold down the left button and drag the range) or the keyboard (hold down the shift key and use the arrow keys). Then right click and select Duplicate or click on the Duplicate button (if available) to copy the value at the beginning of the range to all other cells in the range.
- **Interpolate** to enter a beginning and ending number and have the computer calculate numbers for the intervening intervals. Enter the beginning and ending values in the appropriate cells. Highlight the entire range from beginning to end. Then right click and select Interpolate or click on the Interpolate button (if available) to have the values interpolated and entered into each of the cells. When you use the right click option to interpolate values you will have the option to select the type of interpolation, including linear, s-shaped, exponential and front loaded. When you use the Duplicate button, the interpolation is linear.
- **Multiply** to multiply a cell, column or row by a specific number. Highlight the range (column, row or cells to be affected). Enter the multiplier in the dialogue box, then click "Ok" to accept. The entire range will be multiplied by the designated number.
- **Source** allows you to keep a record of the data sources and assumptions as you make the projections and will be maintained with the data files. You will also see source information for default data when it is available. It is strongly recommended that you use the source feature whenever possible to avoid later confusion. Some editors have access to the sources via the right click. Most editors have a [Source button](#) located on the bottom of the editor window.

Some editors have the Duplicate, Interpolate and Multiply options available as buttons on the bottom of the editor.

When you hover over a **result** and right click, the following options appear.



You can easily change the type of display by selecting one of the available options. You can use Copy Chart to copy the graph and paste it into another program such as Excel or Word.

## 5 Interacting with Excel

### 5.1 Copy and paste selected cells from Excel

**You can copy selected cells in Excel and paste them into an editor by following these steps:**

1. Enter data into Excel.
2. Select the cells that contain the data.
3. Copy the selected cells.
4. Right-click on the editor and select "Paste".

### 5.2 Copy and paste a table into Excel

**You can copy an entire editor and paste it into Excel by following these steps:**

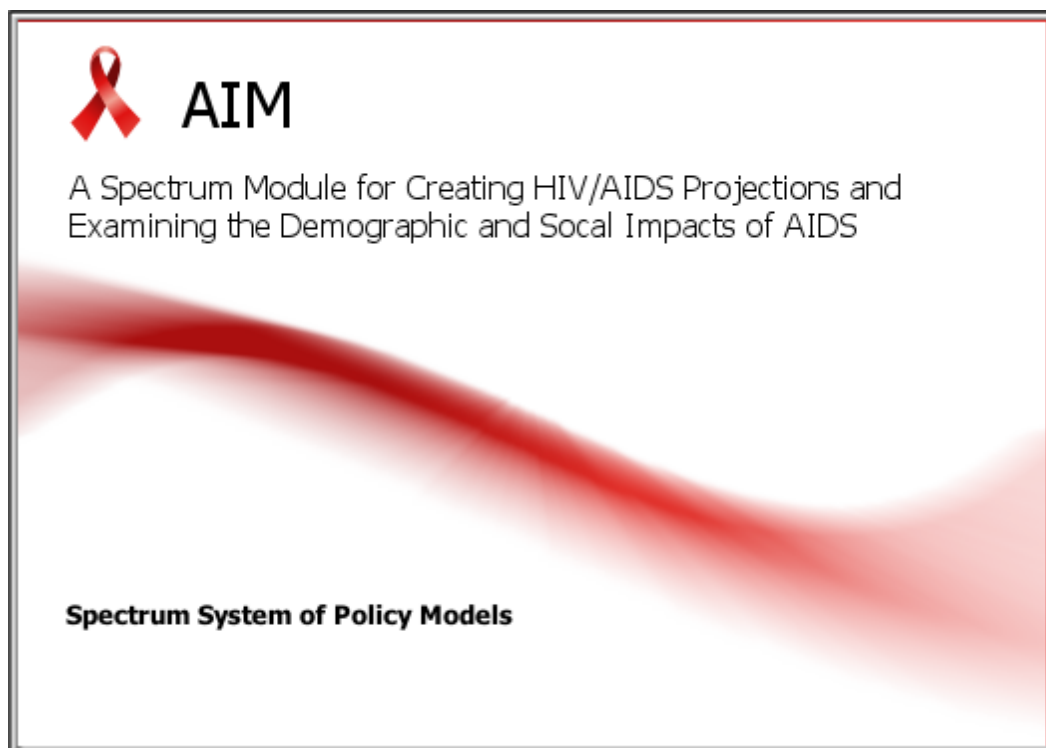
1. Right-click on the table and choose "Copy all".
2. Paste the table into Excel.
3. This is the only way to include the column and row headers.

**You can copy a portion of an editor and paste it into Excel by following these steps:**

1. Click on any part of the editor and drag the mouse to highlight a portion of it.
  2. Right-click and choose "Copy".
  3. Paste the highlighted data into Excel.
-

## 6 AIDS Impact Module (AIM)

### 6.1 AIM



#### 6.1.1 What is AIM?

The AIDS Impact Model, known as AIM, is a computer program for projecting the impact of the AIDS epidemic. It can be used to estimate the number of people infected with HIV, the number of new infections, the need for treatment, the need for programs to prevent mother-to-child transmission and many other indicators of interest. It can also project the demographic and social impacts of AIDS. These projections then can be used in graphic policy presentations intended to enhance knowledge of AIDS among policymakers and to build support for effective prevention and care.

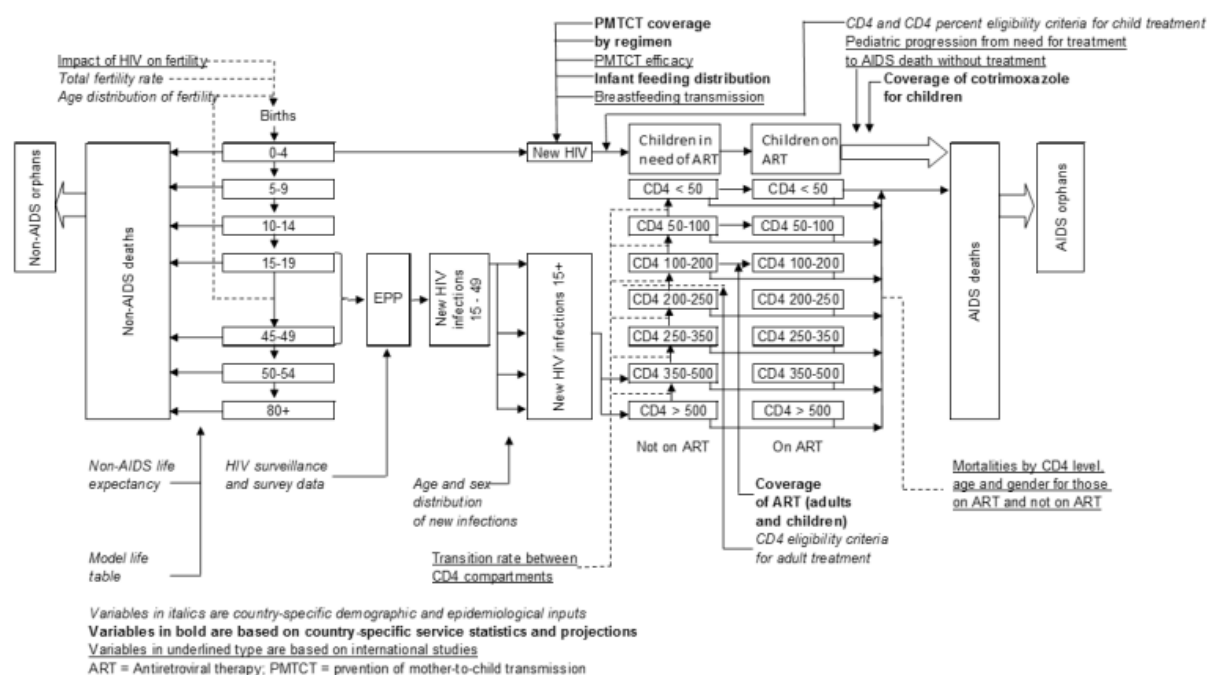
The Futures Group, in collaboration with Family Health International, prepared the first version of AIM in 1991 under the AIDS Technical Support (AIDSTECH) and AIDS Control and Prevention (AIDSCAP) projects. The program has been revised a number of times since then in collaboration with the UNAIDS Reference Group on Estimates, Models and Projections. Since 2009 it has been maintained and updated with support from the Bill & Melinda Gates Foundation and UNAIDS.

AIM (and the entire Spectrum system of models) is designed to produce information useful for policy formulation and dialogue within a framework of computer programs that are easy to use. The focus is on generating information useful for policy and planning purposes rather than on carrying out detailed research into the underlying processes involved. For this reason, the program is designed to be used by program planners and policy analysts. AIM uses data that are readily available and requires little technical expertise beyond what can be acquired through literature review and use of this manual.

The major inputs and outputs of AIM are shown in Figure 1. Demographic projections are based on user inputs or projections prepared by the United National Population Division. The projections start with an

estimate and projection of adult incidence, which is combined with information on the age and sex distribution of incidence and progression to death to estimate the number of new adult infections by age and sex. New infant infections are estimated from prevalence among pregnant women and the rate of mother-to-child transmission, which is dependent on infant feeding practices and the coverage of prophylaxis with antiretrovirals (ARVs). New infections progress over time to lower CD4 counts and are subject to AIDS-related mortality. Those who receive first and/or second line ART experience extended survival. People at any stage are also subject to non-AIDS mortality at the same rates as those who are not infected. Adult deaths result in orphans.

**Figure 1. Structure of AIM module**



## 6.1.2 Overview of estimation and projection tools

### 6.1.2.1 Introduction

#### 6.1.2.1.1 Purpose of estimation and projection tools

A well planned response to the HIV epidemic requires specific information on the projection of the disease over time. This projection needs to be based on previous measures of prevalence in the population as well as data from programs on their effectiveness and coverage.

UNAIDS and partners have developed software to assist countries to map their HIV epidemic and determine the consequences of the epidemic. Consequences such as number of people living with HIV, number of new infections, number of pregnant women infected with HIV, mortality due to AIDS and treatment needs are all provided from these programs. From these data countries can estimate their potential service and pharmaceutical needs, can plan for health care service requirements, and can get a general understanding of the overall impact of their response.

#### 6.1.2.1.2 Reference group on estimates, modeling and projections

The computer programs are informed by a Reference Group of experts from multiple disciplines and institutions. These experts include epidemiologists, demographers, clinicians, modelers, as well as implementers from countries with different types of epidemics. The functions and assumptions used in

the models are based on the recommendations of this Reference Group. The Reference Group meets at least annually and updates the software every two years. For more information on the Reference Group go to [www.epidem.org](http://www.epidem.org).

#### 6.1.2.1.3 Processes to create estimates and projections

Every two years UNAIDS and partners hold regional trainings to explain new features and review the computer programs with country epidemiologists. Country teams usually consist of individuals from the national programs who have a strong capacity for epidemiology and modeling and may include development partners who work on HIV surveillance in the country. These teams work in groups at the trainings to update the estimates with the country's most recent surveillance and program data. As a result, the country is able to use the software to estimate and project the future consequences of the epidemic for the country.

After the regional trainings, countries are expected to refine and share the outcomes with other interested parties in the country. Once the models are completed the country provides the final results to UNAIDS headquarters to inform the regional and global estimates of HIV. Countries are encouraged to create estimates and projections reports for their individual countries and to communicate the results to a broad spectrum of potential users of the data.

#### 6.1.2.1.4 Different types of epidemics

There are significant variations in HIV epidemics around the world. Different epidemics require different types of surveillance and modeling techniques. UNAIDS uses the classifications, generalized and concentrated to differentiate types of epidemics.

The type of epidemic also determines which computer programs are necessary for modeling the epidemic and how to use those programs.

##### 6.1.2.1.4.1 Generalized epidemic

- HIV is firmly established in the general population.
- Although sub-populations with higher risk may continue to contribute disproportionately to the spread of HIV, sexual networking in the general population is sufficient to sustain an epidemic independent of subpopulations at higher risk for infection.
- Numerical proxy: HIV prevalence is consistently over 1% in pregnant women.
- In generalized epidemics, the prevalence among pregnant women is usually a fairly good indicator of prevalence in the total adult population. Prevalence is usually higher in urban areas than in rural areas. Therefore, most countries with generalized epidemics can be modeled using two distinct sub-populations (an urban population and a rural population).

##### 6.1.2.1.4.2 Concentrated epidemic

- HIV has spread rapidly in at least one defined sub-population, but is not well-established in the general population. Most often more than one subpopulation with higher risk is affected.
- This epidemic state usually suggests active networks of risk exist within and between the sub-populations.
- Numerical proxy: HIV prevalence is consistently over 5% in at least one defined subpopulation. HIV prevalence is below 1% in pregnant women in urban areas.
- In concentrated and low-level (low prevalence) epidemics HIV infection is primarily concentrated in

certain sub-populations. Therefore, countries with concentrated epidemics are usually modeled by combining epidemic curves for several subpopulations.

#### **6.1.2.2 Data required for estimation and projection**

The quality and accuracy of the estimates depend on the quality and accuracy of the data used for the models. If very little information is available on HIV prevalence in the country the model will rely heavily on assumptions used in the model. On the other hand, countries which have conducted routine surveillance and covered groups which are most important to the epidemic will be able to inform the models with substantial data resulting in high quality estimates and projections.

In generalized epidemics, data from sentinel surveillance sites at antenatal clinics (ANC) are required. Data from population based surveys are also very useful for informing the models. The models are able to utilize data to distinguish urban and rural epidemics or different regional epidemics.

In concentrated epidemics more specific information is required about the populations that are at increased risk to HIV. The software separates the epidemic into sub-populations. However the user must have information on each of the sub-populations that are used in the epidemic structure. For example if a country specifies female sex workers and injecting drug users as important risk categories they will be required to enter data for those two sub-populations and the remaining general population. Data required for each sub-population include estimates of the population size, HIV surveillance data from the group over time.

For all epidemic types, the software requires additional program data on the number of men, women and children on ART, the number of women receiving ARVs for prophylaxis (PMTCT) and other demographic and epidemiological information to determine the impact of HIV.

If there are no recent data on HIV prevalence available in the country then no estimate should be created.

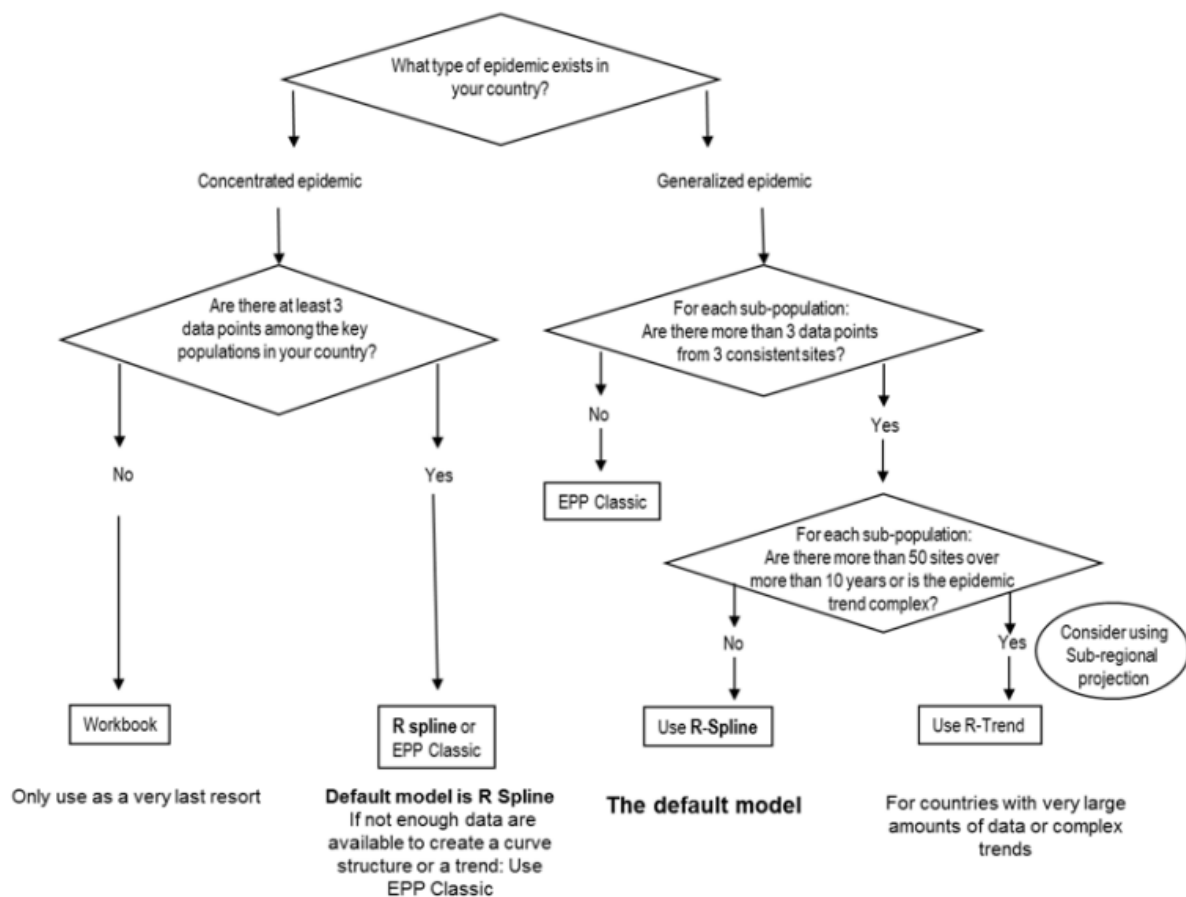
#### **6.1.2.3 Computer programs for estimation and projection**

This guide describes the Spectrum program that has been developed to support national estimates and projections. The 2014 version of Spectrum includes the Estimates and Projections Package (EPP) used to generate an epidemic curve that used to be a separate program. Its functions are now integrated into Spectrum. Some countries with very little surveillance data may also use an Excel-based program called Workbook. The Workbook program will generate an HIV point prevalence estimate for a given year. This should be repeated for several years; these prevalence estimates are then used in EPP to generate an epidemic curve. Consult with UNAIDS if your country needs to use Workbook (See figure below.) EPP now contains multiple models that can be chosen based on the amount of data available (the models are described in Step 9).

**Figure . Decision tree on use of estimates tools**

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### 6.1.3 AIM input editors

AIM requires data describing the characteristics of the HIV/AIDS epidemic and the response to it. Some of these inputs require national data while others rely on recommended values based on a review of scientific studies. All AIM projections require a demographic projection. There are six categories of HIV-related inputs:

- Program statistics (country specific)
  - Number of women provided with PMTCT services by type of regimen
  - Number or percent of adult men and women receiving anti-retroviral therapy (ART)
  - Number or percent of children receiving ART and/or co-trimoxazole
- Eligibility for treatment (country specific)
  - Eligibility criteria for adults
  - Eligibility criteria for children
- Advanced options (usually based on global or regional default patterns)
  - The amount of time spent in each CD4 cell count category
  - The distribution of new adult HIV infections by CD4 cell count
  - Adult HIV mortality rate without ART by CD4 cell count, sex and age
  - Adult HIV mortality rate while on ART by CD4 cell count when initiating ART, sex, and age
  - Survival on ART for children

- Effectiveness of co-trimoxazole in reducing mortality for HIV+ children
- Survival of HIV+ children without ART by time since infection and timing of infection
- Ratio of fertility of HIV+ to HIV- women by age
- Adult HIV incidence (generated using EPP)
- Sex/Age pattern (Based on either country-specific estimates or global patterns)
  - The ratio of new adult female infections to new adult male infections by year
  - The incidence rate ratio by age, sex and year

Each of these inputs is discussed in detail in the following sections.

#### 6.1.3.1 Demographic projection

AIM requires that a demographic projection first be prepared using DemProj, another model in the Spectrum system. Model users should keep three key points in mind when preparing a DemProj projection for use with AIM:

1. DemProj contains a feature called EasyProj that automatically provides the necessary demographic data once you have set the first and last years of the projection and selected the country.
2. The first year of the projection should be before the starting year of the HIV/AIDS epidemic. It is possible to start the projection in a year after the beginning of the AIDS epidemic, but this type of projection will be less accurate.
3. The life expectancy assumption entered into DemProj should be the life expectancy in the absence of AIDS. AIM will calculate the number of AIDS deaths and determine a new life expectancy that incorporates the impact of AIDS. It is necessary to use this two-step process because model life tables (for specifying the age distribution of mortality) do not contain patterns of mortality that reflect the excess deaths caused by AIDS.

##### 6.1.3.1.1 Adjusting the population size to match current estimates

If you use [EasyProj](#) for your demographic projection it is possible that the population size may not match the most recent census estimate. The United Nations Population Division bases their estimates and projections on the latest available demographic data for each country. However, a typical application of Spectrum starts the projection in 1970 or 1980 and projects forward to today. Small variations in any of the inputs can affect the population size 25 to 30 years later. Perhaps the most important difference is that the UN Population Division estimates may use a different HIV prevalence trend than the one you are using in Spectrum. In that case, the population projected by Spectrum may not match the UN Population Division estimate or the latest census estimate. Variations in the age distribution of mortality or migration can also cause small difference in the population size today.

If this problem occurs you can get a better match to the census population by adjusting some of the inputs to the demographic projection. Changes to the fertility rate, life expectancy, the model life table chosen and the migration inputs can help to fine tune the projection. Of course, changes to the HIV prevalence curve could also make a difference.

One quick way to get a good match to today's population estimate is to adjust the starting population. One of the demographic inputs is the population by age and sex in the base year. These inputs might need to be adjusted upwards or downwards to modify the current year population projection. This can be done easily by using the "Multiply" button in the editor for the base population to multiply all the inputs by

a constant factor. That factor could be the ratio of the actual current year population to the projected population. After making this adjustment the new population projection should match the current estimate better. This approach is only a quick fix. It is always desirable to examine the fertility, mortality and migration assumptions as well as the starting population to reconcile them with national statistics. Most countries have national population projections that can be used as a source of information for the Spectrum projection.

You do not need to use EasyProj to generate the demographic projection. You can input your own data. However, this should be done with caution. Raw census data on the number of people by age and sex should be adjusted to account for age mis-reporting and undercounts before they can be used in Spectrum. The projection requires past and future trends in the total fertility rate and non-AIDS life expectancy. Information on the non-AIDS life is not likely to be readily available. Thus it is often better to start with EasyProj and then adjust any inputs as necessary than to build your own projection from the start.

### 6.1.3.2 Program statistics

#### 6.1.3.2.1 Prevention of mother-to-child transmission of HIV (PMTCT)

The mother-to-child transmission rate is the percentage of babies born to HIV-infected mothers who become infected. The rate depends on a number of factors including the stage of infection of the mother, the duration of breastfeeding and the use of ARV prophylaxis to prevent the transmission.

The input editor of PMTCT is accessed by selecting: *Modules -> AIM -> Program statistics -> PMTCT*

There are three inputs associated with PMTCT: the number of women receiving PMTCT services, the pattern of breastfeeding and the transmission rates.

##### 6.1.3.2.1.1 Women receiving PMTCT services

The editor for women receiving PMTCT services is accessed by clicking on the 'ARV regimen' button.

For past years the entries should generally be the number of women receiving each type of prophylaxis. For future years the entries may be either projections of the number of women expected to receive services or the coverage (the percentage of HIV+ pregnant women receiving services). The types of prophylaxis are:

- No prophylaxis
- Single dose nevirapine: single dose of nevirapine (NVP) given to the mother at the time of delivery and the child shortly after birth.
- Dual ARV: Daily zidovudine (ZDV) for the pregnant woman from the 28<sup>th</sup> week of gestation, plus single-dose NVP during labor and 7 days of ZDV plus lamivudine (3TC) postpartum.
- Option A: Twice daily ZDV starting from the 14<sup>th</sup> week of gestation, single-dose nevirapine at the onset of labor, twice daily ZDV+3TC for seven days post-partum plus daily NVP for the infant until one week after the cessation of breastfeeding.
- Option B: Triple ARV drugs for the pregnant woman starting from the 14<sup>th</sup> week of gestation until delivery or one week after the cessation of breastfeeding.
- Triple ART started before current pregnancy: Pregnant woman started on life-long triple ART before the current pregnancy.

- Triple ART started during current pregnancy: Pregnant women started on triple life-long ART during the current pregnancy.

WHO currently recommends that all HIV+ pregnant women receive ART for their own health and to reduce transmission to their babies. The other regimens are still included in AIM in order to capture past program effects and because not all countries have adopted the new guidelines.

It is usually best to enter numbers of women by regimen for past years and coverage (percentage of HIV + pregnant women receiving PMTCT) for future years. It can be difficult to estimate the numbers for future years especially if the need changes significantly. A future coverage goals can be entered and the program will calculate the number of women needed services to achieve that goal.

#### 6.1.3.2.1.2 Breastfeeding patterns

The editor for breastfeeding patterns is accessed by clicking on the 'Breastfeeding' button.

This editor accepts information on the typical breastfeeding pattern of all women and women enrolled in the PMTCT program. By default they are the same, but the pattern for women enrolled in the program can be changed if information is available.

The data are entered as the percentage of women no longer breastfeeding by the age of the child in two month intervals. These data usually come from a national survey, such as a Demographic and Health Survey. Default data are supplied for most countries based on the latest survey.

Data may be entered for the current year or for all years (chosen by selecting the appropriate radio button at the top of the screen). If data are entered for the current year only, then those data will be used for all years in the calculations. If program recommendations regarding breastfeeding by HIV+ mothers have changed over time then these changing patterns can be entered by selected the 'Data for all years' option.

#### 6.1.3.2.1.3 Abortion

A third editor in this section allows the specification of the percent or number of pregnancies among HIV+ women that are terminated by abortion. Most countries do not include abortion as an option in their PMTCT programs. In those cases this editor can be ignored.

#### 6.1.3.2.1.4 Transmission probability

The probability of transmission of HIV from mother to child depends on the stage of infection of the mother, the duration of breastfeeding and the prophylactic regimen. The table below summarizes the default probabilities currently used in AIM. These are based on expert review of available studies. It is not recommended to change these rates.

**Table . Probability of Mother-to-Child Transmission**

Regimen	Perinatal Transmission	Postnatal Transmission through Breastfeeding (per month)	
		CD4<350	CD4≥350
No prophylaxis			
Existing infection			
CD4 < 200	37%	1.57%	
CD4 200-350	27%	1.57%	
CD4 > 350	15%		0.51%
Incidence infection	30%		28%
Single dose nevirapine	12%	1.57%	0.51%
WHO 2006 dual ARV regimen	4%	1.57%	0.51%
Option A	2%		0.2%
Option B	2%		0.2%
ART			
Started before pregnancy	0.5%	0.16%	0.16%
Started during pregnancy	2%	0.20%	0.20%

Source: Rollins N, Mahy M, Becquet R, Kuhn L, Creek T, Mofenson L. Estimates of peripartum and postnatal mother-to-child transmission probabilities of HIV for use in Spectrum and other population-based models *Sex Transm Infect* 2012;**88**:i44–i51. doi:10.1136/sextrans-2012-050709

#### 6.1.3.2.2 Adult ART

There are three options for specifying coverage of ART for adults. The options are specified using the radio button at the top of the editor.

1. **Number or percent.** With this option you enter the number of men and women receiving ART in each year. Alternatively you can enter the percentage of those eligible who receive ART. (Note that eligibility is defined in the next section.) The best approach is usually to enter the number on ART for past years and use a coverage rate (percentage) for the future. The numbers entered here should refer to the number of adults currently using ART on December 31 of each year. This is not the same as the number newly initiating ART. These figures are routinely reported by national programs to WHO are published in annual treatment progress reports.
2. **CD4 by percent.** As a second option you can specify the coverage of ART by CD4 cell count category. If you select this option then for each year you enter ART coverage for each CD4 count category. Typically you might have high coverage at low CD4 counts and lower coverage at higher counts. You can also specify coverage for population groups that are considered eligible for treatment regardless of CD4 count.
3. **CD4 by number.** This is the same as 'CD4 by percent' except that the number of people on ART is entered for each category instead of the coverage.

#### 6.1.3.2.3 Child treatment

Treatment for children includes both ART and co-trimoxazole. As with the other editors you can enter either numbers of children receiving treatment or coverage (percentage of those eligible) as of December 31 of each year.

### 6.1.3.3 Eligibility for treatment

#### 6.1.3.3.1 Adults

There are two components to defining eligibility for adults: CD4 count and special populations.

1. **CD4 count.** For each year in the analysis you can specify the CD4 count threshold for treatment. That is the CD4 count below which all HIV+ adults are eligible for treatment. According to WHO guidelines this was 200 cells/ $\mu$ l until 2010 then changed to 350 cells/ $\mu$ l and changed again in 2013 to 500 cells/ $\mu$ l<sup>1</sup>. Criteria for national programs may differ. When a new projection is created it will have the WHO criteria listed as a default. Those criteria can be changed to match national guidelines.
2. **Populations eligible for treatment regardless of CD4 count.** Some populations are considered eligible for treatment regardless of CD4 count. In the 2013 WHO guidelines those population include HIV+ pregnant women, those co-infected with HIV and TB or severe HBV disease, and discordant couples. Some programs may also include other populations, such as sex workers, men who have sex with men, and people who inject drugs. Any populations eligible regardless of CD4 count are indicated by checking the box in the 'Eligible' column. You should also specify the year that this population became eligible and the percentage of the adult HIV+ population that is in the special population. The model will calculate this value for pregnant women. For other populations there will be default values presented, which you can accept or change if you have better information. If you include the 'Other' population group then you must specify the percentage of HIV+ adults in this group.

<sup>1</sup> WHO. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Guidelines for a Public Health Approach, Geneva: WHO, June 2013.

#### 6.1.3.3.2 Children

For children there are three components to defining eligibility: age, CD4 count and CD4 percent.

1. **Age.** In many programs all HIV+ children below a certain age are considered eligible for ART. In 2007 WHO recommended that all HIV+ children below the age of 12 months be eligible for treatment. That guideline was raised to 24 months in 2010 and 60 months in 2013.
2. **CD4 count.** Eligibility for children may also depend on CD4 count. If the child is already eligible because of age then the CD4 level does not matter. If the child is above the age of eligibility then eligibility may be determined by CD4 count. In past guidelines the CD4 level for eligibility has varied by age.
3. **CD4 percent.** For very young children eligibility is often based on CD4 percent rather than CD4 count. Eligibility thresholds by CD4 percent can be entered here.

Note that a child is considered eligible for ART if it meets any of the three criteria: age, CD4 count or CD4 percent. Table 2 shows the eligibility criteria recommended by WHO over time.

**Table 2. Criteria for eligibility for ART among children over time**

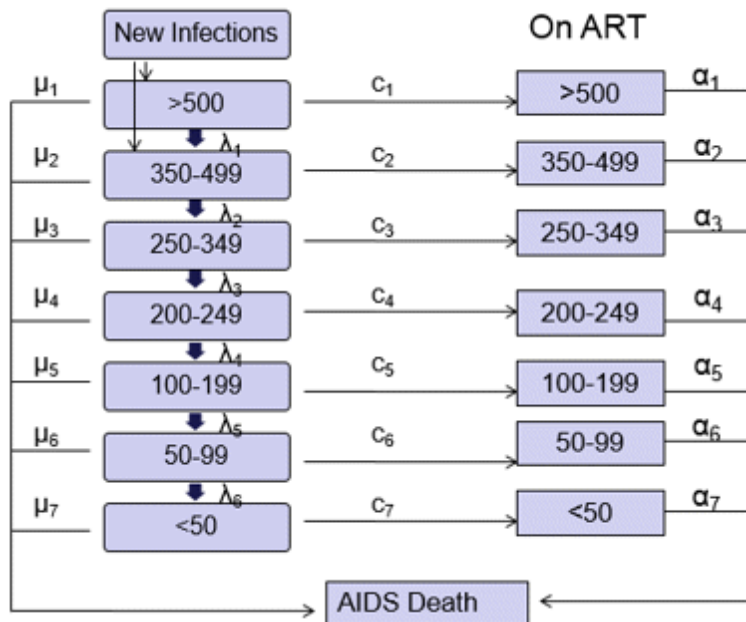
	2000- 2006	2007- 2009	2010- 2012	2013
Age below which all HIV+ children receive treatment (months)	0	12	24	60
<b>CD4 count threshold for eligibility</b>				
Age < 11 months	1,500	NA	NA	NA
Age 12-35 months	750	750	750	NA
Age 35-59 months	350	350	750	NA
Age ≥ 5 years	200	200	350	500
<b>CD4 percent threshold for eligibility</b>				
Age < 11 months	25	NA	NA	NA
Age 12-35 months	25	25	25	NA
Age 35-59 months	25	25	25	NA
Age ≥ 5 years	15	15	15	15

#### 6.1.3.4 Advanced options

##### 6.1.3.4.1 HIV progression and mortality without ART

New adult infections are tracked over time by their CD4 count, mortality and ART status as shown in Figure 3 below.

**Figure . Model of Adult HIV Progression**



The transition rates are specified by the variables  $\mu$ ,  $\lambda$ ,  $c$ , and  $\alpha$ . They are defined as:

- $\mu$ , the annual mortality rate due to HIV

- $\lambda$ , the annual rate of progression to the next lower CD4 count category
- $c$ , the rate of initiating ART
- $a$ , the annual mortality rate while on ART

To estimate the values for these parameters we relied on five major data sources.

1. **ALPHA network data on survival.** The ALPHA network is a collaboration of various cohort sites in sub-Saharan Africa (<http://www.lshtm.ac.uk/eph/dph/research/alpha/>). These sites follow community members over time to collect demographic and health information. ALPHA network researchers pooled their individual site data and analyzed them to determine the survival pattern of people infected with HIV who did not receive ART.<sup>1,2</sup> Those analyses showed a median survival time of about 11 years, with longer survival at younger ages than at older ages.
2. **CASCADE distribution by CD4 count.** CASCADE is a collaboration of 25 cohorts in Europe, Australia, Canada and sub-Saharan Africa. Researchers from the CASCADE group analyzed the data to determine the distribution of CD4 counts immediately after infection and changes in the distribution over time.<sup>3</sup>
3. **Rate of CD4 decline.** A number of studies have reported on the rate of decline of CD4 counts over time among HIV+ adults.<sup>4,5,6,7</sup> These studies have found annual rates of decline between 50 and 100 cells/ $\mu$ l per year.
4. **IeDEA patterns of mortality on ART.** The IeDEA Consortium collects data on ART cohorts from all regions of the world. They have analyzed these data to determine the annual mortality of those on ART by their CD4 count at initiation, sex, age, region and time on ART.<sup>8</sup>
5. **Kenya AIDS Indicator Survey:** The Kenya AIDS Indicator Survey (KAIS) was the first national survey to report the distribution of HIV+ adults by CD4 count.<sup>9</sup> The 2011 Uganda AIDS Indicator Survey has now also reported on the distribution of the population by CD4 count and the 2013 KAIS and South Africa national surveys will report similar information in 2014.

The parameter values for AIM were developed by fitting the progression model shown in Figure 3 to these data. The fit was conducted with the following constraints:

1. The mortality pattern for a cohort of newly infected adults should match the ALPHA network patterns by age.
2. The annual rate of decline in CD4 counts should be a linear function of the CD4 count and should be within the range reported in the literature.
3. HIV-related mortality when not on ART should be an exponential function of CD4 count category.
4. The proportion of new infections starting with CD4 counts below 500 cells/ $\mu$ l should match the CASCADE data.
5. When applied to incidence and ART coverage data from Kenya the resulting distribution of HIV+ adults not on ART by CD4 count should match the pattern reported by the Kenya AIDS Indicator Survey of 2007.



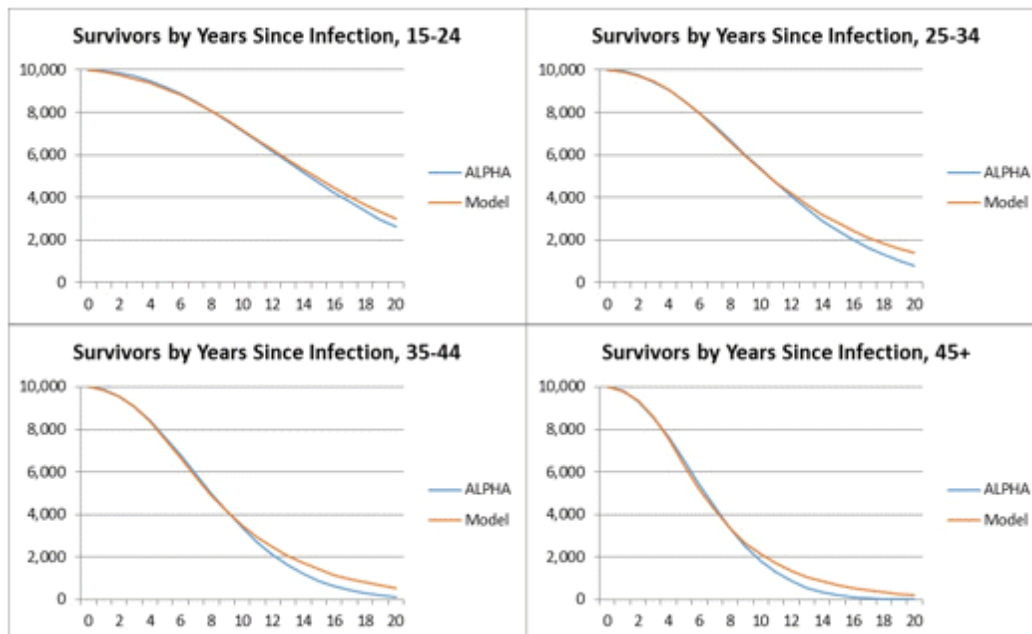
Using these constraints models were fit to data for adults aged 15-24, 25-34, 35-44, and 45+. The resulting model fits to the ALPHA network survival data are shown in Figure 4. The final set of parameter values are shown in Tables 3, 4 and 5.

**Table 3. Average number of years in CD4 count category by age**

CD4 Count	15-24	25-34	35-44	45+
>500	8.53	6.78	5.45	4.70
350-500	4.49	4.17	2.82	1.87
250-349	3.40	2.21	1.72	1.17
200-249	1.97	0.92	0.80	0.55
100-199	4.67	1.57	1.48	1.05
50-99	2.87	0.69	0.69	0.50

Note: These are the default data shown in the editor 'Years in CD count category'.

**Figure 4. Model fits to ALPHA network survival data**



**Table 4. Distribution of new infections by CD4 count category and age**

CD4 Category	15-24	25-34	35-44	45+
>500	64.3	60.7	58.5	55.2
350-500	35.7	39.3	41.5	44.8

Note: These are the default data shown in the editor 'Years in CD4 count category'.

**Table 5. Annual probability of HIV-related mortality when not on ART by age**

CD4 Category	15-24	25-34	35-44	45+
>500	0.005	0.004	0.005	0.005
350-500	0.11	0.10	0.013	0.013
250-349	0.026	0.026	0.036	0.032
200-249	0.061	0.069	0.096	0.080
100-199	0.139	0.185	0.258	0.203
50-99	0.321	0.499	0.691	0.513
<50	0.737	1.342	1.851	1.295

Note: These are the default data shown in the editor 'HIV mortality without ART'. An annual mortality rate greater than one means that survival is less than one year.

<sup>1</sup> Todd J, Glynn J, Marston M, Lutalo T, Biraro S, Mwita W, Suriyanon V, Rangsin R, *et al.* Time from HIV seroconversion to death: a collaborative analysis of eight studies in six low and middle income countries before highly active antiretroviral therapy. *AIDS* 2007, 21(suppl 6):S55-S63.

<sup>2</sup> Marston M, Todd J, Glynn JR, *et al.* Estimating 'net' HIV-related mortality and the importance of background mortality rates. *AIDS* 2007;21(Suppl 6):S65-71.

<sup>3</sup> Lodi S, Phillips A, Touloumi G, Pantazis N, Bucher HC, Babiker A, *et al.* CD4 decline in sseroconverter and seroprevalent individuals in the precombination of antiretroviral therapy era *AIDS* 2010, 24:2697-2704.

<sup>4</sup> Wolbers M, Babiker A, Sabin C, *et al.* Pretreatment CD4 cell slope and progression to AIDS or death in HIV-infected patients initiating antiretroviral therapy—the CASCADE collaboration: a collaboration of 23 cohort studies. *PLoS Med* 2010;7:e1000239.

<sup>5</sup> Mellors JW, Margolick JB, Phair JP, *et al.* Prognostic value of HIV-1 RNA, CD4 cell count, and CD4 Cell count slope for progression to AIDS and death in untreated HIV-1 infection. *JAMA* 2007;297:2349-50.

<sup>6</sup> Rodriguez B, Sethi AK, Cheruvu VK, *et al.* Predictive value of plasma HIV RNA level on rate of CD4 T-cell decline in untreated HIV infection. *JAMA* 2006;296:1498-506.

<sup>7</sup> Williams BG, Korenromp EL, Gouws E, *et al.* HIV infection, antiretroviral therapy, and CD4+ cell count distributions in African populations. *J Infect Dis* 2006;194:1450-8.

<sup>8</sup> Yiannoutsos CT, Johnson LF, Boule A, Musick BS, Gsponer E, Balestre E, *et al.* Estimated mortality of adult HIV-infected patients starting treatment with combination antiretroviral therapy *Sex Transm Infect* 2012;88:i33-i43. doi:10.1136/sextrans-2012-050658.

<sup>9</sup> Ministry of Medical Services and Ministry of Public Health and Sanitation. Kenya AIDS Indicator Survey, KAIS 2007, Final Report. Nairobi, Kenya, September 2009.

#### 6.1.3.4.2 HIV mortality with ART

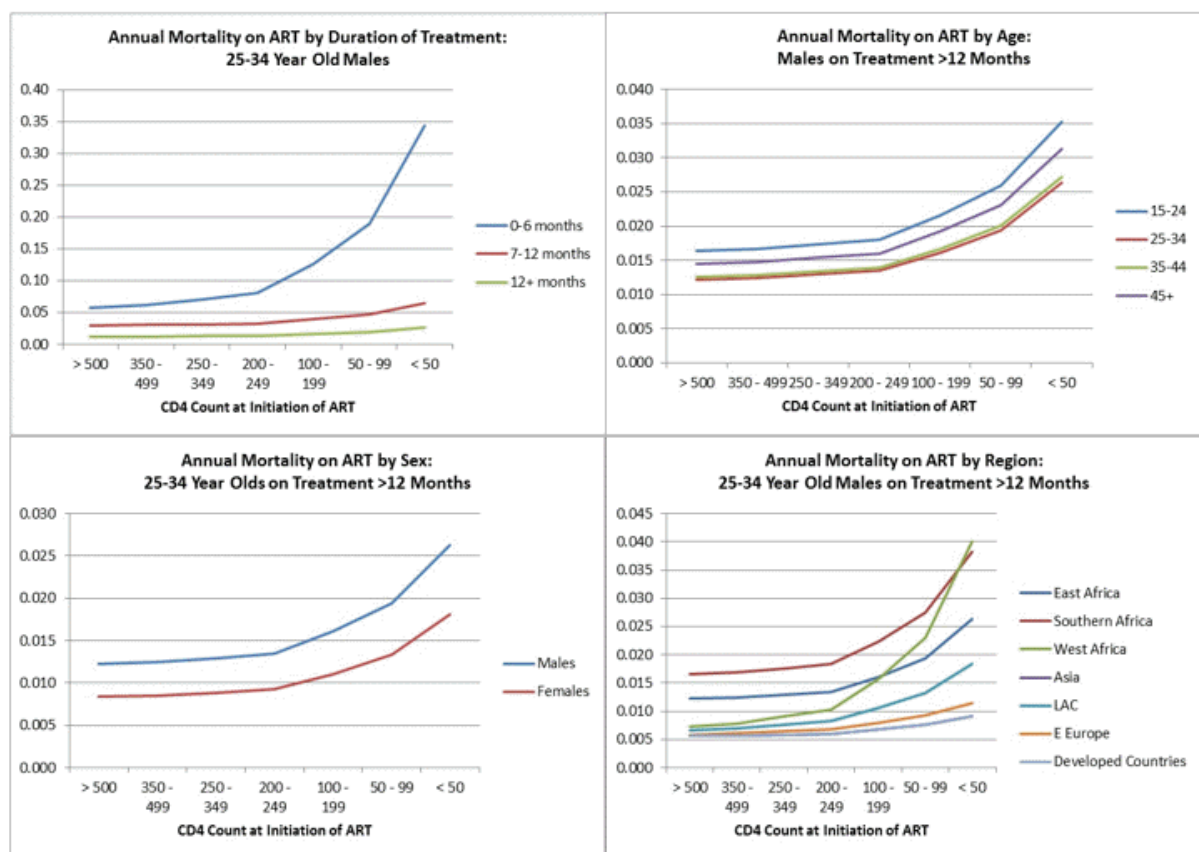
Mortality on ART is based on the analysis by the IeDEA Consortium. These patterns result from an analysis of 123,000 adult ART patients from Eastern, Southern and Western Africa, Asia/Pacific and Latin

America. The analyses include adjustments for patients that were lost to follow-up. The final patterns describe annual mortality on ART by CD4 count at initiation, age group, sex, time on ART and region.

Although the available data include deaths to people who initiated ART at high CD4 counts, most of the data were collected during a period when eligibility for treatment was generally set at CD4 counts less than 200 or 250. Thus, those who started at higher CD4 counts might not be typical of patients who would start at higher CD4 counts now that eligibility criteria have moved to higher CD4 counts. Therefore, we did not use the IeDEA data for CD4 counts above 350 but instead estimated those mortality rates by exponential extrapolation from the lower CD4 counts.

Figure 5 shows the final default patterns used in AIM. They show that mortality is generally higher for those initiating treatment at low CD4 counts compared to higher CD4 counts, for those recently initiating treatment compared to those on treatment for more than one year, for males compared to females, for the youngest and older age groups compared to those aged 25-44, and in southern Africa and West Africa compared to developed countries, Eastern Europe and Latin America.

**Figure 5. Patterns of mortality on ART by age, sex, duration and region**



<sup>1</sup> Yiannoutsos CT, Johnson LF, Boule A, Musick BS, Gsponer E, Balestre E, *et al.* Estimated mortality of adult HIV-infected patients starting treatment with combination antiretroviral therapy Sex Transm Infect 2012;88:i33-i43. doi:10.1136/sextrans-2012-050658.

#### 6.1.3.4.3 Treatment effects for children

AIM considers two types of treatment for children: cotrimoxazole prophylaxis and ART. In settings with high prevalence of HIV and high rates of infectious diseases WHO recommends that cotrimoxazole be provided to all HIV-exposed infants and children starting 4 to 6 weeks after birth and continuing until the

end of exposure to HIV and when it can be definitively determined that the child is not infected. For HIV+ infants and children cotrimoxazole is recommended for all children under the age of five, or those aged 1-4 years with WHO stage 2, 3, or 4, or CD4 percentage below 25. Children over the age of five follow adult guidelines (WHO stage 2, 3 or 4 or CD4 count < 350 cells/ $\mu$ l.)

The effect of cotrimoxazole is to reduce mortality by 33% in each of the first five years of treatment for those children who are not also receiving ART and, for those receiving ART, to reduce mortality by 33% in the first year, 16% in the second year, 8% in the third year, 4% in the fourth year and 2% in the fifth year.

ART can also prolong life for infected children. Current guidelines define eligibility for ART as all children under the age of 5 years with confirmed HIV infection plus all those children over the age of 5 who have CD4 counts less than 500 cells/ $\mu$ l.

In 2008, Dabis and colleagues conducted a literature review on child survival on ART in lower-income countries on behalf of UNICEF. Articles were selected after screening of PubMed/MEDLINE and Scopus up to March 2008 and abstracts of 2007-2008 international conferences. Observational cohorts, clinical trials and programme reports were eligible as long as they took place in lower income countries and included children on ART or on ART and cotrimoxazole. Only studies with death as the outcome were included in this pediatric ART review update. The extracted data included patients demographic characteristics, baseline CD4 count, survival estimates and factors associated with mortality of children receiving cotrimoxazole and/or ART. A total of 14 prospective studies were eligible for the analysis.

The amount of data on the survival of HIV-infected children on ART in lower and middle income countries more than doubled since a previous review that covered a period ending in December 2006. Sample sizes were generally larger, exceeding 400 participants for some of the studies, thereby increasing the accuracy of the findings. Some reports allowed for the production of survival estimates up to 24 months after ART initiation.

The authors concluded that the probability that infants survive the first year of treatment was estimated to be 0.93-0.95 and survival until two years was estimated to be 0.91-0.92. The authors estimated that the provision of cotrimoxazole along with ART additionally reduced mortality by approximately 32% in the first year, 16% in the second year, and 8% in the third year.

After adjusting for the reduced mortality due to the use of cotrimoxazole, the estimated survival among those children who started on ART was 85% in the first year on ART and 93% for subsequent years.

<sup>1</sup> WHO. Antiretroviral Therapy for HIV Infection in Infants and Children: Towards Universal Access. A Public Health Approach. 2010 Revision. Geneva: World Health Organization, 2010.

<sup>2</sup> WHO. Guidelines on Co-trimoxazole Prophylaxis for HIV-Related Infections among Children, Adolescents and Adults: Recommendations for a public health approach. Geneva: WHO, 2006.

<sup>3</sup> UNAIDS. Consultative Meeting on Data Collection and Estimation Methods Related to HIV Infection in Infants and Children. UNAIDS, UNICEF, WHO, 8-10 July, 2008, New York.

<sup>4</sup> WHO. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Guidelines for a Public Health Approach, Geneva: WHO, June 2013.

<sup>5</sup> UNAIDS, World Health Organization, UNICEF. Consultative meeting on Data Collection and Estimation Methods Related to HIV Infection in Infants and Children. New York: UNICEF, 2008. <http://>

[www.epidem.org/Publications/UNAIDS\\_UNICEF\\_Paediatic%20HIV%20Report\\_9%20Dec%202008\\_Final.pdf](http://www.epidem.org/Publications/UNAIDS_UNICEF_Paediatic%20HIV%20Report_9%20Dec%202008_Final.pdf). Accessed on: 18 March 2010

<sup>6</sup> Coffie P, Moh R, Ekouevi DK, et al. Survival of HIV-infected adults and children on antiretroviral therapy in low and middle-income countries. Bordeaux: Institut de Santé Publique, Épidémiologie et Développement (ISPED) Université Victor Segalen 2007.

#### 6.1.3.4.4 Progression from HIV infection to AIDS death in children

Progression from new HIV infection to AIDS death in children who do not receive cotrimoxazole or ART depends on the timing of infection. Children infected at birth progress to death much faster than those infected later through breastfeeding.

Previous versions of Spectrum used two survival curves for "AIDS only" mortality of children, based on data from 12 sub-Saharan African clinical trials and studies: the first to represent children infected at birth, the second to represent those infected through breast feeding. Further analysis of these data gave strong evidence that survival of children infected through breast feeding improved the later they were infected. Marston and Becquet fit double Weibull curves to the data allowing for time of infection to give a pattern of survival post infection for four groups: those infected at birth, at 28–179 days, 180–364 days and after 365. Similar curves representing the survival of HIV negative children from the equivalent time points were used to remove non-AIDS mortality. There is limited information about the survival of HIV infected children beyond 2.5 years, so as with the previous estimates it was assumed that beyond this point the survival for children would be equivalent to that of young adults infected at ages 15–24, with a median survival of 15 years. Survival is described as a double Weibull curve of the form:

$$S_t = (\pi \times e^X + (1 - \pi) \times e^Y) \times 100$$

where

$$X = -1 \times (\lambda_1 \times t)^{\mu_1} \text{ and } Y = -1 \times (\lambda_2 \times t)^{\mu_2}$$

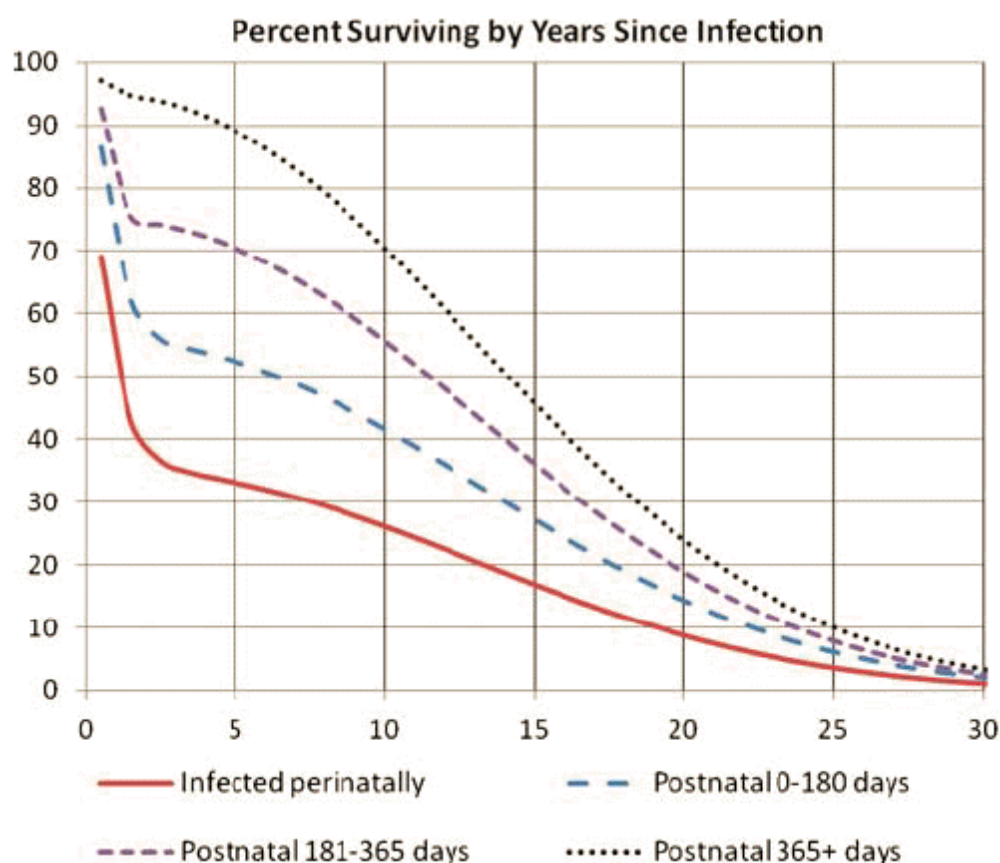
The parameter values are shown in table 6.

**Table 6. Parameter values for child survival patterns**

Parameter	Time of Infection			
	Perinatal	Postnatal 0-180 days	Postnatal 181-365 days	Postnatal 365+ days
$\pi$	0.646	0.440	0.248	0.048
$\lambda_1$	1.336	1.015	1.241	1.873
$\mu_1$	1.062	1.484	2.110	1.708
$\lambda_2$	0.058	0.058	0.058	0.058
$\mu_2$	2.195	2.200	2.200	2.200

The resulting curves give a median AIDS only survival of 1.1, 6.4, 11.5 and 14.1 years resulting in 9% survival at 20 years for those infected at birth and 14%, 19% and 24% for those infected through breast feeding at 28–179 days, 180–364 days and after 365 days (figure 6).

**Figure 6. Percent of HIV+ children surviving by number of years since infection**



<sup>1</sup> Martson M, Becquet R, Zaba B, et al. Net survival of perinatally and postnatally HIV-infected children: a pooled analysis of individual data from sub-Saharan Africa. *Int J Epidemiol* 2010;40:385–96.

<sup>2</sup> Stover J, Brown T, Marston M. Updates to the Spectrum/Estimates and Projection Package (EPP) model to estimate HIV trends for adults and children *Sex Transm Infect* 2012;88:i11–i16. doi:10.1136/sextrans-2012-050640

<sup>3</sup> Marston M, Todd J, Glynn JR, et al. Estimating 'net' HIV-related mortality and the importance of background mortality rates. *AIDS* 2007;21(Suppl 6):S65–71.

#### 6.1.3.4.5 TFR reduction

A number of studies in sub-Saharan Africa have examined the fertility of HIV-infected women compared to women who are not infected. These studies generally show that fertility is lower in HIV-positive women than in HIV-negative women between the ages of 20–45. It is generally higher for HIV-positive women aged 15–19 because they are all sexually active whereas many HIV-negative women in this age group are not sexually active. An analysis of data from national surveys calculated this information for 20 countries and found that the average ratio of fertility among HIV+ to HIV- women drops from 0.765 among women 20–24 to just 0.47 among women 45–49 (table 7). For women 15–19 the ratio depends on the proportion that is sexually active.

**Table 7. Ratio of Fertility among HIV-Infected Women to HIV-Uninfected Women Based on Analysis of DHS Data from 20 Countries in Sub-Saharan Africa**

Age of Woman	Ratio
15-19	2.528 – 0.031 x % sexually active
20-24	0.765
25-29	0.706
30-34	0.647
35-39	0.588
40-44	0.529
45-49	0.470

1 Lewis J, Ronsmans C, Ezeh A, and Gregson S. The Population Impact of HIV on Fertility in sub-Saharan Africa *AIDS* 2004; 18 (suppl. 2): S35-S43.

2 Chen WJ, Walker N. Fertility of HIV-infected women: insights from Demographic and Health Surveys *Sex Transm Infect* 2010;86(Suppl 2):ii22-ii27. doi:10.1136/sti.2010.043620

#### 6.1.3.5 Adult HIV incidence

Most applications of AIM use an incidence trend generated using EPP as described in the [Calculating incidence](#) section of the program tutorial. With this approach the incidence trend estimated by EPP is automatically transferred to AIM. The trend can be viewed by opening the Direct Incidence Input editor (Modules -> AIM -> Incidence -> Direct incidence input). The 'Prevalence' tab in this editor shows the prevalence trend estimated by EPP.

The model used in EPP to estimate incidence from prevalence is simpler than the model used by AIM in that it is a single sex model that uses only a single age group, 15-49. As a result using the incidence from EPP in AIM will not exactly reproduce the prevalence trend fitted by EPP. AIM adjusts for these differences by making small changes in incidence each year in order to match the EPP prevalence trend. These adjustments can be turned off by unchecking the 'EPP prevalence adjustment' box in the 'Direct incidence input editor'. Normally this adjustment should be on. However, it should be turned off for any analysis examining historical effects. For example, you can estimate the number of deaths averted by ART by creating two projections, one with actual ART numbers and one with no ART in any year. However, this comparison will only work correctly if the 'EPP prevalence adjustment' is turned off, since otherwise AIM will ensure the same prevalence in both projections.

The EPP prevalence adjustment is normally small but could be large in a year in which ART coverage changed substantially. In order to avoid discontinuities in the adjusted incidence curve the adjustment is limited to a 20% increase (ratio of 1.2). This restriction can be changed in this editor to see the effects of different restrictions.

#### 6.1.3.6 Age and sex distribution of infections

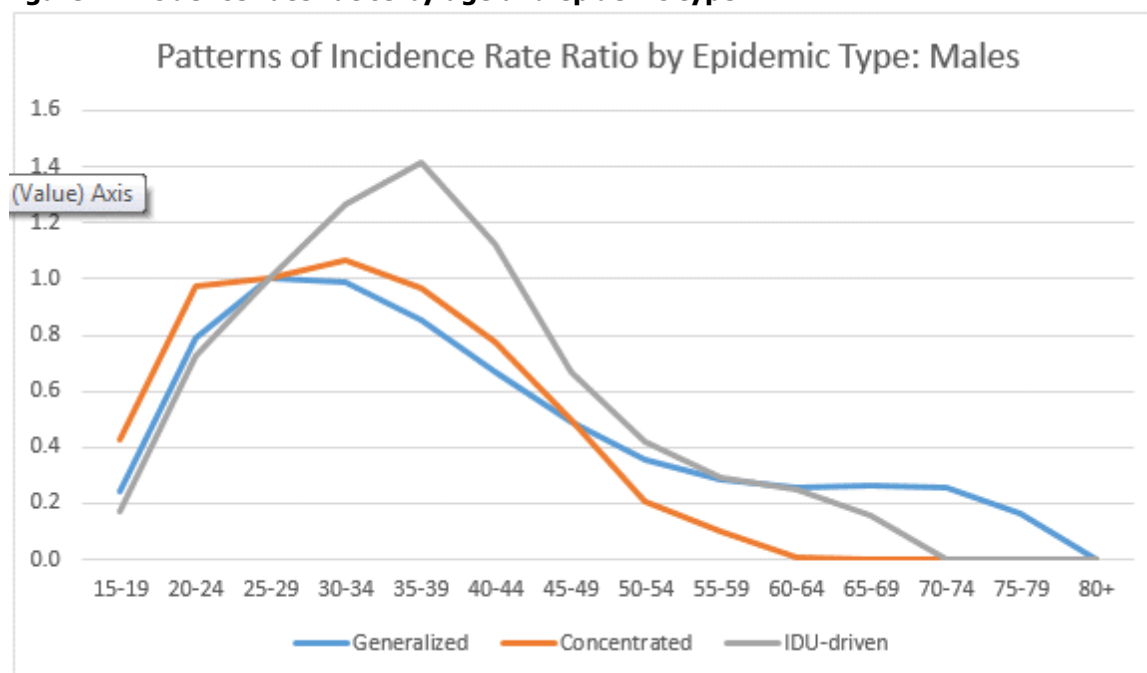
Adult HIV incidence trends estimated by EPP refer to new infections among adults aged 15 and up. For use in Spectrum these infections need to be distributed by age and sex. In recent years a number of national surveys have provided information on HIV prevalence by age for women aged 15-49 and men aged 15-59. Incidence by age can be estimated from two prevalence surveys spaced some years apart.

The same approach can be used to estimate incidence by age from a single survey if prevalence is assumed to be stable over time. We applied this method to data from 32 surveys to estimate incidence by age and sex. We then transformed this information into the distribution of new infections by age. These calculations were done separately for countries with relatively large samples of HIV-infected people (those with HIV prevalence above 4%) and those with lower levels of prevalence. The curves for the 14 surveys from high prevalence countries were averaged to produce standard patterns. The curves for the 17 surveys from lower prevalence countries were smoothed to reduce fluctuations due to small numbers of HIV-infected people and then averaged to produce standard patterns for these countries. For countries with epidemics driven by transmission through needle sharing for drug injection the patterns were developed using data on new case reports provided by WHO.

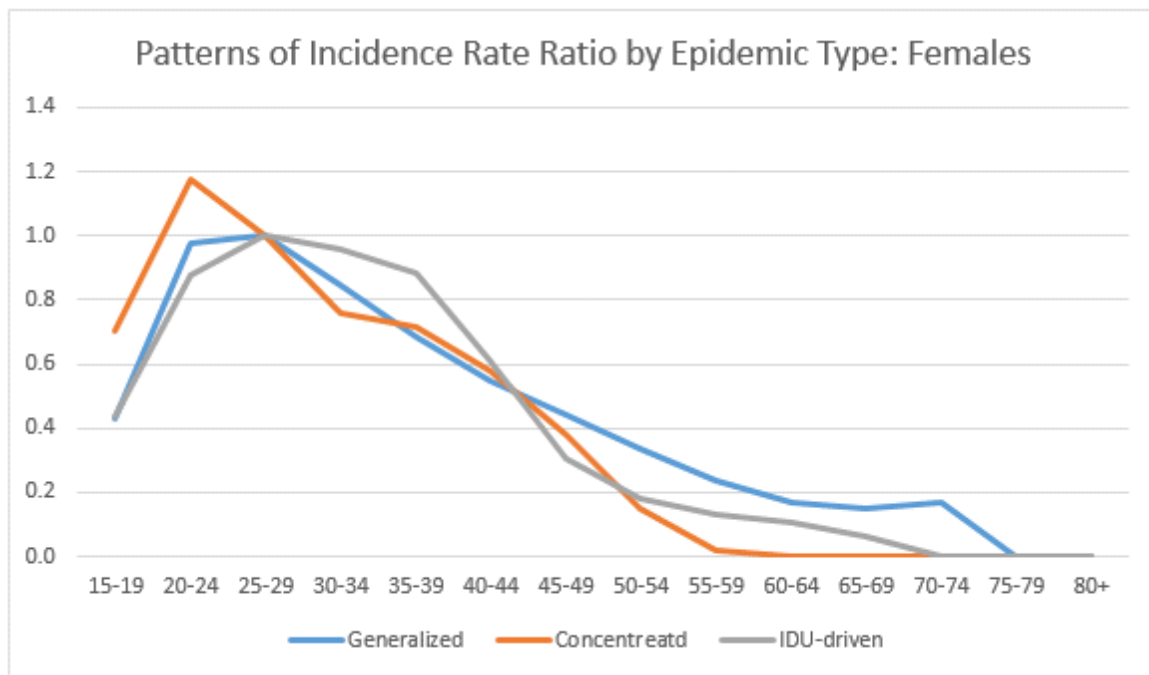
While the distribution of new infections by age is a useful way to describe historical patterns using these distributions in AIM could produce future situations where the number of new infections exceeds the number of susceptible people in some age groups. To avoid the problem AIM uses the incidence rate ratio. This is the ratio of incidence at any age to incidence at the reference age group, 25-29. In this definition 'incidence' refers to the percentage of the uninfected population that becomes infected during the year.

The ALPHA network (<http://www.lshtm.ac.uk/eph/dph/research/alpha/>) conducted a special analysis for the UNAIDS Reference Group on Estimates, Modeling and Projections to determine the incidence rate ratios by age using pooled data from their cohort sites. The ALPHA patterns match well to the pattern for high prevalence countries estimated from national surveys, as described above, for ages 15-49. Since national surveys do not routinely collect data on people older than 49 (or have small sample sizes) the ALPHA patterns provide a better pattern. Therefore, the final patterns used in AIM are derived from the ALPHA network for generalized epidemics, from the survey analysis described above for concentrated epidemics and from the ECDC data for IDU-driven epidemics. These patterns are shown in figure 7. They are assumed to remain constant over time.

**Figure 7. Incidence rate ratios by age and epidemic type**

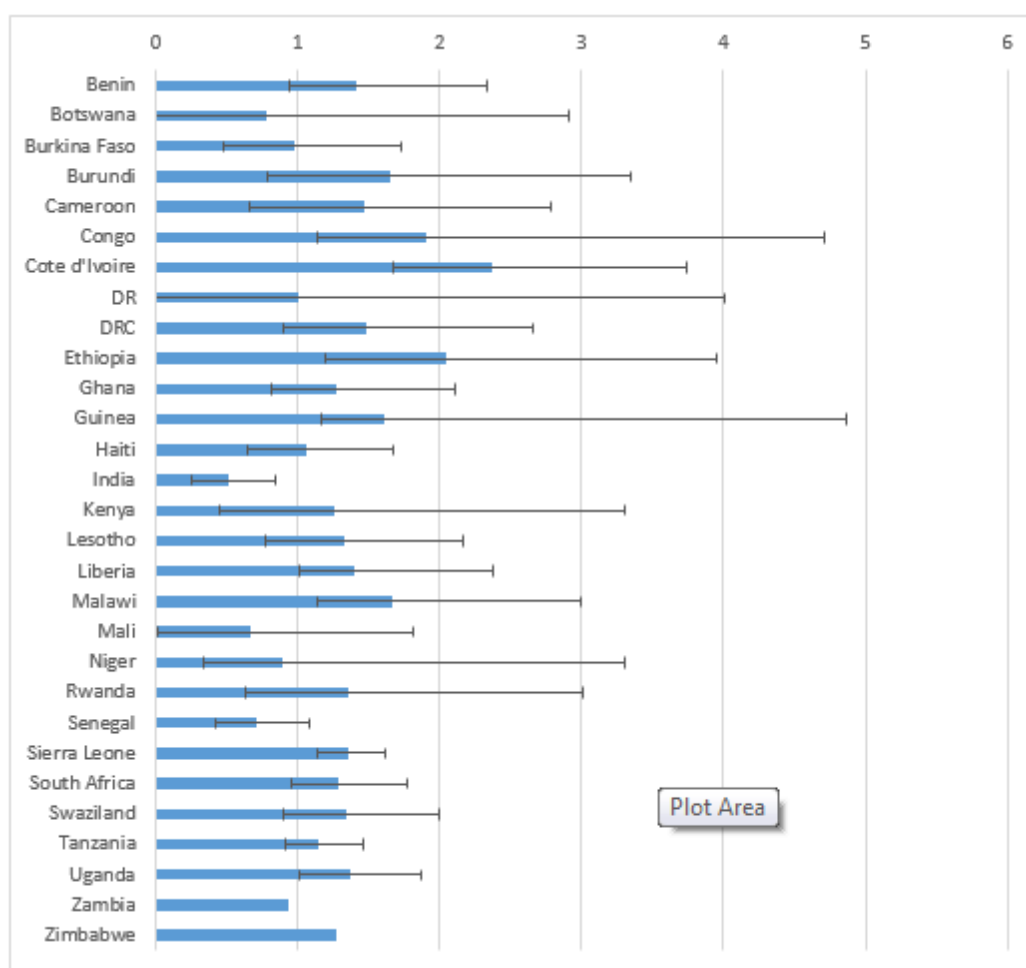






Adult HIV incidence is disaggregated into female and male incidence by specifying the ratio of new female infections to new male infections. We assume that the ratio is much less than one at the beginning of the epidemic but increases to greater than one for generalized epidemics about 10 years into the epidemic. The population-based surveys show a wide variation in the sex ratio of incidence prevalence from just about 0.5 in Niger to 2.4 in the Côte d'Ivoire. These data are shown in Figure 6. Based on these data we assume a ratio of 1.38 for generalized epidemics, 0.84 in most low-level and concentrated epidemics and 0.42 in IDU-driven epidemics (based on the ECDC data).

**Figure 8. Ratio of new infections among adult females to new infections among adult males**



<sup>1</sup> Hallett TB, Zaba B, Todd J, Lopman B, Wambura M et al. (2008) Estimating incidence from prevalence in generalized epidemics: Method and validation. *PLoS Med* 5(4): e80. Doi:10.1371/journal.pmed.0050080.

<sup>2</sup> European Centre for Disease Prevention and Control/WHO Regional Office for Europe: HIV/AIDS surveillance in Europe 2007. Stockholm, European Centre for Disease Prevention and Control, 2008.

<sup>3</sup> Zaba B. Age-specific pattern of incidence: ALPHA sites, 1995-2010, presentation to the UNAIDS Reference Group on Estimates, Modeling and Projections, Geneva, December 5, 2012.

<sup>4</sup> European Centre for Disease Prevention and Control/WHO Regional Office for Europe: HIV/AIDS surveillance in Europe 2007. Stockholm, European Centre for Disease Prevention and Control, 2008.

### 6.1.3.7 Orphans

AIM will estimate the number of AIDS and non-AIDS orphans caused by adult deaths. An orphan is defined as a child under the age of 18 who has lost at least one parent. These estimates are based on the fertility over time and the age at death of the parent. AIM will estimate maternal orphans (children whose mother has died), paternal orphans (children whose father has died), and dual orphans (children whose father and mother have both died). AIDS orphans are children who have lost at least one parent to AIDS. To estimate double AIDS orphans, AIM needs to estimate the proportion of couples with both parents infected with HIV. In sub-Saharan Africa, this estimation is based on a regression equation using

data from national population surveys. These calculations are based on methods developed by Ian Timaeus and Nicolas Grassly.<sup>1</sup>

Outside sub-Saharan Africa the estimation of orphanhood needs to be adapted for the fact that many of the AIDS deaths will occur to high risk groups, such as men who have sex with men, injecting drug users and sex workers, who may have fertility that is very different from the general population. The number of orphans is adjusted for the lower fertility of these groups. Since information on the fertility of these high risk groups is not readily available the proportion married may be used as a proxy.

<sup>1</sup> Grassly NC, Timaeus IM. "Methods to Estimate the Number of Orphans as a Result of AIDS and Other Causes in sub-Saharan Africa." *Journal of Acquired Immune Deficiency Syndromes* 2005 July 1; 39 (3) 365-375.

<sup>2</sup> Stover J, Johnson P, Hallett T, Martston M, Becquet R, Timaeus IM. The Spectrum projection package: improvements in estimating incidence by age and sex, mother-to-child transmission, HIV progression in children and double orphans *Sex Transm Infect* 2010;86(Suppl 2):ii16eii21. doi:10.1136/sti.2010.044222

#### 6.1.4 AIM results

AIM outputs can be displayed by accessing the 'Results' menu (Modules -> AIM -> Results). The indicators are grouped by age group and by types. A complete list of indicators available and their definitions is given below.

#### Displaying All Age Groups in AIM

Displays under 'Total population' show indicators by age group. These include the HIV+ population, new infections, AIDS deaths and need for ART.

You can display the information as a table, 'Summary table', or as a population pyramid showing either numbers of people ('Pyramid (numbers)') or the percent distribution by age and sex ('Pyramid (percent)').

The pyramid display always shows two pyramids. If you are using a single projection, then the pyramids on both the left and the right will be for the base year. You can change the year for the pyramid on the right by clicking one of the buttons at the bottom of the screen to advance the pyramid one year ('Next'), show the previous year ('Previous'), show the first year ('First year'), or show the last year ('Last year').

If you have two projections loaded, then the pyramid on the left will display the first projection and the one on the right will show the second projection. Both pyramids will display the same year.

If you have more than two projections loaded, you will be asked to choose which two pyramids should be shown before the pyramids appear.

##### 6.1.4.1 Total population

- **HIV population:** The total number of people who are alive and infected with HIV.
- **HIV age distribution:** The number of infected people, by age and sex. This information can be displayed as a table or a pyramid chart.
- **Number of new HIV infections:** The total number of new HIV infections each year.

- **New infections by age:** The number of new infections by age and sex and incidence by age and sex.
- **Need for ART by age.** The number of people needing ART by age and sex each year. Need is defined as all those currently receiving ART plus those who are eligible but not yet on ART.
- **AIDS deaths:** The annual number of deaths due to AIDS.
- **Cumulative AIDS deaths:** The cumulative number of AIDS deaths since the beginning of the projection.
- **AIDS deaths by age:** The number of AIDS deaths each year by age and sex.
- **Age-specific AIDS mortality (Mx).** The annual rates of age-specific mortality due to HIV/AIDS.
- **HIV/AIDS summary:** A table the total HIV population, prevalence, new infections and AIDS deaths.

#### 6.1.4.2 Adults (15-49)

- **HIV population:** The total number of adults between the ages of 15 and 49 who are alive and infected with HIV.
- **HIV population by risk group.** The number of HIV+ adults 15-49 by risk group. The risk groups are as defined in EPP. The number of HIV+ adults 15-49 is apportioned to the risk groups on the basis of the populations in EPP.
- **Adult HIV prevalence:** The percentage of adults (population aged 15 to 49) who are infected with HIV.
- **Number of new HIV infections:** The total number of new adult HIV infections each year.
- **Adult HIV incidence:** The percentage of uninfected adults who become infected in each year.
- **Annual AIDS deaths:** The annual number of adult deaths due to AIDS. Note that 'AIDS deaths' refer to any HIV-related death, whether or not the person would have met the clinical definition of AIDS at the time of death.
- **Annual AIDS deaths among those on ART.** The annual number of deaths to adults 15-49 who are receiving ART.
- **Annual AIDS deaths among those not on ART.** The annual number of deaths to adults 15-49 who are not on ART.
- **Annual AIDS deaths among pregnant women.** The annual number of AIDS deaths among HIV+ pregnant women.
- **Distribution by CD4 count - HIV+ not on ART (15-49).** The number of HIV+ adults 15-49 who are not on ART by their current CD4 count.
- **Distribution by CD4 count - HIV+ on ART (15-49).** The number of HIV+ adults 15-49 on ART by their CD4 count at the time of initiating treatment.
- **Adults 15-49 summary:** A table showing indicators just for adults 15-49.

#### 6.1.4.3 Adults (15+)

- **HIV population:** The total number of adults ages 15 and greater who are alive and infected with HIV.
- **Adult HIV prevalence:** The percentage of adults aged 15+ who are infected with HIV.
- **Number of new HIV infections:** The total number of new adult HIV infections each year.
- **Adult HIV incidence:** The percentage of uninfected adults who become infected in each year.
- **Annual AIDS deaths:** The annual number of adult deaths due to AIDS. Note that 'AIDS deaths' refer to any HIV-related death, whether or not the person would have met the clinical definition of AIDS at the time of death.
- **AIDS 45q15.** The proportion of HIV+ that will die from HIV-related causes between age 15 and 60 at the mortality rates prevailing in that year.
- **Annual AIDS deaths among those on ART.** The annual number of deaths to adults 15+ who are receiving ART.
- **Annual AIDS deaths among those not on ART.** The annual number of deaths to adults 15+ who are not on ART.
- **Number of non-AIDS related IDU deaths.** The number of deaths to HIV+ people who inject drugs that are not due to HIV.
- **Distribution by CD4 count – HIV+ not on ART (15+).** The number of HIV+ adults 15+ who are not on ART by their current CD4 count.
- **Distribution by CD4 count – HIV+ on ART (15+).** The number of HIV+ adults 15+ on ART by their CD4 count at the time of initiating treatment.
- **Adults 15+ summary:** A table showing indicators just for adults 15+.

#### 6.1.4.4 Young people (15-24)

- **HIV population:** The total number of adults between the ages of 15 and 24 who are alive and infected with HIV.
- **Adult HIV prevalence:** The percentage of adults (population aged 15 to 24) who are infected with HIV.
- **Number of new HIV infections:** The total number of new adult HIV infections each year.
- **Adult HIV incidence:** The percentage of uninfected adults who become infected in each year.
- **HIV+ pregnant women.** The number of pregnant women aged 15-24 who are HIV+.
- **Annual AIDS deaths:** The annual number of adult deaths due to AIDS. Note that 'AIDS deaths' refer to any HIV-related death, whether or not the person would have met the clinical definition of AIDS at the time of death.
- **Annual AIDS deaths among those on ART.** The annual number of deaths to adults 15-24 who are

receiving ART.

- **Annual AIDS deaths among those not on ART.** The annual number of deaths to adults 15-24 who are not on ART.
- **Adults 15-24 summary:** A table showing indicators just for adults 15-24.

#### 6.1.4.5 Children 0-14

- **HIV population:** The total number of children (0-14) who are alive and infected with HIV.
- **Number of new HIV infections:** The total number of new child HIV infections each year.
- **Annual AIDS deaths:** The annual number of child deaths due to AIDS.
- **Population 0-14:** The number of children between the ages of 0 and 14 years old.
- **Number of HIV+ children not on ART by time of infection:** The number of children aged 0-14 who are not on ART by the timing of their infection: perinatal, 0-6 months after birth, 7-12 months after birth, more than 12 months after birth.
- **Child summary:** A table showing indicators just for children under the age of 15.

#### 6.1.4.6 Children under 1

- **HIV population:** The total number of children under the age of one who are alive and infected with HIV.
- **Number of new infant HIV infections:** The total number of new infant HIV infections each year.
- **Infant AIDS deaths:** The annual number of infant deaths due to AIDS.
- **Summary table for children under 1:** A table showing indicators just for children under the age of one.

#### 6.1.4.7 Children 1-4

- **HIV population:** The total number of children 1-4 who are alive and infected with HIV.
- **Number of new child HIV infections:** The total number of new HIV infections each year among children 1-4.
- **Children AIDS deaths:** The annual number of deaths due to AIDS among children 1-4.
- **Summary table for children 1-4:** A table showing indicators just for children under aged 1-4.

#### 6.1.4.8 Children under 2

- **HIV+ children under 2.** The number of HIV+ children under the age of 2.

#### 6.1.4.9 PMTCT

- **Mothers needing PMTCT:** The number of HIV-positive women giving birth each year and, therefore, in need of prophylaxis to prevent HIV transmission to the baby.
- **Mothers receiving PMTCT:** The number of HIV-positive women giving birth and receiving prophylaxis

to prevent transmitting HIV to the baby.

- **PMTCT coverage.** The percentage of women needing PMTCT who are receiving it in that year.
- **MTCT rate at 6 weeks.** The percentage of babies born to HIV+ mothers who are infected by 6 weeks of age.
- **Final transmission rate including breastfeeding period.** The percentage of children born to HIV+ mothers who will eventually be infected from their mothers at current transmission rates. This includes perinatal transmission and up to 36 months of breastfeeding.
- **Number of new child infections due to mother-to-child transmission.** The number of children who become infected due to transmission from their mothers.
- **HIV+ pregnant women with CD4 counts < 350.** The number of HIV+ pregnant women who have CD4 counts less than 350 cells/ $\mu$ l.
- **Treatment coverage for HIV+ pregnant women.** The percentage of HIV+ pregnant women receiving ART to treat their infection.
- **PMTCT summary.** A table with all PMTCT indicators.

#### 6.1.4.10 ART - Dec 31

- **Total need for ART (15+) - (Dec 31):** Number of adults aged 15 and older who are eligible for ART, including those already on ART on December 31.
- **Total number receiving ART (15+) - (Dec 31):** Number of adults aged 15 and older who are receiving ART on December 31.
- **ART coverage of eligible population (15+) - (Dec 31):** The percentage of HIV+ adults 15 and older who are eligible for ART who are receiving ART on December 31.
- **ART coverage of all HIV+ adults (15+) - (Dec 31):** The percentage of all HIV+ adults 15 and older who are receiving ART on December 31.
- **Children needing cotrimoxazole (0-14) - (Dec 31):** The number of children eligible for cotrimoxazole on December 31.
- **Children receiving cotrimoxazole (0-14) - (Dec 31):** The number of children receiving cotrimoxazole on December 31.
- **Total coverage for cotrimoxazole(0-14) - (Dec 31):** The number of children eligible for cotrimoxazole who are receiving it on December 31.
- **Children needing ART (0-14) - (Dec 31):** The number of children eligible for ART, including those already receiving ART. on December 31.
- **Children receiving ART (0-14) - (Dec 31):** The number of children receiving ART on December 31.
- **ART coverage of eligible population (0-14) - (Dec 31):** The percentage of children eligible for ART who are receiving it on December 31.
- **ART coverage of all HIV+ children (0-14) - (Dec 31):** The percentage of all HIV+ children who

are receiving ART on December 31.

- **ART - Dec 31 summary (all ages):** Summary table showing all ART indicators for December 31.

#### 6.1.4.11 ART - mid-year

- **Total need for ART (15+) - (mid-year):** The total number of people needing ARV therapy. This includes all those currently receiving ART plus those who are eligible but not receiving treatment.
- **Total number receiving ART (15+) - (mid-year):** The number of people receiving ARV therapy.
- **Total ART coverage (15+) - (mid-year):** ART coverage is the number of people currently receiving ART divided by those in need (those on ART plus those eligible).
- **ART coverage by CD4 count (15+) - (mid-year):** ART coverage by CD4 count category.
- **Median CD4 count at ART initiation (15+) - (mid-year):** The median CD4 count of adults initiating ART in each year.
- **Number newly needing treatment (15+) - (mid-year):** The number of adults progressing to the stage where become eligible for ART.
- **Unmet need for treatment (15+) - (mid-year):** The number needing ART who are not receiving it.
- **Total need for ART (15-49) - (mid-year) :** The total number of people needing ARV therapy. This includes all those currently receiving ART plus those who are eligible but not receiving treatment.
- **Total number receiving ART (15-49) - (mid-year):** The number of people receiving ARV therapy.
- **Total ART coverage (15-49) - (mid-year).** ART coverage is the number of people currently receiving ART divided by those in need (those on ART plus those eligible).
- **ART coverage by CD4 count (15-49) - (mid-year):** ART coverage by CD4 count category.
- **Number newly needing treatment (15-49) - (mid-year):** The number of adults progressing to the stage where become eligible for ART.
- **Unmet need for treatment (15-49) - (mid-year):** The number needing ART who are not receiving it.
- **Total need for ART (15-24) - (mid-year):** The total number of people needing ARV therapy. This includes all those currently receiving ART plus those who are eligible but not receiving treatment.
- **Total number receiving ART (15-24) - (mid-year):** The number of people receiving ARV therapy.
- **Number newly needing treatment (15-24) - (mid-year):** The number of adults progressing to the stage where become eligible for ART.
- **Unmet need for treatment (15-24) - (mid-year):** The number needing ART who are not receiving it.
- **Children needing cotrimoxazole (0-14) - (mid-year):** The number of children in need of cotrimoxazole.



- **Children receiving cotrimoxazole (0-14) - (mid-year):** The number of children receiving cotrimoxazole.
- **Children needing ART (0-14) - (mid-year):** The number of children needing ART. Need is defined as those children receiving ART plus those who are eligible for treatment but not receiving it.
- **Children receiving ART (0-14) - (mid-year):** The number of children receiving ART.
- **Children needing cotrimoxazole (1-4) - (mid-year):** The number of children 1-4 in need of cotrimoxazole.
- **Children needing ART (1-4) - (mid-year):** The number of children 1-4 needing ART. Need is defined as those infants receiving ART plus those who are eligible for treatment but not receiving it.
- **Infants needing cotrimoxazole (0-1) - (mid-year):** The number of infants in need of cotrimoxazole.
- **Infants needing ART (0-1) - (mid-year):** The number of infants needing ART. Need is defined as those infants receiving ART plus those who are eligible for treatment but not receiving it.
- **ART - mid-year summary (all ages):** A table showing indicators just for ART mid-year.

#### 6.1.4.12 Sub-populations

- **Sub-populations summary:** If EPP has been used to prepare the incidence trend, then AIM will display key indicators by sub-population for any year between 2005 and 2020. The sub-populations are those included in EPP. Sub-populations may be risk groups (e.g., sex workers, people who inject drugs) or sub-national regions.

#### 6.1.4.13 AIDS impacts

- **Deaths averted by ART:** The annual number of deaths averted by ART. This is calculated by comparing the number of deaths in the current projection with one in which no one receives ART.
- **Infections averted by PMTCT:** The annual number of new infections averted by PMTCT programs. This is calculated by comparing the number of new child infections in the current projection with one in which no one receives PMTCT.
- **Life years gained by ART and PMTCT:** The annual number of additional life-years gained due to the effects of ART and PMTCT.
- **Deaths averted by ART (0-4):** The annual number of deaths to children 0-4 averted by ART.
- **Deaths averted by cotrimoxazole (0-4):** The annual number of deaths to children 0-4 averted by the use of cotrimoxazole.
- **Deaths averted by PMTCT (0-4):** The annual number of deaths to children 0-4 averted by PMTCT.
- **Impacts summary:** A table showing all of the impact indicators.

#### 6.1.4.14 Orphans

- **Maternal AIDS orphans:** Children under the age of 15 who have lost their mother to AIDS.

- **Paternal AIDS orphans:** Children under the age of 15 who have lost their father to AIDS.
- **Dual AIDS orphans:** Children under the age of 15 who have lost both parents to AIDS.
- **All AIDS orphans:** Children under the age of 15 who have lost one or both parents to AIDS.
- **Maternal non-AIDS orphans:** Children under the age of 15 who have lost their mother due to causes other than AIDS.
- **Paternal non-AIDS orphans:** Children under the age of 15 who have lost their father due to causes other than AIDS.
- **Dual non-AIDS orphans:** Children under the age of 15 who have lost both their parents due to causes other than AIDS.
- **All non-AIDS orphans:** Children under the age of 15 who have lost one or both parents due to causes other than AIDS.
- **Maternal orphans:** Children under the age of 15 who have lost their mothers due to any cause.
- **Paternal orphans:** Children under the age of 15 who have lost their father due to any cause.
- **Dual orphans:** Children under the age of 15 who have lost both their parents due to any cause.
- **Total orphans:** Children under the age of 15 who have lost one or both parents due to any cause.
- **Orphans summary by age:** A table showing orphans by type and single age.
- **Orphans summary table:** A table showing all orphans by type and year.
- **Total new orphans:** The number of children newly orphaned each year.

### 6.1.5 Validation

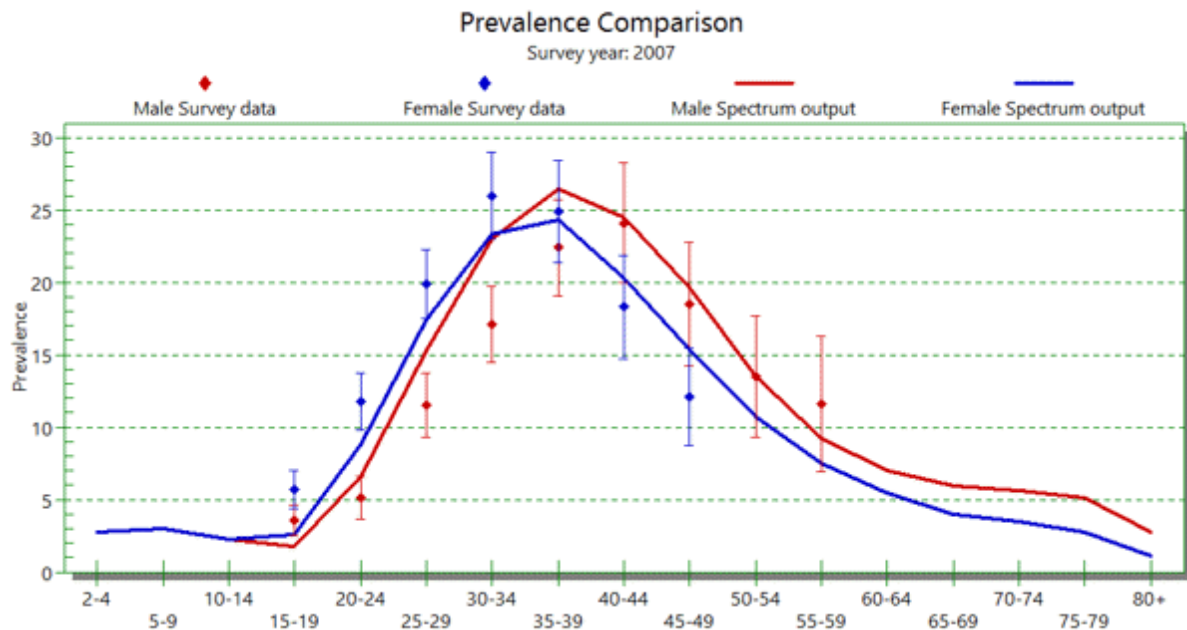
The validation section of AIM is intended to facilitate comparing AIM output with other sources of data such as national surveys or vital registration. There are eight validation sections:

- Prevalence
- Adult mortality (15+)
- Mortality by age (all ages)
- Adult ART (15+)
- PMTCT
- Under 5 mortality rate
- Child ART (0-14)

#### 6.1.5.1 Prevalence

This section compares the pattern of prevalence by age as estimated by AIM with the pattern from a national survey. Data from most surveys are included in a database which you can read by selected the 'Read from database button'. The chart will look like the example below. The solid lines show the prevalence pattern estimated by AIM (red = male, blue = female) and the dots represent the survey

data. The lines extending above and below the survey dots represent the 95% confidence interval for the estimate. If the AIM pattern does not match the survey well it may be necessary to modify the age pattern of incidence rate ratios.



#### 6.1.5.2 Adult mortality (15+)

This section compares the AIM output with other data that may be available for four indicators of adult mortality:

- **AIDS 45q15:** This is the probability for an HIV+ person of dying of HIV/AIDS between age 15 and 60 at the current age-specific mortality rates.
- **Non-AIDS 45q15:** This is the probability of dying of a non-AIDS cause between 15 and 60 at the current age-specific mortality rates.
- **Total 45q15:** The probability of dying from AIDS or non-AIDS causes between 15 and 60 at the current age-specific mortality rates.
- **Mortality rates by age:** This display compares mortality rates by age from Spectrum with those that you enter from another source.

#### 6.1.5.3 Mortality by age (all ages)

- **All cause mortality:** This display compares mortality from any cause by age from Spectrum with data that you can enter from another source.
- **AIDS mortality:** This display compares mortality from AIDS by age from Spectrum with data that you can enter from another source.

#### 6.1.5.4 AIDS mortality (all ages)

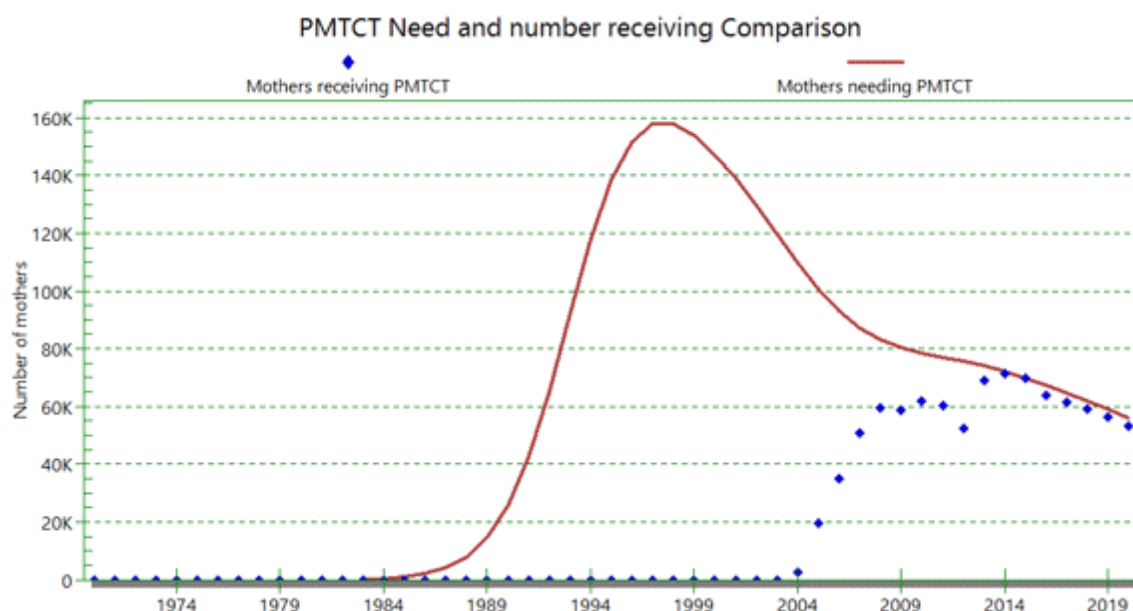
This display compares the total AIDS mortality rate (all ages combined) from Spectrum with you can enter from another source.

#### 6.1.5.5 Adult ART (15+)

This compares the number of people on ART with the estimated need for ART. If the implied coverage too high or too low according to expectations it may indicate a problem with input data.

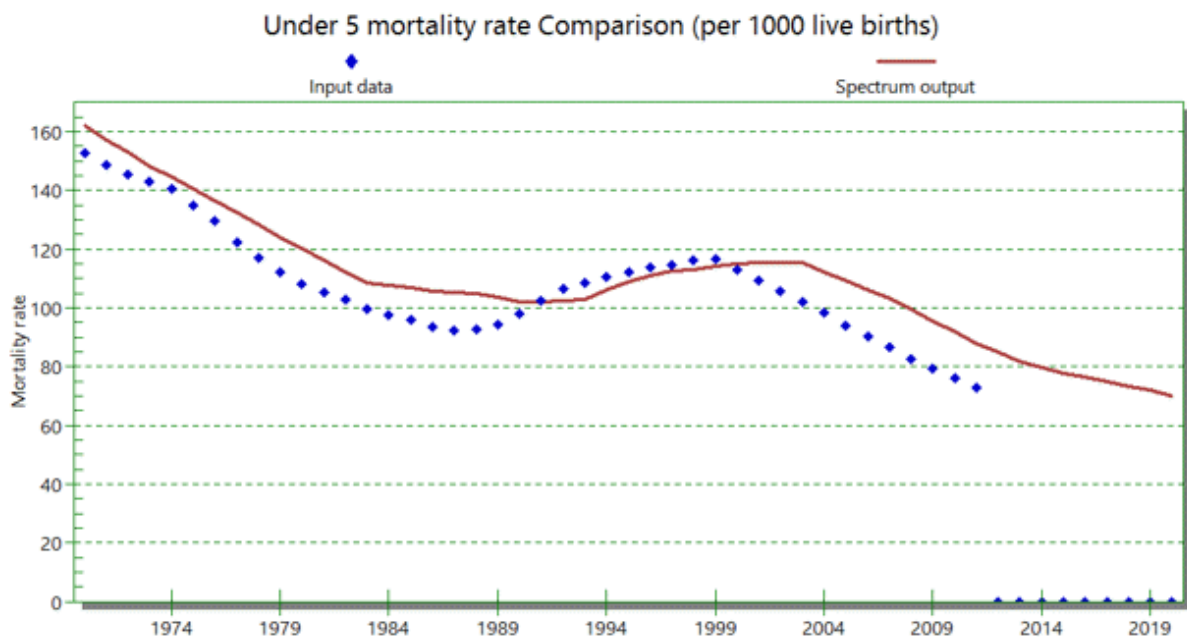
#### 6.1.5.6 PMTCT

This compares the number of HIV+ pregnant women receiving PMTCT services with the estimated need for PMTCT. If the implied coverage too high or too low according to expectations it may indicate a problem with input data. It will look like the sample below. The red line is the Spectrum estimate of need for PMTCT and the blue diamonds represent the number on PMTCT.



#### 6.1.5.7 Under 5 mortality rate

This compares the Spectrum estimate of the under five mortality rate with an external estimate over time. A good source of under five mortality estimates is the IGME (Interagency Group for child Mortality Estimation) website at [www.childmortality.org](http://www.childmortality.org). The comparison chart looks like the sample below. The blue diamonds represent the external estimate and the red line is the Spectrum estimate.



#### 6.1.5.8 Child ART (0-14)

This compares the number of children on ART with the estimated need for ART. If the implied coverage too high or too low according to expectations it may indicate a problem with input data.

### 6.1.6 Program tutorial

This program tutorial describes how to:

Create a demographic projection using data from the United Nations Population Division.

Create an HIV/AIDS projection using surveillance data.

Display various HIV/AIDS indicators such as the number of people infected, the number of new infections, AIDS cases, AIDS deaths, the number of people needing ART and the number of orphans.

#### 6.1.6.1 Installing the program

The Spectrum program can be downloaded from [www.futuresinstitute.org](http://www.futuresinstitute.org). If you are installing Spectrum, it can also be downloaded from [www.unaids.org](http://www.unaids.org). Spectrum will run on any computer running Windows 95 or later Windows versions. It requires about 70MB of hard disk space.

To install Spectrum from a file downloaded from the internet, just double click on the file named "SpecInstall.exe". This will start the installation program. Just follow the instructions on the screen to complete the installation.

If you have trouble installing Spectrum it may be that you do not have the appropriate permission to install programs on your computer. In that case you should contact your IT support office to do the installation for you.

#### 6.1.6.2 Changing the language

The first time you run Spectrum after installing it, all the displays will be in English. You can change to another language by selecting the Spectrum Menu Button (the rainbow icon at the top left of the screen),

then "Options" and "Environment" from the Spectrum menu. Then select the language you want to use and click on the "Ok" button. If you select a language other than FrenchFrench, SpanishSpanish or PortuguesePortuguese, you must have the proper fonts or version of Windows to display the language correctly.

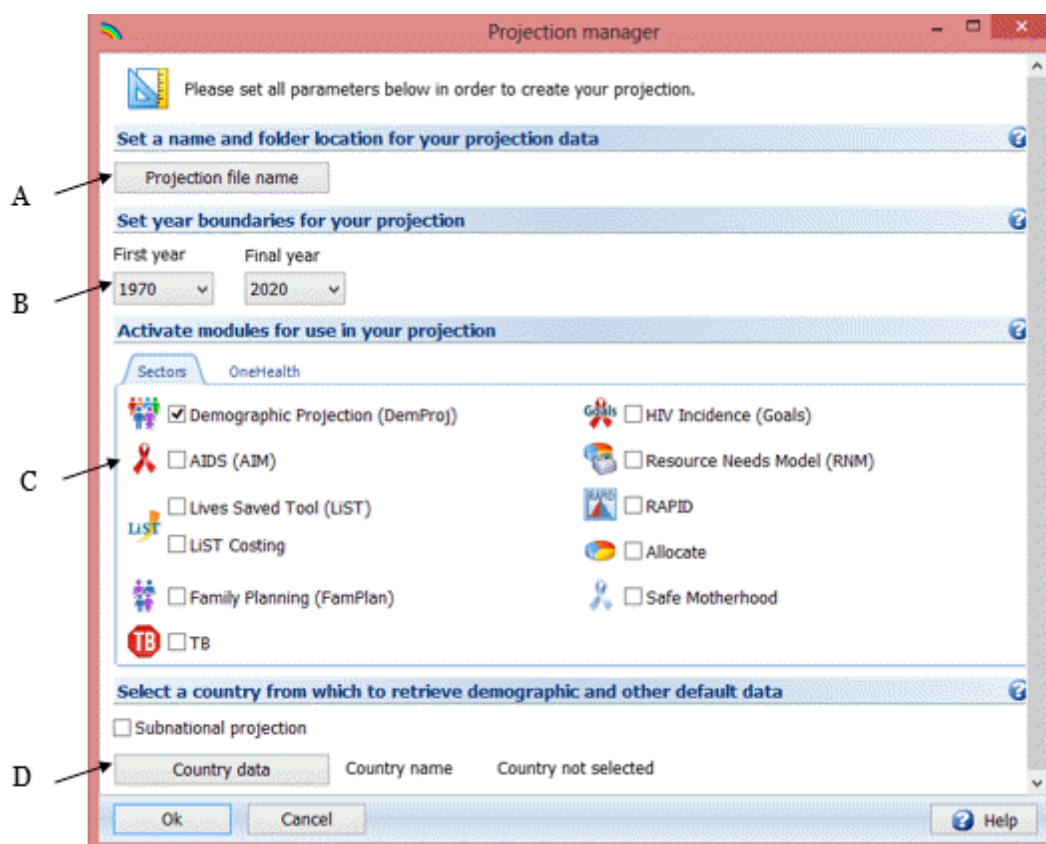
### 6.1.6.3 Start the program

Start the Spectrum program by selecting it from the "Start" menu on your computer Windows 7 or earlier) or your Start Screen (Windows 8). When the program starts you will see an opening screen giving you the option to select 'New Projection', 'Open existing projection', select a 'Recently opened projection' or use 'Spectrum online support'.

If you have a projection file from previous rounds of estimates you can start with that file by opening an existing projection (skip to [Displaying the AIM menus](#)), or you can start over by creating a new projection.

### 6.1.6.4 Create a population projection

When you create a new projection you will see the "ProjectionProjection managerProjection manager" dialogue box, shown below.



Follow these easy steps to complete the "Projection manager" screen:

- A. Click the **ProjectionProjection file name** button and enter a file name for the projection.
- B. The **First year** and **Final year** will be set to 1970 and 2020 by default. In most cases you should accept these values. You can change them if you wish, but projections submitted to UNAIDS

should use the default settings.

- C. Click the check box next to **AIDS (AIMAIM)** to add the AIM module to the projection.
- D. Then click the **Country Data** button. EasyProjA list of countries will appear. Once you select your country from the list Spectrum will automatically load all the demographic data you need for your projection.

In addition Spectrum now will load data on HIV incidence, and number of people receiving ART, cotrimoxazole and PMTCT services based on data published by UNAIDS and WHO. It is important that users compare these inputs with their program data and make any revisions that might be necessary. In particular, the data provided on PMTCT services should be reviewed.

- E. When you are done click the **OK** button.

If you are updating an existing file you might want to extend the years of the projection. Select the Manager button then change the end year (i.e. from 2015 to 2020). Remember that projections more than five years into the future are unreliable.

#### 6.1.6.5 Display the AIM menus

Select **Modules** from the Spectrum menu and click the **AIM** icon to display the AIM menu as shown below.



To produce the projection you just need to advance through these menu items one-at-a-time: **Program statistics, Eligibility for Treatment, Incidence, Sex/age pattern, Advanced options, Results, Validation**. The following sections explain each of these items in detail.

#### 6.1.6.6 Enter program statistics

Click on the **Program statistics** menu item to see the program data editor. It will look like this:

AIM - Program statistics - Sample Country

PMTCT Adult ART Child treatment

Distribution of HIV+ pregnant women by treatment regimen

Display numbers only

	2001	2002	2003	2004	2005	2006	2007
<b>Prenatal prophylaxis</b>							
Single dose nevirapine	0	0	0	6,400	18,600	23,040	24,147
Dual ARV	0	0	0	0	0	2,560	8,140
Option A - maternal	0	0	0	0	0	0	0
Option B - triple prophylaxis from 14 weeks	0	0	0	0	0	0	0
ART started before current pregnancy	0	0	0	0	0	0	0
ART started during current pregnancy	0	0	0	0	0	0	3,018
<b>Total</b>	0	0	0	6,400	18,600	25,600	35,305
<b>Postnatal prophylaxis (among women not on ART)</b>							
Option A	0	0	0	0	0	0	0
Option B	0	0	0	0	0	0	0
<b>Total</b>	0	0	0	0	0	0	0
<b>Monthly drop-out rate of postnatal prophylaxis</b>							
Option A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Option B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ART	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Calculated mothers needing PMTCT</b>	0	0	0	0	0	0	0

Option B+: Enter the number or percent of women starting Option B+ with the current pregnancy under 'ART started during current pregnancy' and the number or percent of women who were already on ART from a previous pregnancy under 'ART started during previous pregnancy'.

Option A: Mother receives AZT as early as 14 weeks plus sd-NVP at onset of labor, AZT+3TC during labour and delivery, AZT+3TC for 7 days postpartum if antepartum AZT is started less than 4 weeks before delivery. Infant receives daily NVP from birth to one week after cessation of all breastfeeding. Non-breastfeeding infants receive AZT or NVP for 6 weeks.

Option B: Mother receives triple ARV prophylaxis as early as 14 weeks until delivery and until 1 week after infant exposure to breast milk has ended. Infant receives daily NVP or twice daily AZT from birth until 4 to 6 weeks of age.

ARV Regimen Breastfeeding Abortion

Ok Cancel Duplicate Interpolate Source Transmission probability Convert values

Enter your program data using the three tabs at the top for: **PMTCT** (prevention of mother-to-child transmission of HIV), **men and women receiving ART**, and **Child treatment** (including ART and cotrimoxazole).

In each of these editors you may enter data as the *number* of people receiving the service or as *coverage*, the percentage of those in need of the service who receive it. If you enter coverage, Spectrum will calculate the number receiving the service when it makes the projection. Normally you will enter numbers from program statistics for all historical years. For the projection past the last year of program data to 2020 you may enter either numbers or coverage targets. You can enter numbers for some years and coverage for other years but you cannot mix numbers and coverage in the same year. Since the PMTCT editor has a number of rows you can use the drop-down menu in the upper right of the screen to select to show (1) just the rows for numbers, (2) just the rows for coverage or (3) both.

The grey numbers displaying the estimated number in need are based on the last time the projection was run. Substantial changes to the inputs (surveillance data or programme data) will result in a change in the calculation of the need. Consider the needs in grey as indicative values and review them after the whole file has been updated.

All Spectrum editors have **duplicate** and **interpolate** functions to make it easier to enter all the data required. To use these features just select a range of data with your mouse and either click the **Duplicate** or **Interpolate** buttons or right click with the mouse and select **Duplicate** or **Interpolate**



from the menu.

- **Duplicate** copies the data from the first cell of the range to all the other cells in the range. It is useful when you want values to remain constant over time.
- **Interpolate** calculates values for the cells between the first and last cell in the range by interpolation. Spectrum will perform a linear interpolation if you click the Interpolate button. If you right click you will see a menu allowing you to choose the interpolation method: linear, S-shaped, exponential, and front loaded.

When you are finished entering data, click the **Ok** button.

#### 6.1.6.7 Specify eligibility for treatment

Select the **Eligibility for treatment** menu item to see the editor shown below.

AIM - Eligibility for treatment - Sample Country

Adults Children

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
CD4 count threshold for eligibility	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200

Populations eligible for treatment regardless of CD4 count

	Eligible	Estimated percent of HIV+	Year implemented
Pregnant women	<input checked="" type="checkbox"/>	---	2013
TB/HIV co-infected	<input type="checkbox"/>	5.00	2009
Discordant couples	<input type="checkbox"/>	40.00	2011
Sex workers	<input type="checkbox"/>	2.00	2015
Men who have sex with men	<input type="checkbox"/>	5.00	2015
Injecting drug users	<input type="checkbox"/>	0.50	2015
Other population	<input type="checkbox"/>	10.00	2015

Ok Cancel Duplicate Interpolate Source

In the top part of the screen you can specify the eligibility for ART in terms of CD4 count. By default, eligibility is set to 200 cells/ $\mu$ l until 2010 and to 350 cells/ $\mu$ l for 2011 and later. You can modify these inputs to match your country's actual guidelines.

The second part of the editor allows you to specify that people living with HIV in certain population groups may be eligible for treatment regardless of CD4 count. Specify eligible populations by clicking the check box next to the name and set the year in which the guidelines were changed include that population group. Spectrum will calculate the number of HIV+ pregnant women but for all other groups you need to specify the percentage of HIV+ adults that are in that population group. Spectrum does contain default estimates for most countries.

For children eligibility has three components:

- **Age.** Enter the age below which all HIV+ children should be on treatment. By default this is set

to 12 months from 2007 to 2009 and to 24 month thereafter.

- **CD4 count.** The CD4 count for eligibility can be defined by four age groups and by year. The default values follow WHO guidelines for the corresponding years.
- **CD4 percent.** Eligibility may also be defined in terms of CD4 percent by age. The default values follow WHO guidelines.

Children are considered eligible for treatment if they meet any of the three criteria.

#### 6.1.6.8 Advanced options

The **Advanced options** menu item gives you access to the default parameter values used in the projection. These parameter values are based on special studies and surveys from a number of sites around the world. In most cases the default values should be used. This section allows you to see these default patterns, and change them if you have the information to do so. The patterns are grouped into four categories:

- **Transition parameters.** These include the amount of time a typical HIV+ adult spends in each CD4 category, the distribution of new infections by CD4 count, HIV-related mortality by CD4 category without ART, HIV-related mortality on ART by CD4 count at the initiation of treatment, survival on ART for children, the patterns of progression from new infection to death for children, and the effects of HIV infection on fertility.
  - Different parameters exist by region for HIV-related mortality. By selecting the tab for HIV-related mortality you can select the country's region to improve the mortality estimates.
- **Treatment and PMTCT costs.** This section contains unit costs for key components of treatment and PMTCT. It is only required to produce estimates of the financial resources required.
- **Orphans.** This section is used to indicate the relative fertility of the HIV+ population in concentrated epidemics in order to provide a better estimate of the number of orphans caused by AIDS.

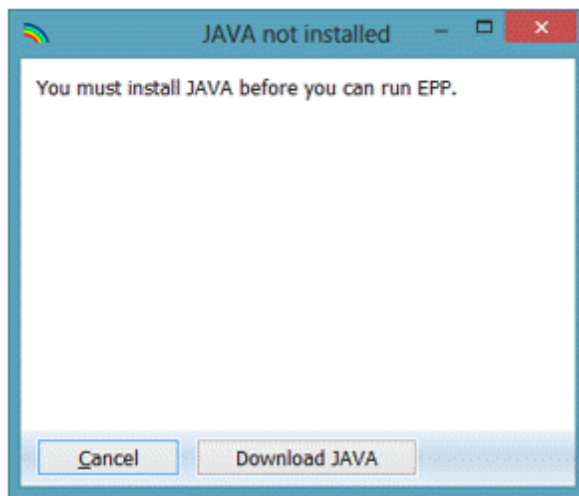
#### 6.1.6.9 Calculating incidence

When you select **Incidence** from the menu you will see a drop down menu with six choices:

**Configuration**, **Surveillance**, **Curve fitting**, **Restore values**, **Direct incidence input**, **Review**. If you are creating a new projection only **Configuration** and **Direct input** will be active. Once you choose **Configuration** and enter the necessary details then the **Surveillance** item will become active and once you enter surveillance data, the **Curve fitting** item will become active. Each of these options is described in detail in the next sections.

(Previously HIV incidence was calculated through the Estimation and Projection Package (EPP) and the results were imported into Spectrum. Now, EPP is no longer a standalone program, but is invoked transparently through this menu. )

NOTE: If you do not have the Java Runtime installed on your system, the first time you go to run an incidence calculation, you will see the following prompt within Spectrum to download and install Java before proceeding:



Click on "Download JAVA" and you will be taken to the Java site, where you can click on "Free Java Download" followed by "Agree and Start Free Download" to begin the install. When asked if you want to "run or save this file?", click on "Run" and follow the prompts to install the software.

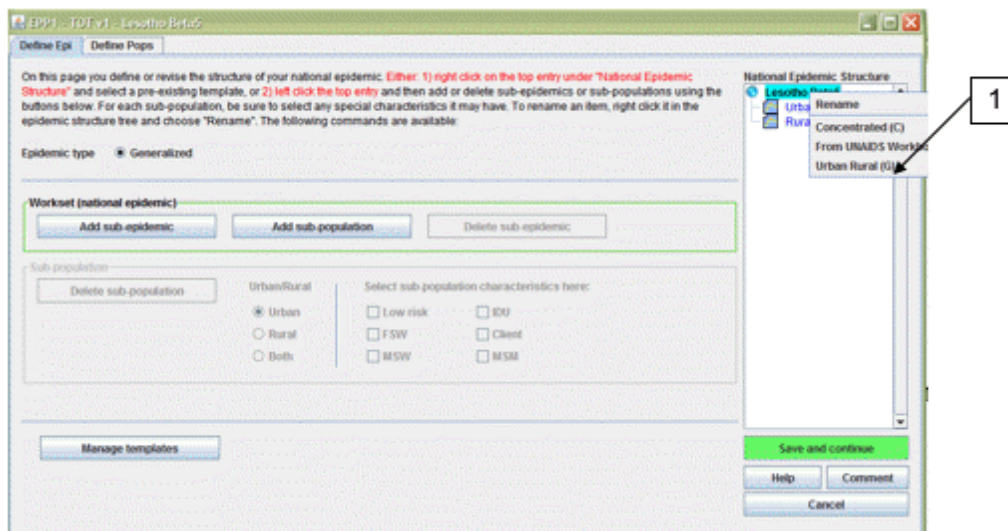
As an alternative, you can visit the site [java.com](http://java.com) and install the Java software directly from there prior to running Spectrum.

#### 6.1.6.9.1 Configuration (EPP)

The first step under incidence is to define the epidemic structure of the country by selecting an appropriate template.

#### Define the epidemic structure.

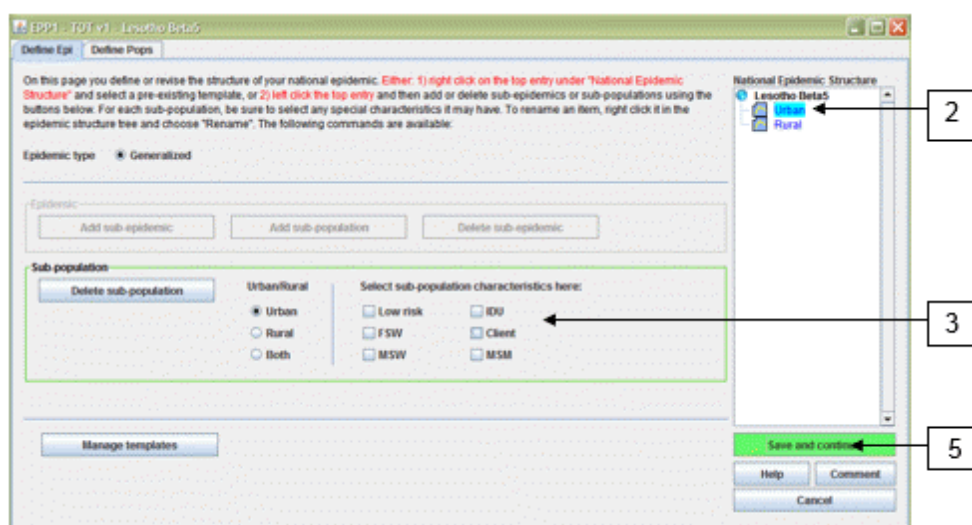
1. Right click on the top entry under National epidemic structure. Select the appropriate template. There are three template options: Concentrated (C), From UNAIDS Workbook, and Urban/rural (G). For most countries with generalized epidemics use the Urban/Rural template. For most other countries, use the Concentrated template.



Alternatively, create a custom template by left clicking on the top entry and then add or delete sub-epidemics or sub-populations using the buttons to the left, as shown below. For each sub-population, be sure to select any special characteristics it may have. To rename an item, right click it in the epidemic structure tree and choose "Rename".

### Define the sub-population characteristics

2. Highlight the sub-population in the epidemic structure.
3. Click on the characteristic of that sub-population (for examples sex workers should be "FSW" and the "General pop women" should be "low risk").
4. Repeat this for each sub-population
5. Click on "Save and continue"



### Generalised epidemics:

For many countries with generalised epidemics, one urban and one rural sub-population are sufficient to describe the epidemic. Alternatively you could create sub-epidemics by region if there are significant differences in regions of the country.

#### Box 1. Producing estimates for sub-national regions other than rural and urban

In some setting it might be necessary to create estimates based on sub-national regions to provide more specific estimates. Three options are available to help countries create sub-national estimates.

Option 1. Create a national Spectrum file using urban/rural configuration and apply the HIV prevalence by region through an excel sheet

Option 2. Create a national Spectrum file using sub-regions (instead of urban/rural) to fit curves and display a regional summary table within Spectrum

Option 3. Create separate regional Spectrum files

### **Option 1**

Fit the epidemic curve using urban and rural for generalized and most at risk populations for concentrated epidemics. Prepare a single Spectrum file for the national projection. Use a spreadsheet to allocate key indicators by region (example available) based on regional prevalence from national survey or surveillance.

Use this option when there are few surveillance sites but one or more national surveys exist. The disadvantage is that estimates are only for regions with HIV prevalence in the national survey and it assumes epidemic dynamics are the same in each region of the country.

Example: Kenya district level estimates.

### **Option 2**

Create an epidemic structure in the configuration page using regions. Assign the sites to each region and produce sub-epidemic curves for each region. Produce national curve in Spectrum. Use Spectrum's Regional Table output to see regional estimates.

Use this option when a number of surveillance sites are available in each region. This option captures the different epidemics for each region. However the indicators are only allocated on the basis of prevalence or incidence.

### **Option 3**

Create one separate Spectrum file and curve fit for each region. Use the Spectrum Aggregate tool to produce a national estimate.

Use this option when there are many surveillance sites in each region and you have full epidemic information for each region (programme data, size estimates, non-AIDS population data). This option produces full epidemic information (all variables) for each region. However it requires that all of the demographic projection information is available by region.

Examples: Mozambique, India, China.

## **Concentrated epidemics:**

For concentrated epidemics each sub-population created will require the following data: HIV prevalence data, estimates of the number of persons in the population, average time spent with the risk behaviour for those sub-populations of persons with high risk behaviour. Do not create sub-populations for which no data are available.

In concentrated and low level epidemics, if there are less than 3 data points from consistent surveillance sites for sub-populations at increased risk to HIV, then use the Workbook template. (As described earlier, you will need to derive point prevalence estimates for several years using Workbook and then will enter those into the incidence page to generate a curve.)

**Tip:** In countries with well documented concentrated epidemics in which HIV in the general population has increased beyond 1% (such as, Russia, Ukraine, Myanmar, Thailand), the concentrated epidemic template should continue to be used.

## Define the populations

The **Define Pops** page allows you to define the size of each sub-population.

### Generalised epidemic (urban/rural template):

In a generalised epidemic, when using the urban/rural structure, you define the number of the adult population in urban and rural areas by specifying the percentage of the population living in urban areas. If using the urban/rural structure, this is all you need to enter. The software already contains the United Nations Population Division values for each country and these are displayed when you first open this page. If you wish to change the urban percentages, you can by filling in the cells marked in blue. When done, click on "Save and continue" to store your results.

Please provide the percentage of population aged 15-49 living in urban areas in your country for each year. By default these values have been set according to the United Nations Population Division's projections for each projection year. If you change them and later want to restore them to the United Nations values, click on "Adjust to UN values". All populations entered here should be based on projections without an HIV epidemic.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
UN Pop Division % urban	10.300	10.820	11.340	11.870	12.390	12.910	13.470	14.030	14.590	15.150
Current worksheet % urban	10.300	10.820	11.340	11.870	12.390	12.910	13.470	14.030	14.590	15.150

Adjust to UN values

Save and continue

Help Source

Cancel

### Generalised epidemic (user defined regions):

If instead you have created your national epidemic using a set of regional sub-populations, you will need to provide the population for each of those regions. The table will appear as shown below. At the bottom of the table is the total number of people aged 15-49 years in the population (based on the UN Population Division Non-AIDS estimates). You must assign all of this population to different groups within the epidemic structure.

Please divide your national population aged 15-49 among the regions you have created by providing the percent or number of the population in each region in the table below. You may vary populations over time, but the total of the values in each year must sum to 100% of the national population. If you select "Populations" below, you may enter the number living in each region for each year. If you select "Percent" you enter the percentage of the total population in each region for each year of projection. If you enter values for the first and last years and hit the "Calculate Proportional Values" button, EPP will generate the values inbetween. All populations entered here should be based on projections without an HIV epidemic.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Hhohho Region	49075	0	0	0	0	0	0	0	0	0
Manzini Region	51759	0	0	0	0	0	0	0	0	0
Shiselweni Region	49075	0	0	0	0	0	0	0	0	0
Lubombo Region	41791	0	0	0	0	0	0	0	0	0
TOTAL	191700	0	0	0	0	0	0	0	0	0
Population still to assign	0	196533	201706	207162	212633	218721	224849	231254	237984	245095
Total Pop 15-49	191700	196533	201706	207162	212633	218721	224849	231254	237984	245095

Display: ☒ Populations ☐ Percent IDU Mortality 1.07

Buttons: Calculate Proportional Values, Adjust for changed pop, Save and continue, Help, Source, Cancel

- For each region, enter the population for each year from 1970 to the end of the projection. Make sure the numbers for each year sum to the national total populations and that "Population still to assign" is zero for each column.

**Tip:** When you return to an existing Spectrum file and update the file with new demographic data, including overall population size, the population still to assign will no longer equal 0. To automatically adjust the population to the updated population figure select "Adjust for changed pop" and EPP will apply the same annual regional distribution to the new population.

- When done entering all population, click on "Save and continue"

If you do not have populations for each year, but do know the percentages of the total population in each region in the starting and ending year, it is possible to have the software fill in the table for you. To do this:

- Change to percentages by selecting "Percent" next to the word "Display:" at the bottom left-hand side of the page.
- Fill in the percentages of the population in each region for the first year, 1970, in the table. Make sure that the percentages sum to 100% so that "Population still to assign" is zero.
- Fill in the percentages for the final year, 2020, in the final column in the table. These need not be the same percentages, as the software will assume they grow or decrease according to the values you enter. Again, make sure that the percentages sum to 100% so that "Population still to assign" is zero.
- Click on the button "Calculate Proportional Values" and the software will fill in the additional entries for the entire table.
- Hit "Save and continue" to store your results and return to the AIM interface.

You can also use "Calculate Proportional Values" for the actual populations (instead of the percentages) if you have the total population in each region for the first year and final year. The procedure is the same: fill in the table for the first and last years, making sure that "Population still to assign" is zero for both years. Then click on "Calculate Proportional Values".



**EPP1 - 13-R00 - Swaziland**

**Define Epi** **Define Pops**

Please divide your national population aged 15-49 among the regions you have created by providing the table below. You may vary populations over time, but the total of the values in each year must sum to 1 below, you may enter the number living in each region for each year. If you select "Percent" you enter the year of projection. If you enter values for the first and last years and hit the "Calculate Proportional Value" populations entered here should be based on projections without an HIV epidemic.

	1970	1971	1972	1973	1974
Hhohho Region	25 600	0 000	0 000	0 000	0 000
Manzini Region	27 000	0 000	0 000	0 000	0 000
Shiselweni Region	25 600	0 000	0 000	0 000	0 000
Lubombo Region	21 800	0 000	0 000	0 000	0 000
<b>TOTAL</b>	<b>100 000</b>	<b>0 000</b>	<b>0 000</b>	<b>0 000</b>	<b>0 000</b>
Population still to assign	0 000	100 000	100 000	100 000	100 000
<b>Total Pop 15-49</b>	<b>100 000</b>	<b>100 000</b>	<b>100 000</b>	<b>100 000</b>	<b>100 000</b>

Display: ☐ Populations ☒ Percent IDU Mortality: 1.07

Calculate Proportional Values Adjust for changed pop

**Define Pops**

of the population in each region in the al population. If you select "Populations" the total population in each region for each generate the values inbetween. All

	2018	2019	2020
20 000	0 000	0 000	29 000
20 000	0 000	0 000	26 000
20 000	0 000	0 000	24 000
20 000	0 000	0 000	21 000
20 000	0 000	0 000	100 000
20 000	100 000	100 000	0 000
20 000	100 000	100 000	100 000

Save and continue Help Source Cancel

### Concentrated epidemics:

For concentrated epidemics this page is more challenging. There are two sub-pages. On the first page the user should provide the estimates of the number of persons in each sub-population. Alternatively the percent of the adult population in each sub-population can be provided. These values can be changed over time if data permit. This is done exactly as previously described for generalized epidemics using user-defined regions.

6. Enter the estimated population size or the proportion of the adult (15-49) population in each sub-population by year (see previous section for a description of the procedure)

### Box 2. Estimates of the size of key populations at increased risk to HIV (For low and concentrated epidemics)

The estimates of the size of key populations should be based on studies from the country. (Guidelines on how to estimate the sizes of most at risk populations are available at the UNAIDS website.) For clients of sex workers, consider using higher size estimates than those available from Demographic and Health Surveys or other population-based surveys. The West African Modes of Transmission project suggests that estimates of client of sex workers are higher than the estimates from these surveys, when calculated on the basis of estimates of number of sex workers combined with data on number of clients reported by sex workers.

Consider applying the percent of the population with increased risk to HIV (for example MSM or IDU) to only the urban population if these behaviours are relatively rare in the rural populations. Similarly, consider using a smaller percent when applying percent of rural population that are sex workers and clients of sex workers.

#### Some estimates of population sizes by region

(MSM and clients as % of male pop ages 15-49; FSW as % of female pop ages 15-49)

#### Men having sex with men

General High risk

#### Injecting drug users

E. Europe and C. Asia 0.06 – 5.21%



E. Asia	3 – 5%	<2.8%	E. Asia and the Pacific	0.021 – 1.33%
S & SE Asia	6 – 12%	1.2-7.2%	M East, N. Africa, SSA	0.05 – 2.07%
E. Europe	6 – 15%	1-5.5%	Latin America	0.29 – 1.15%
Latin America	6 – 20%	0.8-4.8%	& Caribbean	

**Female sex workers**

Sub-Saharan Africa	0.4 – 4.3%
Asia	0.2 – 2.6%
Russian Federation	0.1 – 1.5%
E. Europe	0.4 – 1.4%
W. Europe	0.1 – 1.4%
Latin America	0.2 – 7.4%

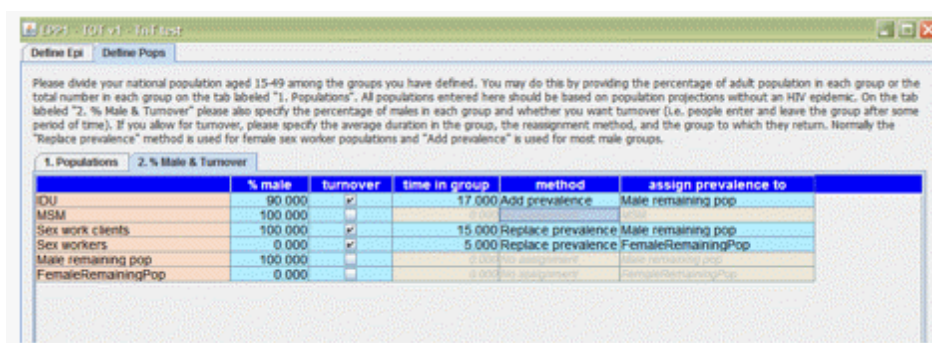
**Clients of sex workers**

All	9 – 10%
Central Africa	13 – 15%
Eastern and southern Africa	10 – 11%
Asia	5 – 7%
Latin America	5 – 7%

Source: Sexually Transmitted Infections, 2006 Jun; 82 (suppl)3; Mathers B et al Lancet 2008, 372:1733-1745.

For concentrated epidemics, additional information is required on the proportion of the sub-population that is male and the average duration an individual stays in the sub-population. These are used to calculate female/male ratios and to calculate the rate of turnover in the sub-population. This is provided on page 2 of the define populations page titled "% Male and Turnover" if you are using a concentrated epidemic template.

7. Indicate whether people are likely to move in and out of this sub-population. If you have evidence that there is a turnover in these groups (i.e. that sex workers move in and out of the sex work occupation) you should select the "on" button. Populations that are static such as the remaining populations will have no turnover.
8. Enter the estimated time (in years) that a person spends in that sub-population. This is used to determine the rate at which new members enter and old members leave the population. For example if it is set to 5 years, then 1/5 of the population must change every year, i.e., 20% of older members are replaced by newer ones. Sex workers in particular are known in most countries to have a short average duration (few years). See box 3
9. If turnover has been selected you will need to specify where the population will go after "turnover", or after they have left the most at risk population.
10. You also need to determine whether to add the prevalence of each sub-population to the overall prevalence or to replace it. You should choose "add prevalence" if those who are HIV positive from the former at-risk group members are added to the HIV positive members of the target population. This means they have NOT been captured in surveillance. You will need to "replace prevalence" if some of the people who are HIV positive in the target population are assumed to come from the former at-risk populations. The remaining infections that occurred "within group" are calculated. Identify the population to which the prevalence from the most at risk group should be added.



### Box 3. Examples of adding or replacing prevalence in concentrated epidemics

*Replacing prevalence:* Suppose we have former sex workers who are detected in antenatal testing. If we fit the data to ANC prevalence, then some of the prevalence here is due to former sex workers and some is due to other sources of infection, e.g., husband-to-wife or boyfriend-girlfriend heterosexual transmission. Thus, the HIV infections among ex-sex workers replace some of the detected prevalence in ANC women. They do not increase the overall prevalence rate among ANC women, but they do mean that less transmission occurred through the other routes of transmission.

*Adding prevalence:* On the other hand men who injected drugs while young and then stopped are unlikely to be detected since we do not have routine surveillance in male populations. We do not detect these infections in our surveillance, but the infections are definitely still out there. We need to add these undetected infections into our total prevalence picture. For former male clients or injecting drug users then, we would want to add these additional infections into the overall prevalence in the male population.

### Estimates of time in most at risk populations by region

#### *Average duration of female sex work, by region*

Region	Duration of behaviour in years
Africa	5.5 (4 studies)
Asia/Oceania	2.9 (12 studies)
North America	10.2 to 11.0 (3 studies)
Europe	8.4 to 10.0 (10 studies)
Latin America	11.2 to 12.0 (6 studies)

#### *Average duration of injecting drug use, by region*

Region	Duration of behaviour in years
Africa	5.6 (1 study)
Asia	8.7 (6 studies)
Oceania	17 (1 study)
Europe	13.9 (1 study)
North America	9.5 (1 study)
South America	21 or 19.6 (9 studies)

Source: Fazito E, Cuchi P, Mahy M, Brown T. Analysis of duration of risk behavior for key populations: a literature review *Sex Transm Infect* 2012;**88**:i24-I32. doi:10.1136/sextrans-2012-050647.

## 6.1.6.9.2 Surveillance data (EPP)

Once the epidemic structure and populations have been defined it is time to enter the available HIV prevalence data. From the AIM menu choose: Incidence and Surveillance Data (EPP). This will take you to the Surveillance Data page. There is a separate data entry spreadsheet for each sub-population. When the page is initially open it only has one row (each row represents the data from one site).

1. Count the number of sites with data for the sub-population. Add rows on the data entry page by clicking on "Add sites" so that there is one set of rows per site. (For each site there is a row for the prevalence and a row for the sample size.) You can also add a number of sites at a time using "Add Multiple" and entering the number of sites to be added.
2. Enter the surveillance data: If the data are already available in a spreadsheet format it is easy to copy and paste the data into the workset. Copy and paste the site names into the far left column. Copy and paste the data into the page for that sub-population (e.g. for urban sites or for sex workers). When pasting the data, be sure that the years align correctly.
3. Press "Save and continue". If you forget this step you will lose the data that you have pasted into the page! Enter the data for all of the remaining sub-populations using the same steps as above. After you have saved the data for the last sub-population, you will be automatically taken to the Surveys tab.

**Tip:** If the sample sizes for each site are not available change the "Display" variable to be "% HIV". This will allow you to copy and paste just the prevalence information by site into the workset.

**Tip:** Prevalence estimates should be entered as whole numbers not as percentages. So prevalence of 12% should be entered as 12, not as 0.12.

**Tip:** Be sure the boxes on the left corner are ticked. If they are not ticked the site will not be included in the fitting of the model.

**Tip:** if you do not enter sample sizes, you will receive a message when you click "Save and continue" that will inform you that all samples sizes are being set to a default of 300.

**Tip:** If the prevalence for a site is 0% and this is an actual measured value (not one created to anchor the early prevalence), then leave it in the data set along with its sample size.

**Tip:** if you get a warning that the prevalence is too low for the sample size, you have entered a prevalence value that could not be determined from a set of measurements with the sample size you provided. Please use a larger sample size that reflects the actual origin of the prevalence value. For example, one could not determine a prevalence of 0.5% with a sample of 100 as this would imply that only one-half a person was living with HIV.

	in	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
MECHAN PREV								1 800	1 800	4 200	8 700		21 300	
MEAN PREV								1 800	3 887	6 333	7 600		22 133	
Leribe (%) (%)	<input checked="" type="checkbox"/>							2 300	1 800	11 400	8 700		29 300	
(N)								300	300	300	300		300	
Mafuti (%) (%)	<input checked="" type="checkbox"/>							1 800	1 400	4 200	5 000		21 300	
(N)								300	300	300	300		300	
Mokhotlong (%) (%)	<input checked="" type="checkbox"/>													
(N)														
Quthing (%) (%)	<input checked="" type="checkbox"/>							0 700	8 400	3 400	9 100		15 800	
(N)								300	300	300	300		300	
Mokane's Hoek (%) (%)	<input checked="" type="checkbox"/>													
(N)														
St James (%) (%)	<input checked="" type="checkbox"/>													
(N)														
Paray (%) (%)	<input checked="" type="checkbox"/>													
(N)														
Berea (%) (%)	<input checked="" type="checkbox"/>													
(N)														

- Enter survey data. If your country has collected HIV prevalence in a national population based survey you can add those data here to inform your curve. Data can be entered for up to 5 surveys. Be sure to include the prevalence, survey year, standard error, sample size for the survey, and the non-response rate for HIV testing (that is the percent of the total survey sample who did not receive an HIV test for any reason: refusal to provide blood, missing test, or not interviewed. In DHS reports this is 100% minus the "percentage interviewed and tested"). In some surveys the HIV prevalence results from national population based surveys can be biased because of persons refusing to take part in the survey or persons who are absent from the household at the time of the survey. Many surveys thus publish an estimate of HIV prevalence adjusted for any non-response bias. These adjusted values are available on the training workshop CD or in the published reports. HIV prevalence values which have been adjusted for non-response should be used in the model.

If your country does not have HIV prevalence data from a national population survey, click on the button labeled "Do not include any surveys in the fitting process".

#### 6.1.6.9.3 Curve fitting

On this page the data entered in the previous pages are used to create an HIV epidemic curve and to analyze the uncertainty around that curve. There are three models that can be used for the curve fitting:

- R-Spline: This will be the best model for most applications.
- R-Trend: This will be the best model for countries with many years (8+) of surveillance data and many (7+) surveillance sites.
- EPP Classic. This will be the best model for countries with few data points.

- Select the model you wish to use in the upper left portion of the screen.
- If you are running the model as an exercise, click the "Training" button under "Purpose of run" a smaller number of curves will be calculated (400). If you are running the model as your final country estimation, click "For national projection" under "Purpose of run" which will increase the number of curves to 1,900. This number of curves will take much longer to run.

3. To produce the HIV incidence curve, click the green 'Fit' button. This will fit a curve for the sub-population selected. To run the curves for all sub-populations together, click 'Fit all' *after* selecting each sub-population in the list of sub-populations on the right and choosing the model to be used for each one.
4. Review the curve. The median curve will be shown as a red line and the 95% confidence intervals will be shown as blue dashed lines. Make sure the start year of the epidemic reflects the best understanding of the HIV epidemic in your country. This is especially important if you are using EPP classic or R-Trend.
5. If you are satisfied with the fit choose "Save and continue" and move on to fitting a curve for the next sub-population.
6. If you are not satisfied with the curve you can use the model parameters tab in the lower left of the interface to constrain the curves (see Box 4). For example if there is little data for early on in the epidemic, the model will often allow the curves to grow very quickly at the start of the epidemic. This can be constrained by limiting the prevalence in 1980 to <1% (or some appropriate value).

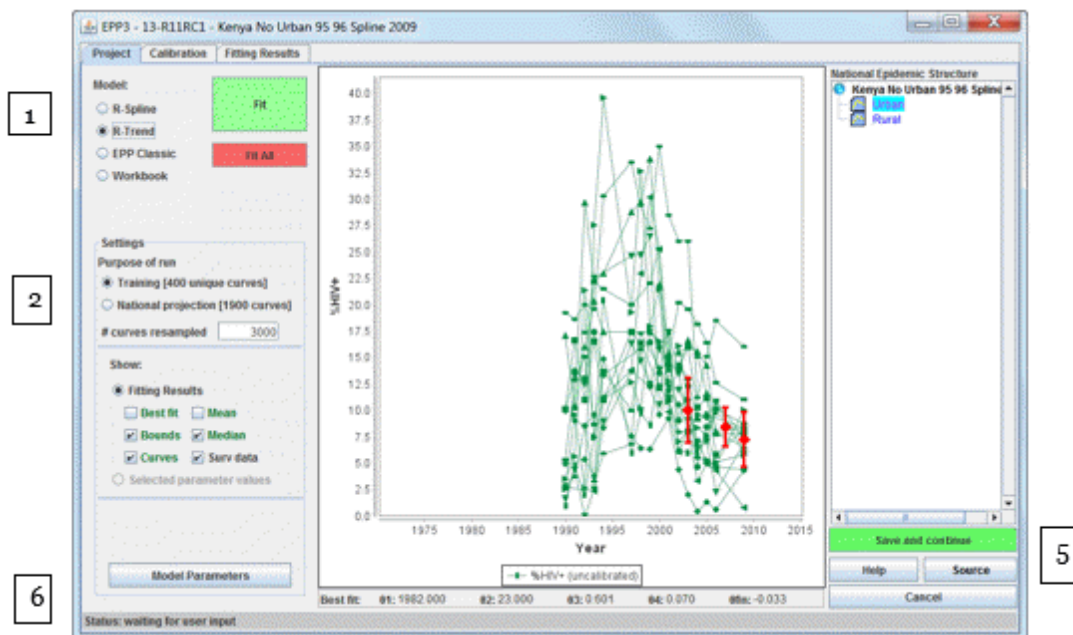
#### Box 4. Setting restrictions on prevalence curves

In some instances, where there is limited data, the models will find curves that are not realistic given what is known about the epidemic in your country. If the model produces curves that are not realistic, constraints should be placed on the curves using the **Model parameters** tab. Under this tab, you can: a) alter the range of possible start years to be more realistic for your country; and 2) apply conditions on prevalence that allow you to eliminate epidemiologically unrealistic sets of curves. These constraints on start years and prevalence should be used sparingly and with careful consideration of the following guidance:

1. **Before making prevalence conditions make sure the start year covers the full range of possible start years** (a range of about 15-20 years). Normally, they should start up to 5 years before the first detection of local transmission of HIV or AIDS in your country and run until about 5 years after the first non-zero data point. This will give the models the flexibility they need to consider all possibilities. NOTE: this does not apply to R-Spline where the start year is already set in a country-specific way.
2. **Also before applying any prevalence conditions run the model without any constraints.** Then carefully examine the results to determine if there are curves which are absolutely outside the realm of possibilities given your data.
3. **Limit the number of prevalence conditions to the minimum number needed** to eliminate unrealistic curves. If you apply too many constraints you may eliminate curves that are legitimate fits to the data given its statistical uncertainties.
4. **Do not set lower constraints and higher constraints in the same year.** This will artificially restrict the uncertainty in your curves and they will not reflect the true uncertainty in your data.
5. **Avoid setting restraints close to years in which data are available** (within 3-5 years) if possible. If you must apply them in the available data range use them to reflect knowledge of allowable prevalence in the early stages of the epidemic when data was less available or to eliminate unrealistically high curves, e.g., 80-90% prevalence or 5 to 10 times the peak prevalence

in the EPP fit during the data years.

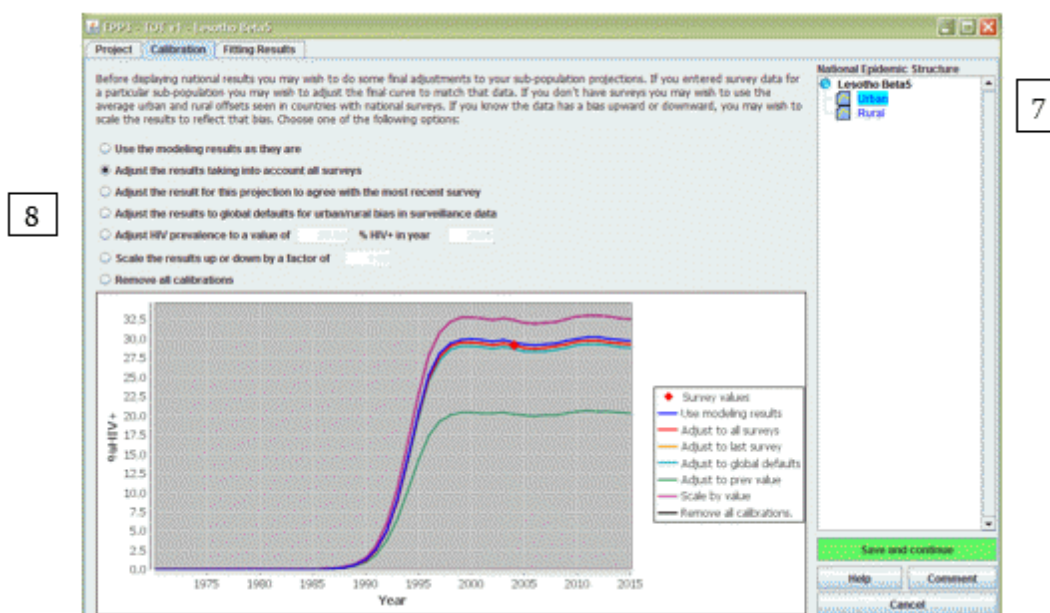
6. **Look at the resulting fit (red line with crosses) relative to the data in terms of deciding if the fit is reasonable** and not necessarily the full range of possible curves (gray) some of which may be very high or low in future years. These high or low future values may reflect the true uncertainty in your epidemic's future when data is sparse.



It is important to know that some calibration is normally done during the fitting procedure. If you have entered surveys in either a generalized or concentrated epidemic, they are used to adjust the final results of the calculation using a method that picks a best fit curve that is a good balance between the survey data and the observed surveillance data. It should be noted that this curve will not always pass exactly through the survey point itself – this is normal, do not be concerned by it. You can change it on the next page, the Calibration Page.

If you do not have surveys, but have marked your sub-populations as either urban or rural on the Define Epidemics page (or used the urban/rural template, which automatically sets these values), then downward adjustments will be made based on the observed urban and rural difference between national surveys and surveillance data in a large number of countries. Again, these adjustments are done automatically during the fitting procedure for generalized epidemics. For concentrated epidemics, no such global adjustments are made at present, although again normally some downward adjustment will need to be made for surveillance data done with women attending antenatal clinics. This adjustment can be made on the Calibration Page that follows the Project Page.

On the Calibration tab you can calibrate the curve based on additional data sources.



### Generalised epidemics:

On this page you are able to adjust the curves based on any national population based survey data that you have entered. If you have had one or more national surveys then you can use all of the data from those surveys. Alternatively you could use the most recent survey if it better represents HIV prevalence than the earlier survey.

If you have not had a national population based survey then leave the default setting on "Use the modeling results as they are". As described earlier, this has already shifted urban and rural prevalence down to roughly 80% of the original value based on evidence from numerous surveys that ANC surveillance overestimates adult HIV prevalence.

There are additional options available for adjusting the curves, which are described in the next section, but these are not normally used in generalised epidemics.

### Concentrated epidemics:

The calibration page gives you the option of specifying either an expected prevalence in a given year or a scale factor for each individual sub-population.

To use the calibration section:

7. Select the sub-population you wish to scale in the list of sub-populations shown
8. Select one of the options
  - i. *Use the modeling results as they are.* This option keeps the calibration that was established during the fitting.
  - ii. *Adjust the results taking into account all surveys.* This calculates an average offset between the EPP fitted curve and the survey values in the years where surveys are done. This is then

applied to modeled prevalence curve.

- iii. *Adjust the result for this projection to agree with most recent survey.* This calculates an offset that assures the adjusted EPP curve goes directly through the survey most recently completed and applies it to the modeled curve.
- iv. *Adjust the results to global defaults for urban/rural bias in surveillance data.* In the case of generalized epidemics, this adjusts all urban and rural sub-population projections downward by UNAIDS-specified urban and rural amounts developed by comparing national surveys with ANC data in a number of countries.
- v. *Adjust HIV prevalence to a user specified value.* This calibrates the best fit curve by multiplying all prevalence values by a constant number which ensures that the adjusted best fit curve goes through a user-specified prevalence value in a user-specified year. This might be the value from a more representative sample of the specific surveillance population, e.g., an IBBS study of female sex workers.
- vi. *Scale the results up and down by a factor.* Choosing this option scales all prevalence by the user-provided provided number. For example, if you enter 0.5, it gives a prevalence curve with each value cut in half.
- vii. *Remove all calibrations.* This removes all calibrations done during the curve fitting and uses the EPP curve without any upward or downward adjustments.

#### **Box 5. Adjusting prevalence for the “remaining population” (low risk populations)**

ANC prevalence can represent the remaining female population. However, when using surveillance data from ANC to describe the remaining female population the ANC estimate needs to be adjusted because women attending ANC are likely to have higher HIV prevalence because of biases in the geographic selection of antenatal clinics in the sentinel surveillance as well as a bias in the age of women attending ANC versus women in the general population. Comparing data available from ANC against HIV prevalence coming from population based surveys in 12 low and concentrated epidemic countries (or states), show that on average, HIV prevalence among all women was 60 percent of that measured in ANC prevalence. Thus a proposed adjustment value for women in the remaining population of **0.6** is required when assigning the ANC data to the remaining female population. The option “Scale HIV by factor of” should be chosen and 0.6 should be entered into the cell.

For men a similar analysis showed that the scale of HIV prevalence in the remaining male population is approximately 0.5 of ANC prevalence. Thus the adjustment from ANC data to men in the general population should be **0.5**. (Note that these adjustments are based on a small number of countries.)

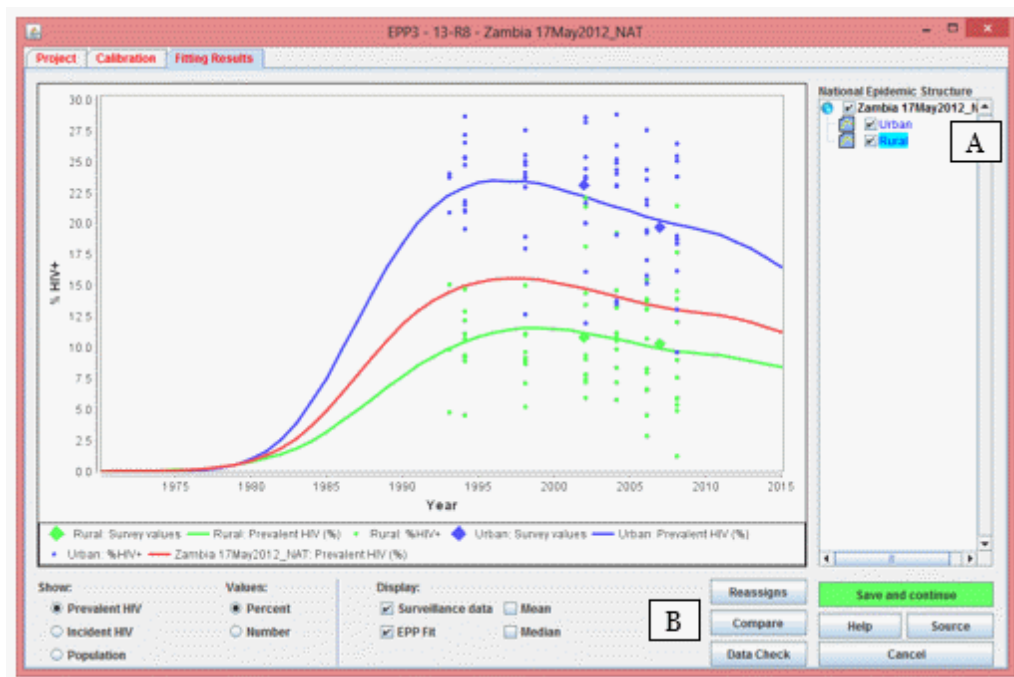
If prevalence is available from a population-based survey (e.g. India, Cambodia, Dominican Republic, Senegal, or Mali) use the survey results to calibrate the general population prevalence.

Where universal PMTCT is standard practice (as in Russian Federation, Thailand, among others) it is possible to use these data to also inform the prevalence among the female remaining population. However it is important to standardize the data coming from the PMTCT system to the age structure of the general female population. Similarly if there are data on men from a universal service, such as mandatory military service, (which does not increase their risk to HIV) these data can also be used to inform prevalence among the male remaining population.

Once completed you should click on ‘Save and continue’ to move to the **Fitting Results** page. Here you

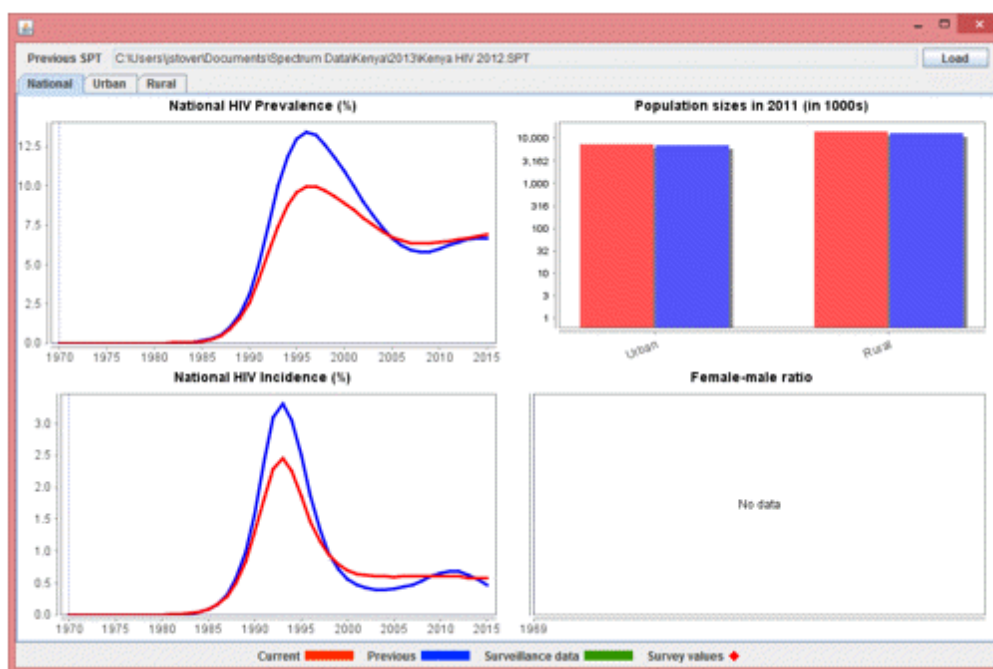


can review the resulting prevalence trends by population type and also see the national trend that is produced by combining the trends for all the sub-populations. Just select the population you want to examine from the list at the top right of the page [A].

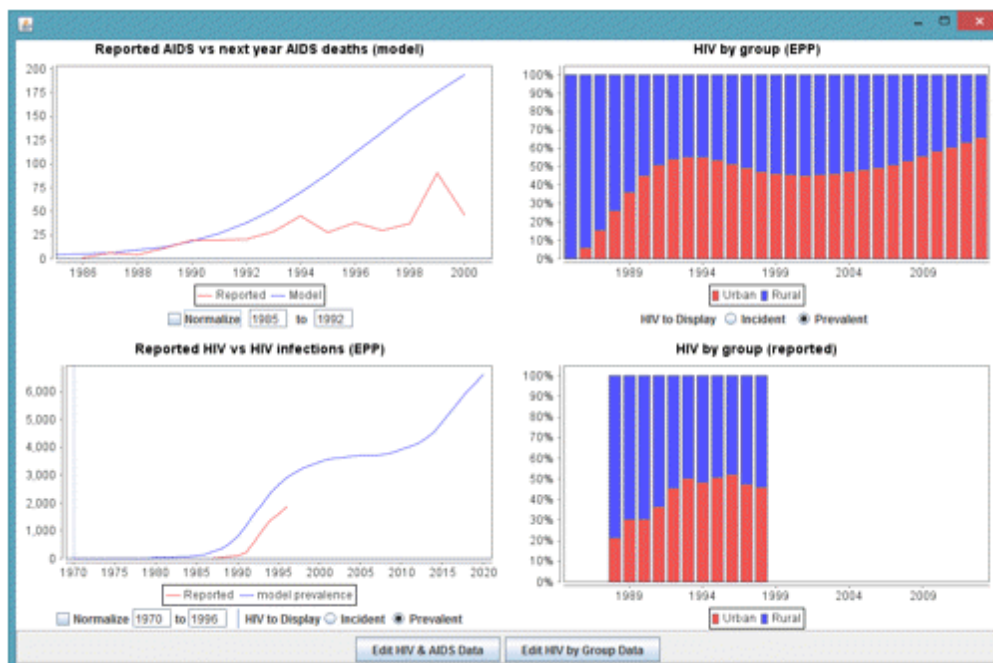


You may also compare your new results with the prevalence trends from a previous projection by clicking the 'Compare' button [B]. That will display a screen like the one shown below. You need to click the 'Load' button [A, figure on next page] and select the comparison projection's Spectrum (\*.SPT) file which contains the necessary information from the previous projection. Then the charts will compare your new projection (red) with the previous projection (blue) for prevalence, incident

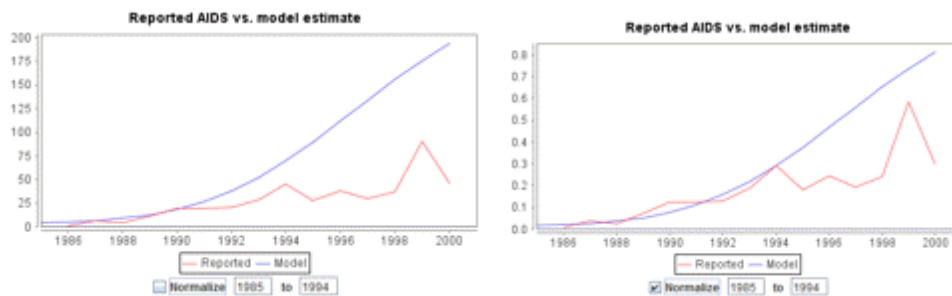
ce, population size and female to male ratio (for concentrated epidemics only, this will remain blank for generalized epidemics where female to male ratio is calculated within Spectrum). When you have finished viewing this page, close it by clicking the 'X' in the top right of the window.



For some countries you will also be able to check the estimated number of AIDS cases or HIV infections (prevalence or incident) from the new trend with program data on the reported number of AIDS and HIV cases. Select this option by clicking the 'Data Check' button. This will bring up the display shown.



If you enter start and end years below the graph and check the box marked "Normalize", the reported and model data for those years will be adjusted to the same scale as can be seen by comparing the graphs below.



Once you have finished viewing the results click 'Save and continue' to move to the next step.

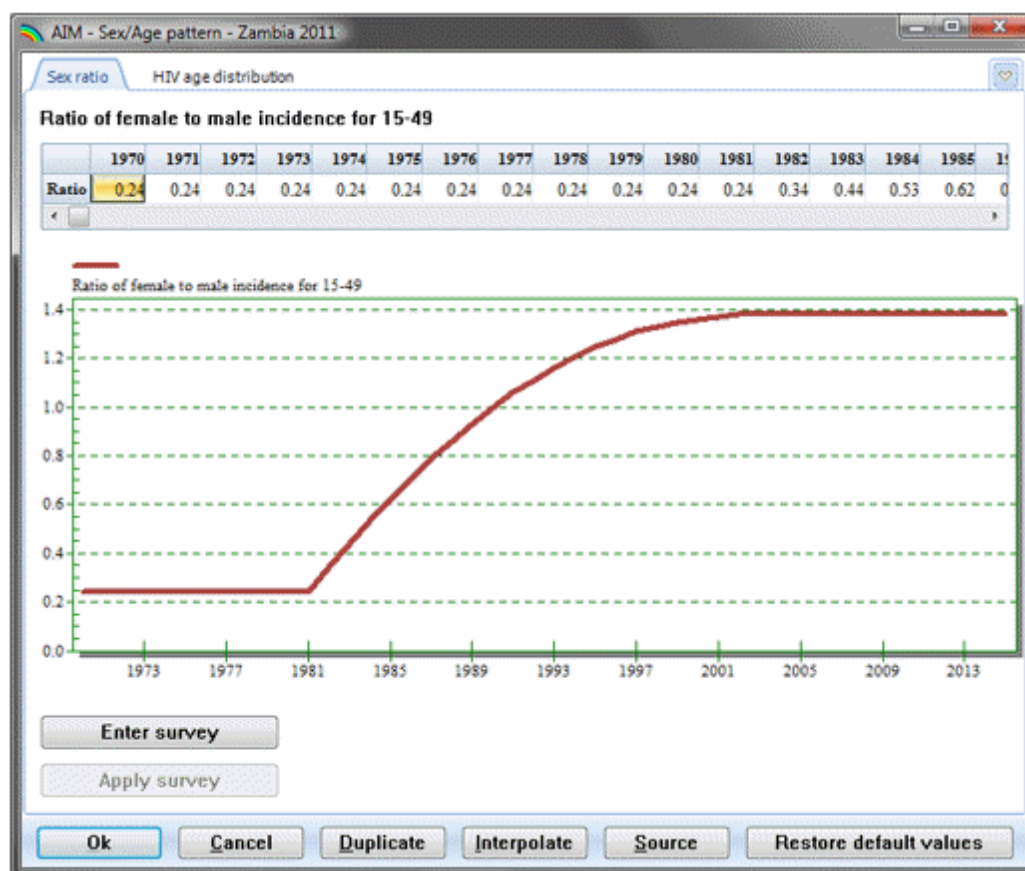
#### 6.1.6.9.4 Direct incidence input

**Direct input** of incidence is used only when you already have an incidence projection that you want to use. In most cases you should go through the [Configuration](#), [Surveillance](#), and [Curve fitting](#) steps to create an incidence projection.

#### 6.1.6.10 Set the pattern of incidence by sex and age

For concentrated epidemics the [curve fitting process](#) will produce an estimate of the sex ratio (the ratio of female prevalence to male prevalence). For generalized epidemics a default pattern will be automatically used that describes the general pattern of an increasing proportion of female infections reaching a ratio of 1.38 ten years after the start of the epidemic.

You can review the sex ratio trend by select the **Sex/age pattern** menu item. It will show a screen like this:



You should examine the chart and determine if this trend is appropriate for your country. If it is not, you can enter a new pattern.

The second tab in this editor (HIV age distribution) allows you to examine and change the ratios of incidence by age to the reference age group (25-29). In most cases you should accept the default pattern.

#### 6.1.6.11 Results

Select the **Results** menu item to see a drop down menu with the categories of HIV/AIDS indicators. They are:

- Total population
- Adults (15-49)
- Adult 15+
- Young adults (15-24)
- Children (0-14)
- Children under 1
- Children 1-4
- Children under 2
- PMTCT

- Regional table
- AIDS impacts
- Orphans

Each category contains indicators that Spectrum can display. Choose one of these indicators, for example, **HIV+ population**. The following screen will appear:

Configure - HIV population

Region: ☒ Total ☐ Urban ☐ Rural

Sex: ☒ Both ☐ Male ☐ Female

Display Interval: ☒ Single year ☐ Five year ☐ Ten year

Chart type: ☒ Line 2d ☐ Bar 2d ☐ Bar 3d ☐ Horizontal bar 2d ☐ Horizontal bar 3d ☐ Table

First year: 1970 Final year: 2015

☒ Scale table values

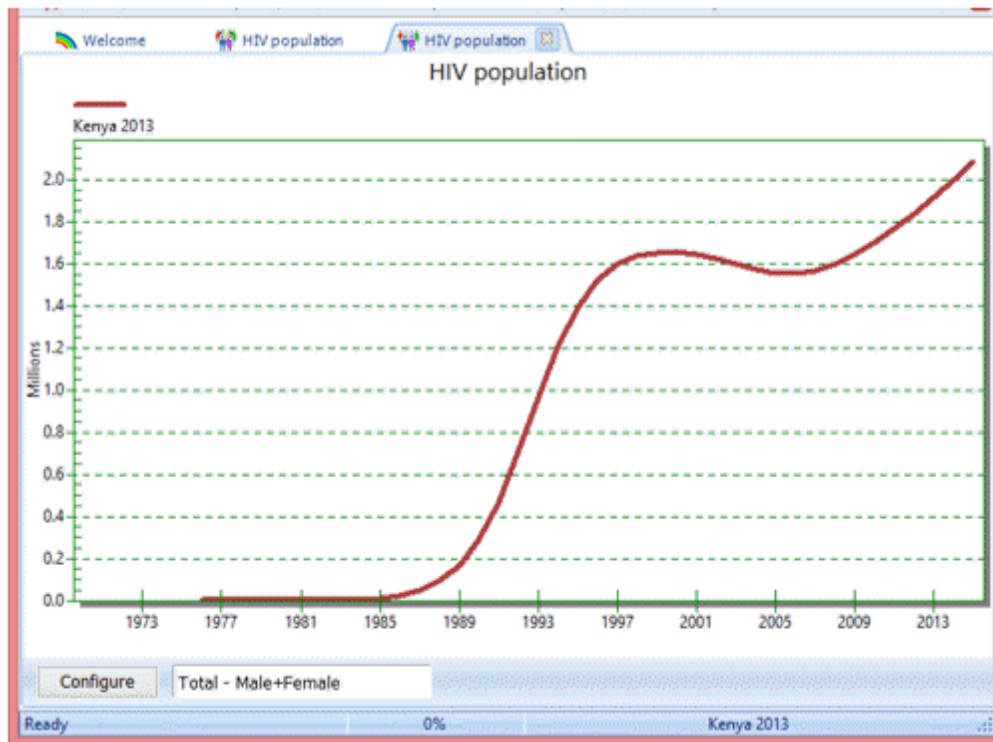
☐ Table plus chart

Ok Cancel

On this screen you can set the options for displaying the results.

- Chart type.** Select the type of chart you wish to display.
- Sex.** By default this is set to display both sexes, but you can change it to male or female only.
- Display interval.** By default this is set to display every year.
- First year** and **Final year.** By default this is set to the first and final year of your projection.

Once you have set the options, click **Ok** at the bottom of the screen. This will display a chart showing the indicator you have chosen, according to the variables you have selected on the previous screen. The following is an example of a line graph:



You can open up to 10 projections at one time and display the results in the same chart. The name of each projection that you open will appear at the bottom of the screen.

#### 6.1.6.12 Save the projection

Save the projection by click the Spectrum menu button and selecting **Save** or **Save As** or by selecting **Home** and clicking the **Save** icon. .

#### 6.1.6.13 Comparing projections

If you want to compare your new projection with a previous one you can open a 'Comparison Projection'. Click on the Spectrum menu icon in the upper left corner of the Spectrum window and select 'Open Comparison' then select the previous projection. You will now have two projections open in Spectrum. Any charts you display will show both the current and the comparison projection so that you can see what has changed. You can use the editors to see the inputs to the comparison projection but you will not be able to change anything. When Spectrum re-projects the current projection it will not re-project the comparison projection. This maintains the integrity of the previous projection and uses it only for comparison purposes.

#### 6.1.6.14 Creating alternate projections

You can compare alternate projections by opening two or more files that have exactly the same inputs except for one indicator that you wish to examine. For example you might want to see the effect on AIDS deaths of increasing ART coverage. The easiest way to do this is to start by opening the base file. Then open the same file again. When you try to do this Spectrum will recognize that you are trying to open the same file twice. It will ask you if you want to go ahead and do this or if you want to rename the projection as you load it. If you choose to rename it, you can provide a new name, such as 'Expanded ART'. Then you will have two projections opens that are exactly the same. You can then edit the 'Expanded ART' projection and change the projected ART coverage. Then you can display the number of AIDS deaths to see the effect of expanded coverage.

When multiple projections are open Spectrum will display the names of the projections at the bottom of the screen and show an asterisk next to the active projection. This is the projection that will appear when you edit the data. To edit a different projection, click the **Set Active** button (when the **Modules** menu item is selected) and select the projection to edit.

#### 6.1.6.15 Uncertainty analysis

Spectrum can calculate the range of plausible values for each of the output indicators. To use this feature you should open one, and only one, projection. If you have more than one projection open the uncertainty menu option will not appear.

To start an uncertainty analysis, select **Tools** from the main menu and then click the **Uncertainty Analysis** icon. You will see a display like the one below.

	Mean	s.d.
<b>Adults</b>		
Ratio of fertility of HIV+ to HIV- women	0.10	
Ratio of female to male incidence	0.05	
Average number of years in CD4 count category	0.05	
HIV mortality without ART	0.05	
HIV mortality with ART	0.05	
<b>Children</b>		
MTCT rates	0.05	
Reduction in child mortality due to cotrimoxazole	0.33	0.10
<b>Survival on ART</b>		
Children Under 1 year old	0.80	0.08
Children Age 1 and older First Year	0.90	0.04
Children Age 1 and older Subsequent years	0.95	0.04

☐ Generate AIDS deaths CSV file  
☐ Generate HIV+ CSV file

Number of iterations:  1000

Process time: 23 min 20 sec      Process date: 2013-Jun-5

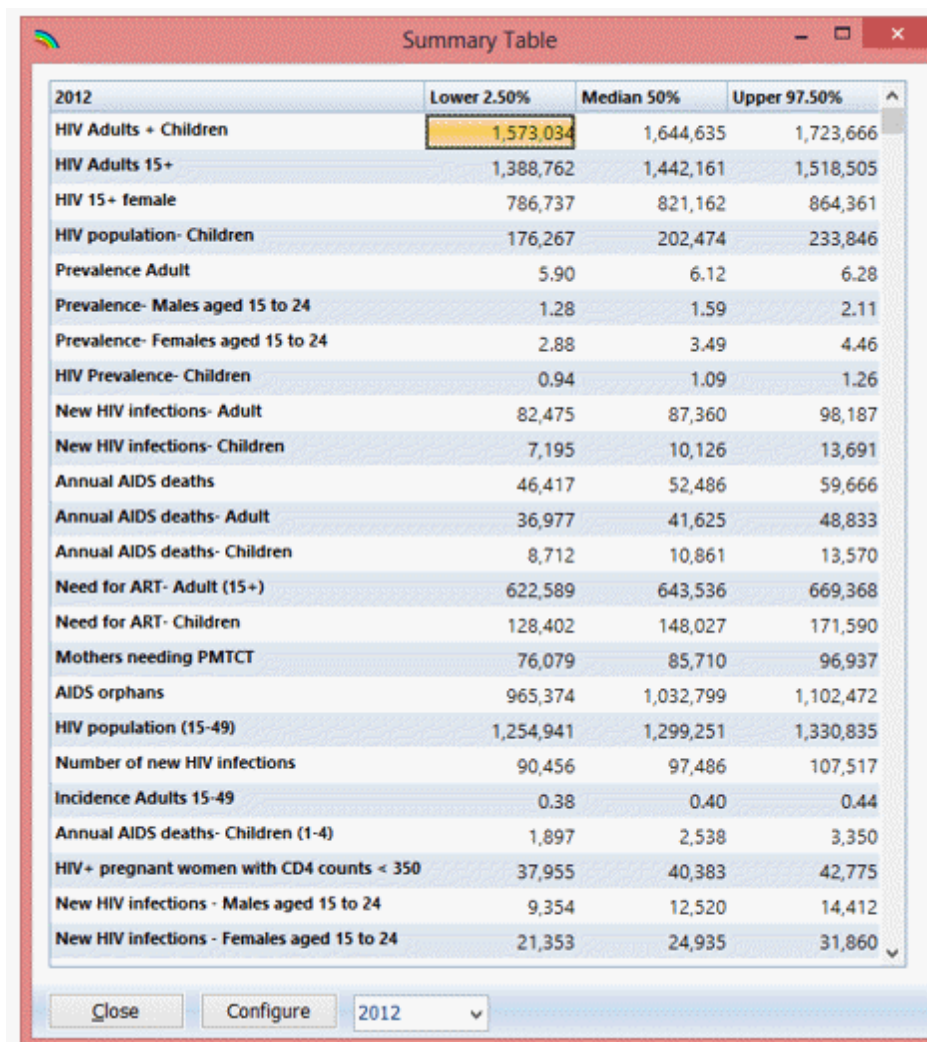
              

The column labeled '**s.d.**' shows the standard deviation (as a proportion of the mean value) used in the uncertainty analysis. You can change any of these standard values if you wish to try a larger or smaller range. The uncertainty analysis will randomly select parameter values for each of these indicators for each iteration.

By default the number of iterations is set to 1000. It will take 20-40 minutes to generate 1000 runs. You can test the procedure by changing this to a smaller number but should generate 1000 curves for your final analysis.

When you are ready to go, click the 'Process' button to start the analysis. When it is finished you can

select any of the indicators to display the average curve and the 95% plausibility bounds. A summary table, shown below, is available to display the ranges for all indicators for a selected year.



2012	Lower 2.50%	Median 50%	Upper 97.50%
HIV Adults + Children	1,573,034	1,644,635	1,723,666
HIV Adults 15+	1,388,762	1,442,161	1,518,505
HIV 15+ female	786,737	821,162	864,361
HIV population- Children	176,267	202,474	233,846
Prevalence Adult	5.90	6.12	6.28
Prevalence- Males aged 15 to 24	1.28	1.59	2.11
Prevalence- Females aged 15 to 24	2.88	3.49	4.46
HIV Prevalence- Children	0.94	1.09	1.26
New HIV infections- Adult	82,475	87,360	98,187
New HIV infections- Children	7,195	10,126	13,691
Annual AIDS deaths	46,417	52,486	59,666
Annual AIDS deaths- Adult	36,977	41,625	48,833
Annual AIDS deaths- Children	8,712	10,861	13,570
Need for ART- Adult (15+)	622,589	643,536	669,368
Need for ART- Children	128,402	148,027	171,590
Mothers needing PMTCT	76,079	85,710	96,937
AIDS orphans	965,374	1,032,799	1,102,472
HIV population (15-49)	1,254,941	1,299,251	1,330,835
Number of new HIV infections	90,456	97,486	107,517
Incidence Adults 15-49	0.38	0.40	0.44
Annual AIDS deaths- Children (1-4)	1,897	2,538	3,350
HIV+ pregnant women with CD4 counts < 350	37,955	40,383	42,775
New HIV infections - Males aged 15 to 24	9,354	12,520	14,412
New HIV infections - Females aged 15 to 24	21,353	24,935	31,860

## 6.1.7 Methodology

### 6.1.7.1 Structure

The population is tracked over time by age, time, sex, time, HIV state and duration in that HIV state. The population array is defined as  $pop_{a,t,s,h,d}$  where:

- a = age (0..79, 80+, total)
- s = sex (male, female, both)
- t = time in years (1 = first year of projection)
- h = HIV state

For children (0-14) the HIV states are:



Neg: not infected

Asym: HIV+, infected at birth

BF\_LT6: HIV+, infected 0-6 months after birth through breastfeeding

BF\_6to12: HIV+, infected 6-12 months after birth through breastfeeding

BF\_GT12: HIV+, infected 12+ months after birth through breastfeeding

OnART: HIV+ and on ART

For adults (15+) the HIV states are:

Neg: not infected

CD4\_<50: HIV+, CD4 count < 50 cells/ $\mu$ l

CD4\_50-99: HIV+, CD4 count 50-99 cells/ $\mu$ l

CD4\_100-199: HIV+, CD4 count 100-199 cells/ $\mu$ l

CD4\_200-349: HIV+, CD4 count 200-349 cells/ $\mu$ l

CD4\_350-500: HIV+, CD4 count 350-500 cells/ $\mu$ l

CD4\_500+: HIV+, CD4 count > 500 cells/ $\mu$ l

ART\_<50: On ART, initiated with CD4 count < 50 cells/ $\mu$ l

ART\_50-99: On ART, initiated with CD4 count 50-99 cells/ $\mu$ l

ART\_100-199: On ART, initiated with CD4 count 100-199 cells/ $\mu$ l

ART\_200-349: On ART, initiated with CD4 count 200-349 cells/ $\mu$ l

ART\_350-500: On ART, initiated with CD4 count 350-500 cells/ $\mu$ l

ART\_500+: On ART, initiated with CD4 count > 500 cells/ $\mu$ l

$d$  = duration (number of years in the HIV state),  $d_{All}$  refers to all durations. For adults duration is always 1 for those who are not infected and those not on ART. For those on ART there are three levels: 0-6 months, 7-12 months, and 12+ months.

Whenever a subscript is omitted it means that the variable refers to all categories. For example  $P_{a,t,s,h,d}$  defines the population by each of the five characteristics, whereas  $P_{a,t,s,h}$  refers to the population of age  $a$ , sex  $s$ , HIV state  $h$  at time  $t$  for all durations  $d$  and  $P_t$  refers to the total population of all ages, both sexes, all HIV states and all durations at time  $t$ .

#### 6.1.7.2 Initializing the population

The base year population may be entered as single ages or by five year age groups. If it is entered by five year age groups then it is split into single ages using a modified Beers approach as described in the manual for DemProj. In the base year the entire population is assumed to be HIV-negative.

#### 6.1.7.3 Progressing the population to the next year

The first step in the projection is to progress the population from the previous year to the current year including all processes not related to HIV: aging, non-AIDS mortality, migration and births. These calculations start with the second year of the projection and continue until the final year. Each population group progresses one year in age and one year longer duration in the current state. Each population

group is also subjected to non-AIDS mortality according to the input non-AIDS life expectancy and the selected model life table. The non-AIDS mortality rate is applied equally to all HIV states and durations within a specific age and sex group. Migration is calculated as a proportion of the population in each category. Thus we assume that migrants, whether in- or out-migrants, are distributed by HIV state and duration in that state according to the distribution of the resident population. The migration rate ( $mr$ ) is the average number of migrants during the year divided by the population at the beginning of the period.

#### 6.1.7.3.1 Uninfected population

The population that is not infected is progressed subject to aging, non-AIDS mortality and migration.

$$P_{a,s,t,h,d} = P_{a-1,s,t-1,h,d-1} \times (sr_{a-1,a,t} + mr_{a,s,t} \times [1 + sr_{a-1,a,t}]/2)$$

Where:

$h = 0$  (uninfected)

$sr_{a-1,a,t,s}$  = proportion of population of sex  $s$  at time  $t$  surviving from age  $a-1$  to age  $a$ . The survival rates defined by country-specific life tables. In most cases these have been prepared by the United Nations Population Division. You may also use any of the nine model life tables built-into DemProj.

$mr_{a,s,t}$  = migration rate for age  $a$  and sex  $s$  at time  $t$ . This is expressed as a proportion of the resident population.

For the HIV-infected population the calculations are somewhat different depending on the age group.

#### 6.1.7.3.2 Children 0-4

For ages 1-14 ( $a$ ) and each HIV state ( $h$ )

$$P_{a,s,t,h,d} = P_{a-1,s,t-1,h,d-1} \times (sr_{a-1,a,t,s} + mr_{a,s,t} \times [1 + sr_{a-1,a,t,s}]/2)$$

#### 6.1.7.3.3 Children 15 years old

At age 15 children transition from the HIV states associated with children 0-14 (uninfected, infected at birth, infected through breastfeeding at 0-6/7-12/12+ months, on ART) to the adult HIV states (uninfected, infected but not on ART by CD4 category, on ART by CD4 category at initiation). HIV-infected children who are not on ART. Children who are not on ART are distributed by CD4 category according to the pattern shown in Table 8. These patterns were derived from the HIV Paediatric Prognostic Markers Collaborative Study (HPPMCS) which took place in western countries before ART was available. The study included a meta-analysis of individual longitudinal data on 3,941 HIV-1 infected children enrolled in cohort studies and randomized control trials in the USA and Europe. Care was taken to avoid using the same children in multiple studies.<sup>1</sup>

**Table 8. Distribution of 15-year olds not on ART by CD4 count category**

CD4 Count Category	Percent of 15 Year Olds not on ART	Percent on ART by CD4 Count at Initiation
<50	28%	29%
50-99	23%	14%
100-199	14%	23%
200-249	7%	23%
250-349	11%	11%
350-500	11%	0%
>500	6%	0%

For HIV states ( $h$ ) including those infected at birth and through breastfeeding:

$$\text{Not\_on\_ART}_t = \sum_h P_{a-1,t-1,s,h,d}$$

For CD4 count categories ( $h$ ) from <50 to >500:

$$P_{15,t,s,h,1} = \text{Not\_on\_ART} \times \text{CD4}_h$$

Where  $\text{CD4}_h$  is as defined in column 2 of table 8.

Children on ART are distributed by CD4 count at initiation according to the pattern in column 3 of table 8 which is based on typical patterns for adults 15-19 years old.

<sup>1</sup> Dunn D. Short-term risk of disease progression in HIV-1-infected children receiving no antiretroviral therapy or zidovudine monotherapy: a meta-analysis. Lancet 2003;362(9396):1605-11.

#### 6.1.7.3.4 Adults 15 to 79 years old

For most countries with concentrated epidemics some portion HIV infections is among people who inject drugs (PWID). In addition to the risks of HIV-related mortality PWID experience higher rates of non-HIV mortality compared to those who do not inject drugs. A review of mortality data found a crude non-AIDS mortality rate of about 2.5% among PWID.<sup>1</sup> AIM includes this excess mortality by adjusting the survival rate for all HIV+ adults by the proportion of the HIV+ population that is PWID and the excess mortality.

$$sr'_{a,t,s} = 1 - \{ (1 - sr_{a,t,s}) + [0.025 - (1 - sr_{a,t,s})] \times \text{PropPWID}_t \times \text{PropPWIDSex}_s \\ / (P_{a-1,t-1,s} / P_{a-1,t-1,\text{BothSexes}}) \}$$

where:

$sr'_{a,t,s}$  = adjusted survival rate taking into account the excess mortality of PWID

0.025 = the crude non-AIDS mortality rate for PWID

$\text{PropPWID}_t$  = proportion of all HIV+ adults that are PWID

$\text{PropPWIDSex}_s$  = proportion of all PWID of sex  $s$

If the population structure does not include designation of PWID (as is the case in most generalized epidemics) then no adjustment is made to the survival rate.

HIV-infected adults over the age of 15 are progressed by accounting for aging, non-AIDS mortality and migration occurring to people in each CD4 category.

For age  $a$  from 16 to 80, and all HIV  $h$  states and durations  $d$ :

$$P_{a,s,t,h,d} = P_{a-1,s,t-1,h,d-1} \times (sr'_{a-1,a,t,s} + mr_{a,s,t} \times [1 + sr'_{a-1,a,t,s}]/2)$$

For those who are not on ART, HIV status  $h$  varies from CD4 count <50 to >500. For those on ART HIV status  $h$  is the CD4 count category at ART initiation.

The number of non-AIDS deaths in each year is the population in the previous year multiplied by one minus the survival rate.

For all HIV states  $h$  and all durations  $d$

$$D_{a,t,s} = \text{pop}_{a-1,t-1,s,h,d} \times (1 - sr'_{a-1,a,t,s}) + (\text{mig}_{a-1,t-1,s} + \text{mig}_{a,t,s}) / 2 \times (1 - sr'_{a-1,a,t,s})$$

Where:

$D_{t,s}$  = deaths occurring from  $t-1$  to  $t$  to the population of age  $a$  and sex  $s$

$\text{mig}_{a,t,s}$  = number of migrants of age  $a$  and sex  $s$  in year  $t$

<sup>1</sup> Mathers BD, Degenhardt L, Bucello C, Lemon J, Wiessing L, Hickman M. Mortality among people who inject drugs: a systematic review and meta-analysis

#### 6.1.7.3.5 Adults 80+

For those aged 80+ the calculations include those aged 79 the previous year who age into the 80+ age group and those aged 80+ in the previous year who may remain in this age group or die.

$$P_{80+,t,s,h,d} = P_{79,t-1,s,h,d} \times (sr'_{79,80,t,s} + mr_{79,s,t} \times [1 + sr'_{79,80,t,s}]/2) + P_{80+,t-1,s,h,d} \times (sr'_{80+,80+,t,s} + mr_{80+,s,t} \times [1 + sr'_{80+,80+,t,s}]/2)$$

#### 6.1.7.4 Births

The number of births is calculated from the number of women of reproductive age (15-49), the total fertility rate and the age distribution of fertility.

$$B_t = \sum_{a=15-49} P_{a,t,\text{female}} \times \text{TFR}_t \times \text{ASFR}_{a,t}$$

Where:

$B_t$  = the number of births occurring in year  $t$

$P_{a,t,\text{female}}$  = the number of women of age  $a$  at time  $t$

$\text{TFR}_t$  = the total fertility rate at time  $t$

$\text{ASFR}_{a,t}$  = the percentage of life time births that occur to women of age  $a$  at time  $t$

Total births are split into male and female births using the sex ratio at birth:

$$B_{\text{male},t} = B_t \times \text{SexRatio}_t / (1 + \text{SexRatio}_t)$$

$$B_{\text{female},t} = B_t \times 1 / (1 + \text{SexRatio}_t)$$

Where:

$B_{s,t}$  = births of sex  $s$  at time  $t$

$\text{SexRatio}_t$  = the number of male births per 100 female births at time  $t$

Women who are HIV+ have lower fertility than those who are not infected.<sup>1</sup> However, that does not affect the calculation of total births since this calculation is based on the TFR as measured by surveys, which would already include any depressing effect of HIV infection. The calculation of births to HIV+ women, described below, is adjusted to account for this effect.

The number of children younger than one is calculated from births, survival to the end of the year and migration. We use  $\frac{1}{2}$  the annual migration rate since only half of migrants in the youngest age group will still be less than one year of age by the end of the time year. For the migrants we use  $\frac{2}{3}$  of the survival rate since, on average, they will be subject to only  $\frac{1}{2}$  year of mortality, but mortality in the first six months of life is higher than during the second six months.

$$P_{0,t,s} = B_{s,t} \times (\text{sr}_{\text{birth},0,t,s} + \text{migr}_{0,t,s} / 2 \times (1 + 2 \times \text{sr}_{\text{birth},0,t,s}) / 3$$

Deaths occurring to newborns are calculated in a similar fashion.

$$D_{0,t,s} = B_{s,t} \times \{1 - \text{sr}'_{\text{birth},0,t,s} + \text{mig}_{0,t-1,s} / [2 \times (1 - \text{sr}'_{\text{birth},0,t,s})/3]\}$$

<sup>1</sup> Chen WJ, Walker N. Fertility of HIV- infected women: insights from Demographic and Health Surveys *Sex Transm Infect* 2010 86: ii22-ii27

#### 6.1.7.5 HIV+ adults not on ART

In each time step the HIV+ adults in each CD4 category may remain in that category, die from HIV-related causes, initiate ART or progress to the next lower CD4 category. Thus new exits from the CD4 category are calculated as:

$$X_{a,t,s,h} = P_{a,t-1,s,h} \times (\mu_{a,s,h} + \lambda_{a,h} + c_{a,s,h,t})$$

Where:

$X_{a,t,s,h}$  = number of HIV+ adults leaving the CD4 category  $h$

$\mu_{a,s,h}$  = annual mortality rate of HIV+ adults of age  $a$ , sex  $s$  and CD4 category  $h$

$\lambda_{a,h}$  = proportion of HIV+ adults progressing the next lower CD4 count category

$c_{a,s,h,t}$  = proportion of HIV+ adults initiating ART

New entrants are calculated as the number progressing from the next higher CD4 category. There will also be new infections entering into some CD4 categories but they are calculated later as described below.

$$N_{a,t,s,h} = P_{a,t-1,s,h+1} \times \lambda_{a,h}$$

Where:

$N_{a,t,s,h}$  = number of HIV+ adults entering the CD4 category  $h$

$I_{a,s,t}$  = the number of new HIV infections among adults of age  $a$  and sex  $s$  at time  $t$

$IP_{a,t,s,h}$  = the proportion of new infections starting in CD4 category  $h$

The updated number of people in each category is calculated from the entrants and exits.

$$P_{a,t,s,h} = P_{a,t-1,s,h} + N_{a,t,s,h} - X_{a,t,s,h}$$

#### 6.1.7.6 ART among adults

Need for ART is defined as all those currently on ART plus those eligible for treatment but not on it. Eligibility for adults is defined by CD4 count and membership in special populations (pregnant women, TB/HIV co-infected, sero-discordant couples, sex workers, MSM, PWID and other special populations).

For age  $a$  from 15 to 80

$$E_{a,s,t} = T_{a,s,t} + \sum_{h=<50,EL} P_{a,t,s,h,d} + \sum_{h=EL+1,>500} SP_{sp,t} \times SPE_{sp,t}$$

Where:

$E_{a,s,t}$  = Population eligible for treatment in year  $t$

$T_{a,s,t}$  = Number on treatment at age  $a$ , sex  $s$  at time  $t$

$EL$  = CD4 count eligibility threshold

$SP_{sp,t}$  = Number of people in special population  $sp$  in year  $t$

$SPE_{sp,t}$  = 1 if special population  $sp$  is eligible for treatment in year  $t$ , otherwise = 0.

Note that eligibility includes the total population  $P_{a,t,s,h,d}$  for all CD4 categories less than or equal to the CD4 threshold for eligibility  $EL$  and any special populations  $SP$  for CD4 categories above the CD4 threshold for eligibility.

The number of HIV+ people in each eligible population except pregnant women is determined from the input on the percentage of all HIV+ adults that are members of each special population.

For HIV state  $h$  indicating CD4 count categories above the eligibility threshold:

$$SP_{sp,t} = SP\%_{sp} \times P_{t,s,h}$$

Where:

$SP\%_{sp}$  = the percentage of all HIV+ adults that are in special population  $sp$

Note that this approach assumes that each special population is distributed by CD4 count the same as the total adult population.

For HIV+ pregnant women AIM calculates the number above the eligibility threshold based on the number of HIV+ women by age, the distribution of fertility by age and the effects of HIV infection on fertility.

$$PW_t = \sum_a P_{a,t,female,HIV+} \times TFR_t \times ASFR_{a,t} \times TFRred_a / [TFRred_a \times prev_{a,t} + (1 - prev_{a,t})]$$

Where

$PW_t$  = the number of HIV+ pregnant women with CD4 counts above the eligibility threshold

$TFR_t$  = total fertility rate

$ASFR_{a,t}$  = percentage of lifetime births occurring to women at age  $a$

$TFRred_a$  = ratio of TFR among HIV+ women to HIV- women of age  $a$

$prev_{a,t}$  = proportion of women age  $a$  who are HIV+ and not on ART. Note: we assume that the fertility of women on ART is that same as uninfected women

The expression  $TFRred_a / [TFRred_a \times prev_{a,t} + (1 - prev_{a,t})]$  converts the fertility reduction for HIV

infection from a ratio of fertility among HIV+ to HIV- women to a ratio of fertility among HIV+ women to all women.

The number of adults on treatment is determined from the inputs, which may expressed as the number of men and women on treatment or the percentage of those eligible who are on treatment. If the inputs are percentages they are converted to numbers by multiplying by the number eligible for treatment.

The numbers (or percentages) of adults on ART are entered for December 31 of each year because that is the normal reporting date for programs reporting to WHO and UNAIDS. Most Spectrum calculations refer to July 1 so the inputs numbers need to be converted to July 1 by interpolation. The AIM calculations for adults are done in 1/10 year time steps. So for the first 5 time steps (from July 1 to Jan 1) the interpolation is between the data entered for  $t-1$  to  $t$  and for the second 5 time steps (Jan 1 to July 1) the interpolation is between data entered for  $t$  to  $t+1$ . In other words, to calculate the number on treatment for October 2012 the model interpolates between entries for December 31, 2011 and December 31, 2012 and for March 2013 it interpolates between entries for December 31, 2012 and December 31, 2013. This interpolation established the number on treatment at any time  $t$ .

The number that need to start treatment at time  $t$  is the difference between the number on treatment and the number surviving on treatment from the previous time step.

$$\text{NewT}_{a,t,s} = \text{NeedT}_{a,t,s} - \sum_d T_{a,t-1,s,h,d} \times (1 - a_{a,t,h,d})$$

Where:

$\text{NewT}_{a,t,s}$  = number of adults of age  $a$  and sex  $s$  newly starting treatment at time  $t$

$\text{NeedT}_{a,t,s}$  = number of adults of age  $a$  and sex  $s$  eligible for treatment at time  $t$

$T_{a,t,s,h,d}$  = number of adults of age  $a$  and sex  $s$  who initiated treatment at CD4 category  $h$  who have been on treatment for duration  $d$  at time  $t$ . Note that duration is either 0-6 months, 7-12 months or 12+ months. CD4 categories are <50, 50-99, 100-199, 200-249, 250-349, 350-500, 500+.

$a_{a,t,h,d}$  = mortality rate among adults of age  $a$  and sex  $s$  who initiated treatment at CD4 category  $h$  who are still on treatment at time  $t$

New ART patients are distributed by CD4 count according to the average of two allocation schemes. The first scheme assumes that new patients are distributed according to the distribution of the number eligible for treatment but not on treatment.

$$P1_h = E'_h / \sum_h E'_h$$

Where:

$P1_h$  = proportion of new ART patients starting ART at CD4 category  $h$  under scheme 1

$E'_h$  = number eligible for ART but not on ART at CD4 category  $h$

The second scheme allocates new patients according to the expected number of deaths no one starts ART.



$$P2_h = E_h \times \mu_h / \sum_h (E_h \times \mu_h)$$

Where:

$P2_h$  = proportion of new ART patients starting ART at CD4 category  $h$  under scheme 2

$\mu_h$  = mortality rate for HIV+ adults not on treatment with CD4 count  $h$

The final allocation is the average of the two approaches.

$$P0_h = (P1_h + P2_h) / 2$$

New ART patients are distributed according to the final proportions:

$$NewT_{a,t,s,h} = NewT_{a,t,s} \times P0_h$$

These new patients are added to existing patients.

$$T_{a,t,s,h} = T_{a,t,s,h} + NewT_{a,t,s,h}$$

In each time step the number of people on ART by CD4 category at initiation may be increased by those newly initiating ART and decreased by death. ART patients are tracked by duration on treatment. Thus the calculations are done for three categories of ART patients: those on ART for 6 months or less ( $d=1$ ), those on ART for 7-12 months ( $d=2$ ) and those on ART for longer than 12 months ( $d=3$ ):

For those on treatment for 0-6 months

$$A_{a,t,s,h,1} = A_{a,t,s,h,1} \times (1 - a_{a,s,h,1} - 12/6) / ts + NewT_{a,t,s,h}$$

Where:

$A_{a,t,s,h,1}$  = number on treatment

$a_{a,s,h,1}$  = mortality rate of those on treatment for 0-6 months

$ts$  = time step equal to 1/10 year

$12/6$  = adjustment to account for movement to the 7-12 month duration category

For those on treatment for 7-12 months

$$A_{a,t,s,h,2} = A_{a,t,s,h,2} \times (1 - a_{a,s,h,2} - 12/6) / ts + A_{a,t,s,h,1} \times (12/6) / ts$$

For those on treatment 12+ months

$$A_{a,t,s,h,3} = A_{a,t,s,h,3} \times (1 - a_{a,s,h,2}) / ts + A_{a,t,s,h,2} \times (12/6) / ts$$

### 6.1.7.7 New adult HIV infections

New adult HIV infections are calculated from HIV incidence among adults aged 15 to 49 provided by EPP. The incidence provided by EPP is defined calculated as:

New Infection from July 1 year  $t$  to July 1 year  $t+1$

Susceptible population on July 1 2006

Since Spectrum is age and sex-structured (calculating by sex and single age) and EPP is not (calculating for all 15-49 and both sexes) when the incidence provided by EPP is used in Spectrum it may not exactly reproduce the prevalence trend fit by EPP. Therefore Spectrum adjusts the incidence each year in order to more closely match the EPP prevalence curve.

First we calculate the number of HIV+ adults 15-49 needed to match the prevalence specified by EPP.

$$\text{NeededHIV}_t = P_{15-49,t} \times p_t$$

Where

$\text{NeededHIV}_t$  = number of HIV+ adults 15-49 needed to match EPP prevalence

$P_{15-49,t}$  = number of adults 15-49

$p_t$  = prevalence among adults 15-49 in year  $t$  from EPP

$$\text{NeededNewHIV}_t = \text{NeededHIV}_t - P_{15-49,t,\text{Both Sexes,HIV+}}$$

Where:

$\text{NeededNewHIV}_t$  = the number of new infections among adults 15-49 needed to match EPP prevalence

$P_{15-49,t,\text{Both Sexes,HIV+}}$  = the number of adults 15-49 of both sexes who are HIV+

The adjustment factor is the needed incidence ( $\text{NeededNewHIV} / (\text{population} - \text{HIV population})$ ) divided by the incidence coming from EPP.

$$\text{AdjF}_t = [\text{NeededNewHIV}_t / (P_{15-49,t} - P_{15-49,t,\text{Both Sexes,HIV+}})] / I_{\text{EPP}_t}$$

Where:

$\text{AdjF}_t$  = incidence adjustment factor at time  $t$

$I_{\text{EPP}_t}$  = incidence provided by EPP in year  $t$

The incidence adjustment factor is calculated for all historical years. The adjustment factor for the current year is used for all future years.

The incidence adjustment factor may be turned off by unchecking the 'EPP prevalence adjustment' in the 'Direct incidence input' editor. It should be turned on for most analyses but should be turned off when comparing two files with different historical inputs (such as difference levels of ART coverage).

In the approach currently used in EPP a smooth prevalence curve is fit to surveillance and survey data and then incidence is estimated from the prevalence curve. This approach works well to smooth annual fluctuations in surveillance data. However, when something happens that should cause a sharp change in prevalence, such as a sharp rise or fall in ART coverage, then this approach works less well, since it will still produce a smooth prevalence curve and the rapid changes will show up in the estimated incidence curve. To avoid these sharp changes in incidence from showing up in Spectrum output, we impose a limit on the size of the adjustment factor, usually 1.2, in order to smooth fluctuations in incidence.

The final incidence is the incidence from EPP multiplied by the adjustment factor.

$$I_t = I_{EPP,t} \times AdjF_t$$

Incidence among males and females is determined from incidence among all adults 15-19 ( $I_t$ ) and the sex ratio of incidence, which is an input. The sex ratio of incidence is defined as female incidence divided by male incidence.

$$I_{f,t} = I_t \times (P_{15-49,t,f} - P_{15-49,t,f,HIV+} + P_{15-49,t,m} - P_{15-49,t,m,HIV+}) / [P_{15-49,t,f} - P_{15-49,t,f,HIV+} + (P_{15-49,t,m} - P_{15-49,t,m,HIV+}) / SR_t]$$

$$I_{m,t} = I_{f,t} / SR_t$$

Where:

$I_{f,t}$  = female incidence at time  $t$

$I_{m,t}$  = male incidence at time  $t$

$SR_t$  = ratio of female to male incidence at time  $t$

New male and female infections are calculated from incidence.

$$NI_{s,t} = I_{s,t} \times (P_{15-49,t,s} - P_{15-49,t,s,HIV+})$$

Where:

$NI_{s,t}$  = new infections among sex  $s$  at time  $t$

New adult infections within each sex are distributed by age according to the input pattern of incidence rate ratios. These patterns describe the ratio of incidence at any age to incidence in the 25-29 age group. Thus a ratio of 0.5 means that incidence at that age is half the incidence at age 25-29.

The first step is to calculate new infections if the incidence for the 25-29 age group were 1.0. In that case the number of new infections would be simply the susceptible population multiplied by the incidence rate ratio for each age.

For all ages 15 to 80

$$I1_{s,t} = \sum_a P_{a,t,s,HIV-} \times IRR_{a,t,s}$$

Where:

$I1_{s,t}$  = New infections is incidence among 25-29 were 1.0

$P_{a,t,s,HIV-}$  = uninfected population of age  $a$  and sex  $s$  at time  $t$

$IRR_{a,t,s}$  = incidence rate ratio for age  $a$  and sex  $s$  at time  $t$

Then an adjustment factor is calculated as the ratio of the total number of new infections required divided by the number of incidence among 25-29 were 1.0.

$$IAF_{s,t} = NI_{s,t} / I1_{s,t}$$

Where:

$IAF_{s,t}$  = incidence adjustment factor for sex  $s$  at time  $t$

New infections at each age are calculated from the EPP incidence, the adjustment factor and the incidence rate ratio for that age.

For all ages  $a$  from 15 to 80

$$NI_{a,t,s} = P_{a,t,s,HIV-} \times I_{s,t} \times IAF_{s,t} \times IRR_{a,t,s}$$

Note that this final calculation includes all ages up to age 80. Thus the pattern of incidence rate ratios specifies the new infections occurring to adults above the age of 49.

Finally, new adult infections are added to the appropriate population.

$$P_{a,t,s,h} = P_{a,t,s,h} + NI_{a,t,s} \times IP_{a,t,s,h}$$

Where:

$IP_{a,t,s,h}$  = the proportion of new infections starting in CD4 category  $h$

#### 6.1.7.8 Births to HIV+ women

The number of HIV+ births is calculated from total births, the prevalence among pregnant women and the transmission rate.

Births to HIV+ women are calculated in a similar manner to the calculation of all births. The number of HIV+ women in each age group is multiplied by the total fertility rate and by the proportion of life time

births that occur in that age group. The fertility of HIV+ women is adjusted for the effects of HIV infection on fertility as described in Chapter 4.

For age  $a$  from 15 to 49

$$PW_t = \sum_a P_{a,t,f,HIV+} \times TFR_t \times ASFR_{a,t} \times TFRred_a / [TFRred_a \times prev_{a,t} + (1 - prev_{a,t})]$$

Where:

$PW_t$  = the number of HIV+ pregnant women with CD4 counts above the eligibility threshold

$TFR_t$  = total fertility rate

$ASFR_{a,t}$  = percentage of lifetime births occurring to women at age  $a$

$TFRred_a$  = ratio of TFR among HIV+ women to HIV- women of age  $a$

$prev_{a,t}$  = proportion of women age  $a$  who are HIV+ and not on ART. Note: we assume that the fertility of women on ART is that same as uninfected women

The expression  $TFRred_a / [TFRred_a \times prev_{a,t} + (1 - prev_{a,t})]$  converts the fertility reduction for HIV infection from a ratio of fertility among HIV+ to HIV- women to a ratio of fertility among HIV+ women to all women.

In some countries some women who know that they are HIV-infected may elect an abortion to avoid the chance of transmitting the infection to their newborn child. The number of births to HIV+ mothers is reduced by the proportion of pregnancies terminated by abortion.

$$B_{HIV+,t} = PW_t \times (1 - AbortionRate_t)$$

Where:

$B_{HIV+,t}$  = births occurring to HIV+ women at time  $t$

Abortion Rate $_t$  = the proportion of pregnancies occurring to HIV+ women that are terminated by abortion

Note that the number of births to HIV+ women is different from the number of HIV+ pregnant women. About 15% of pregnancies do not result in a live birth due to miscarriage, spontaneous abortion and still births.<sup>1</sup> However, most of these miscarriages occur early in the pregnancy, often before a woman knows she is pregnant. Most services for HIV+ pregnant women are provided later in the pregnancy. So we do not adjust for miscarriage.

The need for prophylaxis to prevent mother-to-child transmission (PMTCT) is defined as the number of HIV+ women giving birth.

<sup>1</sup> Nybo Anderson AM, Wohlfahrt J, Christens P, Olsen Jorn, Melbye M (2000) Maternal age and fetal loss: population based register linkage study BMJ 2000;320:1708-1712.

#### 6.1.7.9 Mother-to-child transmission

The transmission of HIV from mother to child is divided into two components: transmission during gestation and delivery and postnatal transmission through breastfeeding. The perinatal mother-to-child transmission rate is the weighted average of the proportion in each prophylaxis group and the corresponding probability of transmission. The prophylaxis groups are:

- No prophylaxis, CD4 count < 200 cells/ $\mu$ l
- No prophylaxis, CD4 count 200-350 cells/ $\mu$ l
- No prophylaxis, CD4 count >350 cells/ $\mu$ l
- Incident infection
- Single dose Nevirapine
- Dual ARVs
- Option A
- Option B
- ART started during current pregnancy
- ART started before current pregnancy

The transmission probabilities are as defined in Table 1 in Chapter 4.

$$PTR_t = \sum_c \text{Prophylaxis}_{c,t} \times TR_c$$

Where:

$PTR_t$  = perinatal transmission rate

$\text{Prophylaxis}_{c,t}$  = the proportion of women by prophylaxis category

$TR_c$  = probability of transmission of HIV by prophylaxis category

The distribution of women not receiving prophylaxis by CD4 count is assumed to be the same as for all HIV+ women 15-49 not on ART.

The proportion of women with an incidence infection is assumed to be the same as all the incidence rate for all women 15-49.

In general we assume that women receiving Option A or Option B have CD4 counts greater than 350 cells/ $\mu$ l, otherwise they should be receiving ART. However, if the number of women receiving Option and/or Option B exceeds the number of pregnant women with CD4 counts > 350 cells/ $\mu$ l then we assume that the excess represents women with CD4 counts < 350 cells/ $\mu$ l. We assume that the transmission rate for these women is double the rates when CD4 counts are > 350 cells/ $\mu$ l. In this case the transmission rate for all women receiving Option A or Option is increased by multiplying by  $1 + \text{ExcessRatio}$ , where the ExcessRatio is the proportion of HIV+ pregnant women receiving Option A or Option B divided by the

proportion of HIV+ pregnant women with CD4 counts > 350 cells/ $\mu$ l.

The number of HIV+ births is equal to the number of births to HIV+ women multiplied by the perinatal transmission rate.

$$B_{HIV+,t} = B_{HIV+,t} \times PTR_t$$

These births are added to the HIV+ population of age 0.

$$P_{0,t,s,PTR} = B_{HIV+,t} \times SRB_s$$

Where:

$P_{0,t,s,PTR}$  = Population at age 0 infected perinatally (PTR)

$SRB_s$  = proportion of births that are of sex  $s$

HIV transmission from mother to child also may occur through breastfeeding. The number of children infected through breastfeeding is calculated as the product of the number of children born to HIV+ mothers who were not infected perinatally, the proportion of children exposed to transmission through breastfeeding, the monthly probability of transmission through breastfeeding and the duration of breastfeeding.

The distribution of women by type of feeding is an input. The distribution of women may be different for those exposed to the PMTCT program and those not exposed to it and may change over time. The overall distribution is a weighted average of the distributions for women exposed to the program and those not exposed.

Women using Option A or Option B at the start of breastfeeding, may not continue on prophylaxis for the entire breastfeeding period. The proportion still on Option A or Option B is calculated by month from the monthly dropout rate.

$OptA_{0,t}$  = input percentage of breastfeeding women using Option A

$$Opt\_A_{m,t} = Opt\_A_{m-1,t} \times e^{m \times 2 \times \ln(1 + OptA\_DOT)}$$

$OptB_{0,t}$  = input percentage of breastfeeding women using Option B

$$Opt\_B_{m,t} = Opt\_B_{m-1,t} \times e^{m \times 2 \times \ln(1 + OptB\_DOT)}$$

Where:

$OptA_{0,t}$  = Percentage of mothers using Option A at start of breastfeeding

$OptA_{m,t}$  = Percentage of mothers using Option A in month  $m$

$m$  = age of child in months

OptA\_DO = monthly rate of drop out from prophylaxis

For each month  $m$  from birth to 36 months, the number of new infections through breastfeeding is calculated as:

$$\text{No\_prophylaxis}_{m,t} = 1 - \text{OptA}_{m,t} - \text{OptB}_{m,t} - \text{ARTbefore}_t - \text{ARTRduring}_t$$

$$\text{BFTR}_{m,t} = \text{No\_prophylaxis}_{m,t} \times [\text{PropLT350} \times \text{TR}_{\text{LT350}} + (1 - \text{PropLT350}) \times \text{TR}_{\text{GT350}} + \text{PropInc}_t \times \text{TR}_{\text{incident}}] + \text{OptA}_{m,t} \times \text{TR}_{\text{OptA}} + \text{OptB}_{m,t} \times \text{TR}_{\text{OptB}} + \text{ARTbefore}_t \times \text{TR}_{\text{ARTbefore}} + \text{ARTcurrent}_t \times \text{TR}_{\text{ARTcurrent}}$$

Where:

$\text{BFTR}_{m,t}$  = breastfeeding transmission rate at month  $m$

$\text{PropLT350}$  = proportion of HIV+ pregnant women with CD4 counts < 350

$\text{TR}$  = monthly transmission rate

$\text{PropInc}_t$  = incidence among HIV+ pregnant women

The number of new infections is the number of exposed children (HIV-negative children born to HIV+ mothers who are still breastfeeding) multiplied by the transmission rate.

$$\text{NI}_{m,t} = (\text{B}_{\text{HIV},t} - \sum_{m1=0 \text{ to } m-1} \text{NI}_{m1,t}) \times \text{PropBF}_{m,t} \times \text{BFTR}_{m,t}$$

Where:

$\text{NI}_{m,t}$  = new infections occurring through breastfeeding in month  $m$  to children born in year  $t$

$\text{PropBF}_{m,t}$  = proportion of children born in year  $t$  who are still breastfeeding at age  $m$  months

#### 6.1.7.10 ART for children

Eligibility for ART for children may be defined as all HIV+ children below a specific age or those with CD4 counts or CD4 percents below a certain threshold. Children who are not on ART are distributed by CD4 category according to the pattern shown in [Table 8](#). These patterns were derived from the HIV Paediatric Prognostic Markers Collaborative Study (HPPMCS) which took place in western countries before ART was available. The study included a meta-analysis of individual longitudinal data on 3,941 HIV-1 infected children enrolled in cohort studies and randomized control trials in the USA and Europe. Care was taken to avoid using the same children in multiple studies.<sup>1</sup>

HIV+ children at age 0 are distributed by CD4 count and CD4 percent according to the distributions found by HPPMCS shown in Table 9.



**Table 9. Distribution of HIV+ Children Age 0 by CD4 Count and CD4 Percent**

CD4 Count	Percent of HIV+ at Age 0	CD4 Percent	Percent of HIV+ at Age 0
<200	5	<5	1
200-350	3	5-10	3
350-500	2	10-15	5
500-750	6	15-20	9
750-1000	6	20-25	10
1000-1500	17	25-30	12
1500-2000	16	30-40	26
2000+	45	40+	34

The distribution of children at older ages is determined by the retention rates, the proportion of children in a category who remain in that category the following year. These retention rates were calculated from the HPPMCS data. They are shown in Table 10. These retention rates are used rather than the actual distributions from the HPPMCS data because some children will get on ART and they are likely to come from the lowest CD4 categories resulting in a changing distribution with ART coverage.

**Table 10. Proportion of children remaining in the category after one year**

CD4 Count	Retention Rate	CD4 Percent	Retention Rate
<200	0.986	<5	0.906
200-350	0.799	5-10	0.759
350-500	0.761	10-15	0.787
500-750	0.757	15-20	0.795
750-1000	0.666	20-25	0.785
1000-1500	0.644	25-30	0.756
1500-2000	0.460	30-40	0.813
2000+	0.500	40+	0.700

The percentage of HIV+ children not on ART by CD4 count is calculated as

$$CD4\_Dist_{a,c,t} = CD4\_Dist_{a-1,c,t-1} * RR_c + CD4\_Dist_{a-1,c+1,t} * (1 - RR_c)$$

Where:

$CD4\_Dist_{a,c,t}$  = proportion of HIV+ children of age  $a$  in CD4 count category  $c$  at time  $t$

$RR_c$  = retention rate for CD4 category  $c$

A similar calculation is used for CD4 percent distributions.

The unmet need for ART is determined as all those HIV+ children not on ART who are below the age threshold or below the CD4 threshold for that age or below the CD4 percent threshold for that age.

The number of children on ART is defined directly by the inputs if they are provided in terms of the number of children on ART or calculated from need if the inputs are provided as coverage of those eligible for ART.

The number of children newly starting on ART is calculated as the difference between the total number that should be on ART (from the inputs converted from December 31 to July 1) minus those surviving on ART from the previous year.

$$\text{NewART}_t = (\text{OnART}_t - \text{OnART}_{t-1}) / 2 - \sum_{a=0,14} P_{a,t,\text{ART}}$$

New child ART patients are distributed by age and sex according to unmet need.

$$\text{NewART}_{a,t,s} = \text{NewART}_t \times \text{UnmetNeed}_{a,t,s} / \sum_{a=0-14, s=\text{male to female}} \text{UnmetNeed}_{a,t,s}$$

The child populations are updated for changes in ART.

$$P_{a,t,s,\text{ART}} = P_{a,t,s,\text{ART}} + \text{NewART}_{a,t,s}$$

$$P_{a,t,s,\text{NoART}} = P_{a,t,s,\text{NoART}} - \text{NewART}_{a,t,s}$$

<sup>1</sup> Dunn D. Short-term risk of disease progression in HIV-1-infected children receiving no antiretroviral therapy or zidovudine monotherapy: a meta-analysis. *Lancet* 2003;362(9396):1605-11.

#### 6.1.7.11 Cotrimoxazole for children

Children are assumed to need cotrimoxazole under the following conditions:

- Less than 18 months of age, born to an HIV+ mother with unknown HIV status because PCR is not available
- HIV+ and under the age of five
- Age 5 and older and in need of treatment

For children less than 18 months of age the need for cotrimoxazole is all children born to HIV+ mothers. The totals are inflated to 18 months by multiplying by 1.5.

$$\text{NeedCTX}_t = \text{PW}_t \times 1.5 + \sum_{a=18\text{months to } 4 \text{ years}} P_{a,t,\text{HIV+}} + \sum_{a=5-14} P_{a,t,\text{NeedART}}$$

The number of children receiving cotrimoxazole may be a direct input or may be calculated from the input coverage.

#### 6.1.7.12 Child AIDS mortality

Children who are HIV+ and in need of ART but are not receiving either ART or cotrimoxazole progress to AIDS death according to the mortality schedules shown in Figure 6. For children on ART or cotrimoxazole or both the mortality rate is reduced by according to the input rates as described in Chapter 4.

For HIV+ children not on ART:

$$\mu_{p'd} = \mu'_{p'd} \times (1 + \%Ctx \times CtxRed_d)$$

where:

$\mu'_{p'd}$  = mortality rate for children infected at age  $p$  and  $d$  years ago not on cotrimoxazole

$\mu_{p'd}$  = mortality rate adjusted for cotrimoxazole use

$\%Ctx$  = percent of children on cotrimoxazole

$CtxRed_d$  = reduction in mortality among children receiving cotrimoxazole for  $d$  years.

For children receiving ART:

$$\mu_{p'd} = \mu'_{p'd} \times ARTRed_d \times (1 + \%Ctx \times CtxARTRed_d)$$

where

$ARTRed_d$  = reduction in mortality for children on ART for  $d$  years

$CtxARTRed_d$  = reduction in mortality for children on both ART and cotrimoxazole)

The child population in any state is reduced by mortality

$$P_{a,t,s,p,d} = P_{a,t,s,p,d-1} \times (1 - \mu_{p'd})$$

Where:

$p$  = indicates the timing of infection: perinatal, at 0-6 months, 7-12 months, 12+ months

$d$  = time since infection, in years

$\mu_{p'd}$  = mortality rate for children infected at age  $p$  and  $d$  years ago

### 6.1.7.13 Orphans

The orphan calculations estimate the number of surviving children of adults who die from AIDS or other causes. The program calculates the expected number of children that were born to an adult before his or her death, and estimates how many are still alive and their age. The same approach is used for AIDS and non-AIDS orphans and for maternal and paternal orphans. For dual AIDS orphans the program uses a regression equation to estimate the proportion of children who are likely to have both parents die from AIDS given that one parent has died. The initial methodology was developed by Timeaus and Grassly and was updated in 2012 to incorporate PMTCT and ART dynamics.

We define a maternal (paternal) orphan as a child of age 0 to 17 years who has lost his/her mother (father) and consider the child a double orphan if he/she has lost both parents. Maternal and paternal orphans are inclusive of double orphans. To analyze the impact of the HIV-infection on the number of orphans, we estimated number of AIDS and non-AIDS orphans as surviving children of adults who, at the time of death, were HIV-infected and uninfected, respectively.

#### 6.1.7.13.1 Maternal non-AIDS orphans

Each year ( $t$ ), age-based estimates of number of deaths in uninfected women and their fertility rates in the past 17 years were used to calculate the number of children born to those women during that time period. Using survival rates of children when uninfected, maternal non-AIDS orphans,  $\Omega_t$ , were estimated using the equation

$$\Omega_t = \sum_{\hat{a}=15}^{a^f+17} \sum_{\substack{\hat{a}-c \\ =\min(\hat{a}, a^f)}}^{\max(15, \hat{a}-17)} D_{t,\hat{a}} f_{t-c,\hat{a}-c} s_{t,c}$$

where,  $\hat{a}$  is the mother's age at death,  $a^f$  is the maximum fertility age for women,  $c$  is the age of child at time  $t$ ,  $D_{t,a}$  are the number of deaths at time  $t$  in women of age  $a$ ,  $f_{t,a}$  are the fertility rates at time  $t$  in women of age  $a$ , and  $s_{t,a}$  is the cumulative survival probability to age  $a$  at time  $t$  (for children of both sex).

#### 6.1.7.13.2 Maternal AIDS orphans

Women infected with HIV have a reduced rate of fertility when not on treatment with antiretroviral therapy (ART). Therefore, in addition to the variables used in non-AIDS orphans, estimating the number of AIDS orphans requires the additional knowledge of the age of the mother at the time of acquisition of HIV and at the time of ART initiation.

To estimate the age at infection for women not on ART we first generate a lookup age-matrix of constant values ( $M$ ) with rows representing age  $a$  and columns representing CD4 count category  $i$  ( $=1$  (highest) to the lowest CD4 cell count categories), such that, for a woman not on ART and at age  $\hat{a}$  and CD4 category  $i$  at death, if matrix element  $m(a,i)$  equals  $\hat{a}$  then age at infection  $a_{h,\hat{a},i+} = a$ . To generate such a matrix we assumed exponentially distributed rates of transition  $\mu_i$  from CD4 count category  $i$  to  $i+1$ , and estimated matrix elements  $m(a,i)$  as the average age of a person in CD4 count category  $i$  given age at infection equals  $a$ . That is,

$$m(a,i) = a + \sum_{k=1}^n (x_1 + x_2 + \dots x_i) / n,$$

Where  $x_i$  are instances of random variables  $X_i \sim \exp(\mu_i)$  and  $n$  is a large number so as to obtain an

average duration of a large enough sample (we assumed  $n = 1000$ ).

Age at infection for women on ART can also be estimated using matrix  $M$  if age at ART initiation is known. To estimate age at ART initiation we generated a constant duration-matrix  $L$  such that the elements  $l(t, i)$  represent the average duration on ART at year  $t$  for women starting ART at CD4 count category  $i$ , i.e.,

$$l(t, i) = \frac{\left\{ \sum_{j=0}^t \sum_{\forall a} N''_{j,a,i} - \left[ \prod_{j=0}^t (\sum_{\forall a} D''_{j,a,i}) (\sum_{\forall a} N''_{j,a,i}) \right] \right\}}{\sum_{\forall a} N''_{t,a,i}}$$

where,  $N''_{t,a,i}$  and  $D''_{t,a,i}$  are the number of surviving persons on ART and number of deaths, respectively, at year  $t$  among women of age  $a$  and CD4 count category at ART initiation of  $i$ . For women with age  $\hat{a}$  at death, we approximate age at ART initiation  $a^A_{t,\hat{a},i} = \hat{a} - l(t, i)$  and, given matrix element  $m(a, i) = \hat{a} - l(t, i)$  approximate age at infection  $a^h_{\hat{a},i} = a$ .

The number of AIDS-orphans for a woman at age  $\hat{a}$  at death and CD4 count category  $i$  (at death, if the woman was not on ART, and at ART initiation, if the woman was on ART) can be estimated as the sum of surviving children born before infection ( $\Omega'_{t,\hat{a},i}$ ), during infection when not on ART ( $\Omega''_{t,\hat{a},i}$ ), and, if the woman was on ART, during infection when on ART ( $\Omega'''_{t,\hat{a},i}$ ), using,

$$\begin{aligned} \Omega_{t,\hat{a},i} &= \sum_{\substack{\hat{a}-c \\ =\max(a^h, \hat{a}-17)}}^{\max(15, \hat{a}-17)} f_{t-c, \hat{a}-c, s_{t,c}}, \\ \Omega'_{t,\hat{a},i} &= \sum_{\substack{\hat{a}-c \\ =\max(a^A, \hat{a}-17)}}^{\max(a^h, \hat{a}-17)} f_{t-c, \hat{a}-c} r_{\hat{a}-c} (p_{t,c} s'_{t,c} + (1 - p_{t,c}) s_{t,c}), \text{ and} \\ \Omega''_{t,\hat{a},i} &= \sum_{\substack{\hat{a}-c \\ =\min(\hat{a}, a^f)}}^{\max(a^A, \hat{a}-17)} f_{t-c, \hat{a}-c} (p_{t,c} s'_{t,c} + (1 - p_{t,c}) s_{t,c}), \end{aligned}$$

where, for notational clarity  $a^A_{t,\hat{a},i}$  and  $a^h_{\hat{a},i}$  were written as  $a^A$  and as  $a^h$ , respectively,  $r_a$  is the relative reduction in the fertility rate due to HIV-infection in women at age  $a$ ,  $p_{t,c}$  are probability values that a child of age  $c$  at time  $t$  had acquired HIV from vertical transmission from mother, and  $s'_c$  are the probability values that a child infected through vertical transmission survives to age  $c$ . Since children can be infected at birth (perinatal) or during breastfeeding we approximate

$$p_{t,c} = \frac{\sum_{j=0}^{\min(c,2)} N_{t-c+j,j}}{\sum_{\forall a} \sum_{\forall i} B'_{t-c,a,i} + B''_{t-c,a,i}} \text{ and } s'_c = \frac{\sum_{\forall i} (N'_{t,c,i} + N''_{t,c,i})}{\sum_{j=0}^{\min(c,2)} N_{t-c+j,j}},$$

where,  $N_{t,a}$  are the number of newly infected children of age  $a$  at time  $t$  infected through vertical transmission,  $B'_{t,a,i}$  are the number of births at time  $t$  to HIV-infected women at age  $a$ , CD4 count category  $i$  and not on treatment at time  $t$ ,  $B''_{t,a,i}$  are the number of births at time  $t$  to HIV-infected women at age  $a$ , CD4 count category  $i$ , and on treatment at time  $t$ ,  $N'_{t,c,i}$  are the number of surviving HIV-infected persons of age  $c$  at time  $t$ , CD4 count category  $i$ , and not on treatment, and  $N''_{t,c,i}$  are the number of surviving HIV-infected persons of age  $c$  at time  $t$ , CD4 count category  $i$ , and on treatment.

The total number of new AIDS orphans from all women dying at time  $t$  was estimated as

$$\sum_{\hat{a}=15}^{\hat{a}^f+17} \sum_{\forall i} \{ (D'_{t,\hat{a},i} + D''_{t,\hat{a},i}) (\Omega_{t,\hat{a},i} + \Omega'_{t,\hat{a},i}) + D''_{t,\hat{a},i} \Omega''_{t,\hat{a},i} \},$$

where,  $D'_{t,\hat{a},i}$  are the number of deaths at time  $t$  in women of age  $\hat{a}$ , at CD4 count category  $i$ , and not on ART, and  $D''_{t,\hat{a},i}$  are the number of deaths at time  $t$  in women of age  $\hat{a}$  with CD4 count category  $i$  at ART initiation. A schematic view of the different time periods has been presented in [Figure 1](#).

#### 6.1.7.13.3 Paternal non-AIDS orphans

The number of surviving children born to uninfected men who died in year  $t$  ( $\Omega_t$ ), i.e., non-AIDS orphans, were calculated using estimates of fertility rates of those men in the past 17 years and also the HIV-status of the mother at the time of birth as it affects the fertility rate of the mother and survival of the child due to chances of vertical transmission, as,

$$\bar{\Omega}_t = \sum_{\hat{a}=15}^{\hat{a}^f+17} \sum_{\substack{a^d-c \\ =\min(\hat{a}, \hat{a}^f)}}^{\max(15, \hat{a}-17)} \bar{D}_{t,\hat{a}} \bar{f}_{t-c,\hat{a}-c} \{ P_{t-c}(w^-|m^-) s_{t,c} + P_{t-c}(w^+|m^-) k_{t-c} [(1 - p_{t,c}) s_{t,c} + p_{t,c} s'_{t,c}] \},$$

where,  $\hat{a}$  is the father's age at death,  $\hat{a}^f$  is the maximum fertility age for men,  $c$  is the age of child at time  $t$ ,  $D'_{t,a}$  are the number of deaths at time  $t$  in men of age  $a$ ,  $f_{t,a}$  are the fertility rates at time  $t$  in men of age  $a$ ,  $s_{t,a}$  are the probabilities of survival to age  $a$  at time  $t$  (for children of both sex),  $p_t(w^-|m^-)$  and  $p_t(w^+|m^-)$  are the conditional probabilities that the mother was not infected and infected, respectively, given that the father was not infected at time  $t$ ,  $k_t$  are the relative reduction in fertility due to HIV-infection in women at time  $t$ ,  $p_{t,c}$  are probability values that a child of age  $c$  at time  $t$  had acquired HIV from vertical transmission from mother, and  $s'_c$  are the probability values that a child infected through vertical transmission survives to age  $c$  (for children of both sex). We use the method proposed by Grassly and Timaeus, 2005<sup>1</sup>, to determine the HIV-status of the mother given the HIV-status of the father at time of birth as,  $P_t(w^+|m^-) = \{P_t(w^+) - P_t(w^+|m^+)P_t(m^+)\} / \{1 - P_t(m^+)\}$ , where,  $P_t(w^+)$  and  $P_t(m^+)$  are the prevalence of HIV among women (and men) in partnerships at time  $t$  and whose

values were approximated by adult prevalence of HIV in women (and men), and  $P_t(w^+|m^-)$  was obtained through logistics regression with dependent factor as the HIV-prevalence ( $P'_t(w^+)$ ) in women tested in antenatal clinics as,  $P_t(w^+|m^-) = \{ \exp[-0.84+9.1P'_t(w^+)] \} / \{ 1 + \exp[-0.84+9.1P'_t(w^+)] \}$ . Assuming HIV-infected women have a reduced rate of fertility when not on ART,  $k_t$  was estimated as

$\{ \sum_{a=15}^{af} \sum_{vi} (r_a N'_{t,a,i} + N''_{t,a,i}) \} / \{ \sum_{a=15}^{af} \sum_{vi} (N'_{t,a,i} + N''_{t,a,i}) \}$ , where the approximation over all ages was performed because it is difficult to predict the age of the mother.

<sup>1</sup>Grassly, N.C. and I.M. Timaeus, Methods to estimate the number of orphans as a result of AIDS and other causes in Sub-Saharan Africa. *J Acquir Immune Defic Syndr*, 2005. 39(3): p. 365-75.

#### 6.1.7.13.4 Paternal AIDS orphans

Similar to the method in maternal AIDS orphans, the total number of paternal AIDS orphans were estimated as,

$$\sum_{\hat{a}=15}^{\hat{a}^f+17} \sum_{vi} \left\{ \left( \bar{D}'_{t,\hat{a},i} + \bar{D}''_{t,\hat{a},i} \right) (\bar{\Omega}_{t,\hat{a},i} + \bar{\Omega}'_{t,\hat{a},i}) + \bar{D}''_{t,\hat{a},i} \bar{\Omega}''_{t,\hat{a},i} \right\}, \text{ with}$$

$$\bar{\Omega}_{t,\hat{a},i} = \sum_{\hat{a}-c}^{\max(a^h, \hat{a}-17)} \bar{f}_{t-c, \hat{a}-c} \{ P_{t-c}(w^-|m^-) s_{t,c} + P_{t-c}(w^+|m^-) k_{t-c} [(1-p_{t,c}) s_{t,c} + p_{t,c} s'_{t,c}] \},$$

$$\bar{\Omega}'_{t,\hat{a},i} = \sum_{\hat{a}-c}^{\max(a^A, \hat{a}-17)} \bar{f}_{t-c, \hat{a}-c} \{ P_{t-c}(w^-|m^+) s_{t,c} + P_{t-c}(w^+|m^+) k_{t-c} [(1-p_{t,c}) s_{t,c} + p_{t,c} s'_{t,c}] \}, \&$$

$$\bar{\Omega}''_{t,\hat{a},i} = \sum_{\hat{a}-c}^{\min(\hat{a}, \hat{a}^f)} \bar{f}_{t-c, \hat{a}-c} \{ P_{t-c}(w^-|m^+) s_{t,c} + P_{t-c}(w^+|m^+) k_{t-c} [(1-p_{t,c}) s_{t,c} + p_{t,c} s'_{t,c}] \},$$

where,  $\bar{\Omega}_{t,\hat{a},i}$ ,  $\bar{\Omega}'_{t,\hat{a},i}$  and  $\bar{\Omega}''_{t,\hat{a},i}$  are the surviving children born to men before they were infected, during infection when not on ART, and, for men on ART, during infection when on ART, respectively,  $\bar{D}'_{t,\hat{a},i}$  are the number of deaths at time  $t$  in men of age  $a$ , at CD4 count category  $i$ , and not on ART, and  $\bar{D}''_{t,\hat{a},i}$  are the number of deaths at time  $t$  in men of age  $a$  with CD4 count category  $i$  at ART initiation. As in maternal AIDS orphans,  $a^h$  and  $a^A$  represent  $a^A_{t,\hat{a},i}$  (age at infection) and  $a^h_{\hat{a},i}$  (age at ART initiation), respectively, and were estimated as in the case of women.

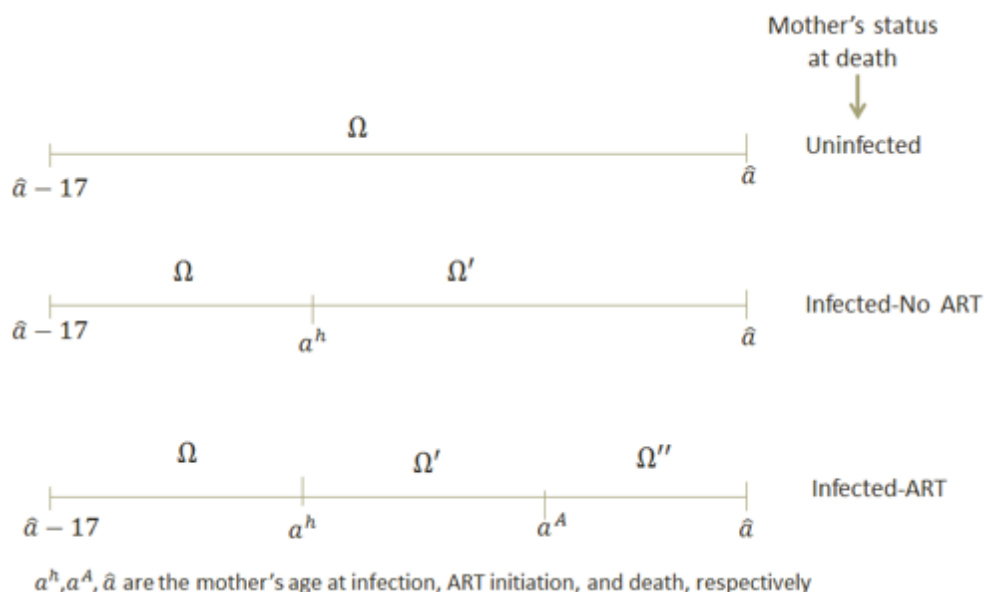
#### 6.1.7.13.5 Double orphans

We estimate double orphans using the regression method first proposed in Grassly and Timaeus<sup>1</sup> and later updated<sup>2,3</sup> where risk of double orphanhood of children at age  $a$  at time  $t$  ( $\lambda_{t,a}$ ) were estimated as correlates of age  $a$ , adult (women and men) HIV-prevalence at two points in time, and risk of double orphanhood if risk of maternal or paternal orphanhood were independent of each other ( $\tilde{\lambda}_{t,a}$ ). as,

$$\ln \lambda_{t,a} = \theta_0 + \theta_1 \ln \tilde{\lambda}_{t,a} + \theta_2 a + \theta_3 \ln P_{t-1}((w+m)^+) + \theta_4 a \ln P_{t-1}((w+m)^+) \\ + \theta_5 \ln P_{t-12}((w+m)^+) + v_k + u_t + \gamma$$

where,  $\theta$  are the coefficient values of the dependent variables,  $v_k$  and  $u_t$  are normally distributed random intercept terms that indicate the degree to which the excess risk of dual orphanhood varies between countries ( $k$ ) and over time ( $t$ ) within countries, and  $\gamma$  is a residual term.

**Figure 12. Schematic representation of surviving orphans born during different time periods of mother's life based on HIV-status of mother at the time of death**



<sup>1</sup> Grassly, N.C. and I.M. Timaeus, Methods to estimate the number of orphans as a result of AIDS and other causes in Sub-Saharan Africa. *J Acquir Immune Defic Syndr*, 2005. 39(3): p. 365-75.

<sup>2</sup> Stover, J., et al., The Spectrum projection package: improvements in estimating incidence by age and sex, mother-to-child transmission, HIV progression in children and double orphans. *Sex Transm Infect*, 2010. 86 Suppl 2: p. ii16-21.

<sup>3</sup> Timaeus, I.M., Estimation and progression of dual orphans in populations with generalized HIV epidemics: Updated methods, Report to UNAIDS, 2008.

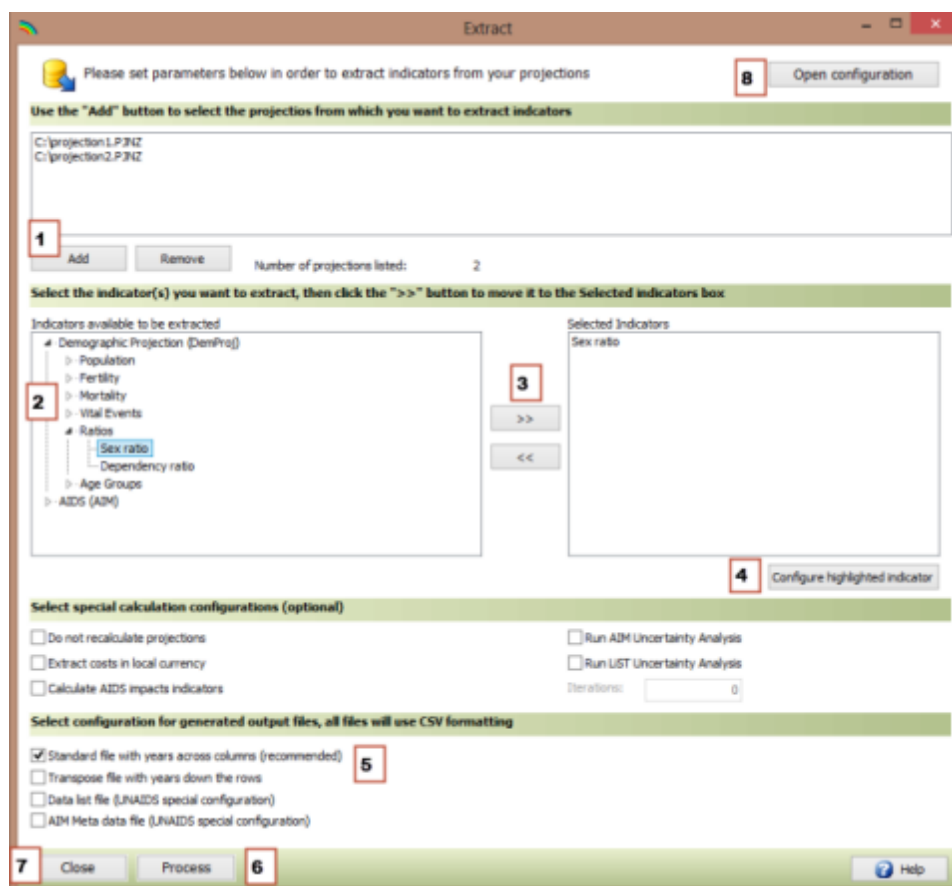


## 7 Tools

### 7.1 Extract

The extract feature enables you to extract the projected data from a previous projection (or multiple previous projections) on one or more indicators. The extracted data is then saved to a CSV file, and can be imported into excel for further analysis. An example would be to use the extract feature to extract the data for "Sex ratio" for both Projection1 and Projection2 into an excel table all at once.

After entering Spectrum, go to "Tools" and click on the "Extract" icon. (Note: this command is not available if you have any projections open. If the command is not available, first click the round application button in the upper left corner of the screen and select "Close projection". If more than one projection is open the "Select projection" window will open. To close all projections select "All projections".) The Extract window will appear as follows:



1. Click "Add" to browse and add a previously saved projection to the selected projections box. You can select as many files as you want. Highlight a projection from the selected projections box and click "Remove" to remove it.
2. Once a projection(s) is added to the selected projections box, the indicators for that projection will appear in the "Indicators available to be extracted" box. Click on the small arrows to the left of the categories open a categories and see the indicators housed within them.

3. To pull an indicator into the box of "Selected Indicators" that you wish to work with, highlight the indicator in the "Indicators available to be extracted" box and click the ">>" button. To remove an indicator from the "Selected Indicators" box, highlight it and click "<<".
4. To further refine your selected indicator by sex or region (urban/rural), highlight the indicator in the "Selected Indicators" box and click "Configure highlighted indicator".
5. Select the output file configuration you would like to use. All files will be saved with CSV formatting.
6. To process the extraction, click the "Process" button. Enter the file name you wish to save the extraction as, and click "Ok". It will then be saved as a CSV file, ready for use in Excel.
7. When you are finished using Extract, click the "Close" button. If this is the first time you have used Extract with the current settings or if you have modified a previously saved configuration file, you will be prompted to save your extract configuration for future use. If you would like to process this extraction in the future, click the "Yes" button, when prompted, to save your selections. Enter a name for the file and click "Ok". It will then be saved as an .ex file.
8. If you have a previous "Extract" configuration saved as an .ex file, you may open it by clicking the "Open configuration" button.

## 7.2 Aggregate

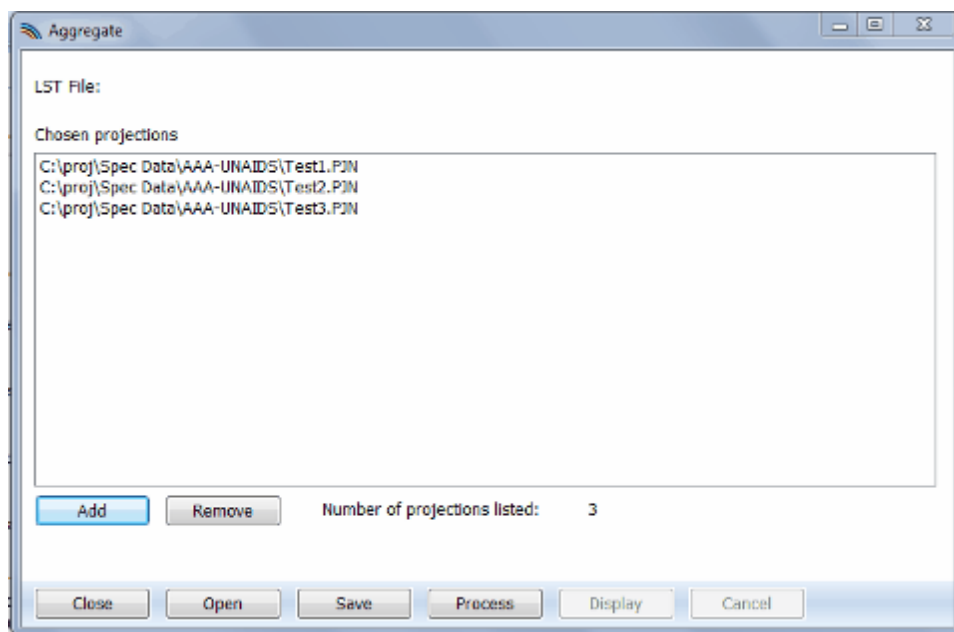
If you want to add together several projections to produce a total for a region, you can do that with the "Aggregate" function. This function will read the projections you specify and calculate them as though they are a single projection.

All indicators referring to numbers of people will be added across all projections. Rates, such as TFR and life expectancy, will be calculated as weighted averages. Weighting will be done by an appropriate population. For example, the TFR for the aggregate population will be calculated as the weighted average of the TFRs for each of the input projections, weighted with the number of women of reproductive age (15-49).

To use this feature, follow these steps:

After entering Spectrum, go to "Tools" and click on "Aggregate" icon. (Note: this command is not available if you have any projections open. If the command is not available, first click the round application button in the upper left corner of the screen and select "Close projection". If more than one projection is open the "Select projection" window will open. To close all projections select "All projections".) The Aggregate window will appear as follows:

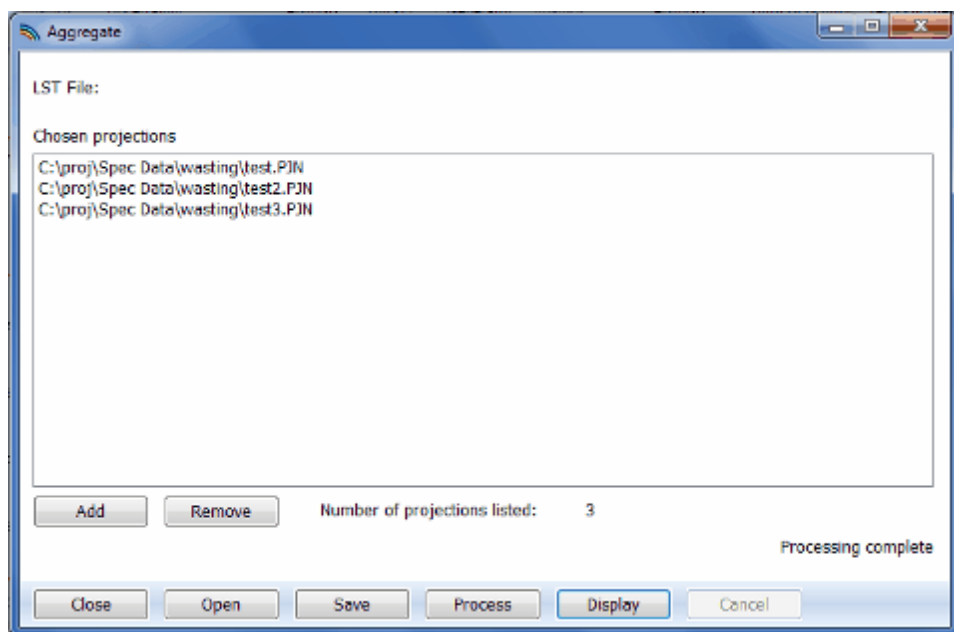
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Click "Add" to browse previously saved projections. Click on the file name to highlight it, and then click "Open". You can select as many files as you want. To remove a selected projection from the "Chosen Projections", click on it to highlight it, and then click "Remove" to remove it.

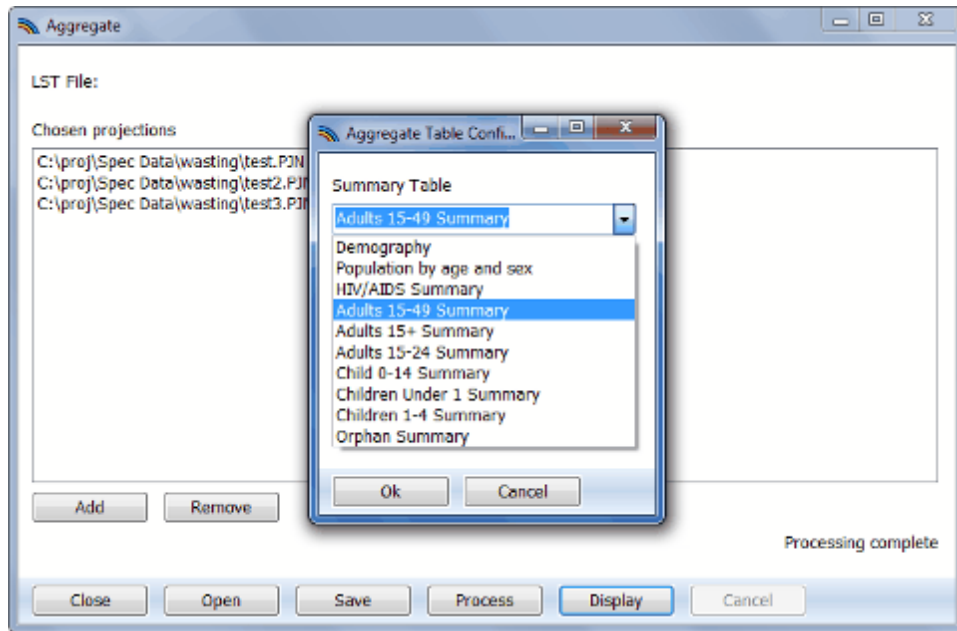
If you would like to process this aggregation in the future, click the "Save" button to save your selections. Enter a name for the file and click "OK". It will then be saved as an .LST file.

To process the aggregation, click the "Process" button. Once the files have been aggregated, "Processing complete" will appear in the lower right corner of the window and the "Display" button will be enabled as shown below:



Click on the "Display" button to select and display the aggregated results for one of the summary tables

listed in the drop down menu as shown below:



## 7.3 Scenario generator for AIM

The **Scenario Generator** tool enables you to vary the targets for PMTCT, Infant Feeding, Adult ART, and Child Treatment in order to project the course of the epidemic following and increase or decrease in the above targets (and thereby effort to achieve them).

After entering Spectrum, go to 'Tools' and click on 'Scenario Generator' from the drop-down menu. A 'Scenario Generator' window will open, in which the white 'choice' boxes will be empty. Below is an example of what the 'Scenario Generator' window looks like once filled in, followed by instructions on how to do so:

**Scenario Generator AIM**

**Data entry method**

☒ Enter data manually

☐ Read data from CSV file

**Scenario name**

**Base Year**

**Target year**

**Selected projections**

☐ Use WHO 2009 treatment eligibility for adults

☐ Use WHO 2013 treatment eligibility criteria

☐ Use EPP prevalence adjustment

	Target	Active
<b>PMTCT - Prenatal prophylaxis</b>		
Single dose nevirapine	0.00	<input checked="" type="checkbox"/>
Dual ARV	0.00	<input checked="" type="checkbox"/>
Option A - maternal	0.00	<input checked="" type="checkbox"/>
Option B - triple prophylaxis from 14 weeks	0.00	<input checked="" type="checkbox"/>
ART started before current pregnancy	0.00	<input checked="" type="checkbox"/>
ART started during current pregnancy	0.00	<input checked="" type="checkbox"/>
None	100.00	
<b>PMTCT - Postnatal prophylaxis (among women not on ART)</b>		
Option A	0.00	<input checked="" type="checkbox"/>
Option B	0.00	<input checked="" type="checkbox"/>
None	100.00	
<b>Adult ART</b>		
Percent of adults in need of first line receiving ART - Male	0.00	<input checked="" type="checkbox"/>
Percent of adults in need of first line receiving ART - Female	0.00	<input checked="" type="checkbox"/>
Migration from first to second line (6% per year)	0.00	<input checked="" type="checkbox"/>
<b>Child treatment</b>		
Percent receiving cotrimoxazole	0.00	<input checked="" type="checkbox"/>
Percent Receiving ART	0.00	<input checked="" type="checkbox"/>

- A. For the 'Selected Projections' box, click 'add' to browse and add a previously saved projection. Highlight a projection from the 'Chosen Projections' box and click 'remove' to remove it.
- B. Choose a 'Scenario Name'. Then choose the 'Base Year' and 'Target Year' for which you wish to generate a scenario. Often, the base year is the current year.
- C. The target data may then be entered manually, or it can be pulled from a CSV file by clicking on 'read from CSV File'. Highlight the CSV file you wish to choose in the 'Open' window, and click 'open'. CSV files are usually used rather than manual entry of the targets if a series of targets (matching the categories shown in the 'Scenario Generator' editor) were previously prepared in CSV files to speed the process of running a series of scenarios for comparison purposes. However, if a CSV file or files are used, Spectrum cannot interpolate between the base Year and Target Year. Therefore, the interpolation for each year must be done in the CSV file before importing into the Scenario Generator for application to the Chosen Projections.
- D. Check the box in the 'Active' column if you want the Scenario Generator to use the target that is listed in the 'Target' column (either the default zero, or the target that you enter). If the 'active' box is left unchecked, a target will not be used for that variable and the scenario will be generated based on any prevention and/or treatment data that was entered to make the projection(s) for which you are generating the scenario.

To process the scenario generation, click the 'Process' button. Enter the file name you wish to save the scenario generation as, and click 'Ok.' It will then be saved as a Scenario Generator file (.SG file).

If you do not wish to process the scenario generation immediately, but would like to save the 'Scenario Generation' window in which you have pulled out the projections that you would like to generate scenarios for in the future, click the 'Save' button. Enter the file name you wish to save the 'Scenario Generator' window as, and click 'Ok.' It will then be saved as an .ex file.

## 7.4 Uncertainty analysis for AIM

The **Uncertainty analysis** tool will enable you to estimate the uncertainty associated with each variable. This analysis estimates the plausible range of values associated with each Spectrum variable.

Unlike other tools, you must have a single projection already open in Spectrum for the 'Uncertainty analysis' choice to appear.

Go to 'Tools' and click on 'Uncertainty Analysis' from the drop-down menu. An 'Uncertainty Analysis' window will open, in which the white 'choice' boxes will be empty. Below is an example of what the 'Uncertainty Analysis' window looks like once filled in, followed by instructions on how to do so:

	Mean	s.d.
<b>Adults</b>		
Ratio of fertility of HIV+ to HIV- women		0.10
Ratio of female to male incidence		0.05
Average number of years in CD4 count category		0.05
HIV mortality without ART		0.05
HIV mortality with ART		0.05
<b>Children</b>		
MTCT rates		0.05
Reduction in child mortality due to cotrimoxazole	0.33	0.10
<b>Survival on ART</b>		
Children Under 1 year old	0.80	0.08
Children Age 1 and older First Year	0.90	0.04
Children Age 1 and older Subsequent years	0.95	0.04

☐ Generate AIDS deaths CSV file  
☐ Generate HIV+ CSV file

Number of iterations:  1000

Process time: 23 min 20 sec      Process date: 2013-Jun-5

In Uncertainty dialogue box, set the number of iterations to be performed. Generally this number should be 1000. Once this is set, click the 'Process uncertainty analysis' button. Spectrum will do the requested number of iterations using the different prevalence curves read from EPP. Each projection will use different input values selected from ranges indicated in the bottom half of the dialogue box.

Once the analysis is complete you can view the results as graphs or tables by clicking 'Display.'

Once you are done examining the results, click the 'OK' button. Spectrum will save the results to a file before quitting the procedure. If you press 'Cancel' instead of 'OK' the results will not be saved.

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