# AIM

## Version 4

### A Computer Program for Making HIV/AIDS Projections and Examining the Social and Economic Impacts of AIDS

Spectrum System of Policy Models

By John Stover
The Futures Group International

The POLICY Project

Spectrum

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**April 2003**

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# I. Introduction

## A. Description of the Spectrum System

### 1. Components

The POLICY Project and its predecessor projects have developed computer models that analyze existing information to determine the future consequences of today's population programs and policies.[1] The new Spectrum Policy Modeling System consolidates previous models into an integrated package containing the following components:

*Spectrum consolidates DemProj, FamPlan, Benefit-Cost, AIM, and RAPID models into an integrated package.*

- **Demography (DemProj)** – A program to make population projections based on (1) the current population, and (2) fertility, mortality, and migration rates for a country or region.
- **Family Planning (FamPlan)** – A program to project family planning requirements to aid consumers and/or nations to reach their goals of contraceptive practice or desired fertility.
- **Benefit-Cost** – A program for comparing the costs of implementing family planning programs, along with the benefits generated by those programs.
- **AIDS (AIDS Impact Model – AIM)** – A program to project the consequences of the AIDS epidemic including the number of people infected with HIV, the number of AIDS deaths and the number of AIDS orphans.
- **Socioeconomic Impacts of High Fertility and Population Growth (RAPID)** – A program to project the social and economic consequences of high fertility and rapid population growth for sectors such as labor force, education, health, urbanization and agriculture.
- **Adolescent Reproductive Health (NewGen)** – A program to examine the effects of policies and programs on the reproductive health of adolescents, including pregnancies, HIV/AIDS, and sexually transmitted infections.

[1] The terms "model" and "module" are used interchangeably in the Spectrum manuals to refer to the separate computer programs within the system.

- **Prevention of Mother-to-Child Transmission of HIV (PMTCT)** – A program to examine the costs and benefits of different programs intended to reduce the transmission of HIV from mothers to their newborn children.

### 2. Software Description

Spectrum is a Windows-based system of integrated policy models. The integration is based on DemProj, which is used to create the population projections that support many of the calculations in the other components—FamPlan, Benefit-Cost, AIM, and RAPID.

Each component has a similarly functioning interface that is easy to learn and to use. With little guidance, anyone who has a basic familiarity with Windows software will readily be able to navigate the models to create population projections and to estimate resource and infrastructure requirements. The accompanying manuals contain both instructions for users, and equations for persons who want to know exactly how the underlying calculations are computed.

## B. Uses of Spectrum Policy Models

*Policy models are designed to answer a number of "what if" questions. The "what if" refers to factors that can be changed or influenced by public policy.*

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 modeql can both reduce the burden of manipulating those variables and present the results in an accessible way.

Some of the policy issues commonly addressed by the Spectrum set of models include:

- 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.

*A set of policies under consideration may not be acceptable to all stakeholders.*

- 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.

## C. Organization of the Model Manuals

Each manual begins with a discussion of what the model does and why someone would want to use it. The manual also explains the data decisions and assumptions needed before the model can be run, and possible sources for the data. It defines the data inputs and outputs. The manual contains two tutorials, information on the methodology behind the model, a glossary, and a bibliography.

## D. Information about the POLICY Project

The POLICY Project is a USAID-funded activity designed to create a supportive environment for family planning and reproductive health programs through the promotion of a participatory process and population policies that respond to client needs. To achieve its purpose, the project addresses the full range of policies that support the expansion of family planning and other reproductive health services, including:

- national policies as expressed in laws and in official statements and documents;
- operational policies that govern the provision of services;
- policies affecting gender roles and the status of women; and
- policies in related sectors, such as health, education and the environment, that affect populations.

*The POLICY Project is implemented by the Futures Group in collaboration with Research Triangle Institute (RTI) and the Centre for Development and Population Activities (CEDPA).*

More information about the Spectrum System of Policy Models and the POLICY Project are available from:

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Telephone: (202) 775-9680
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The POLICY Project
US Agency for International Development
Center for Population, Health, and Nutrition
1300 Pennsylvania Ave.
Washington, DC 20523
Telephone: (202) 712-5787 or -5839

## E. 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 project the future number of HIV infections, AIDS cases, and AIDS deaths, given an assumption about adult HIV prevalence. It can also project the demographic and social development 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. A revised version was released in 1995. Since 1991, AIM has been applied in a number of countries in Africa, Latin America, and Asia.

*The* Impacts *section of AIM is available in two forms. It can be used as a module with Spectrum or as an Excel spreadsheet. In either case, the projection results are usually transferred to presentation software, such as PowerPoint, for presentation to leadership audiences.*

AIM requires an assumption about the future course of adult HIV prevalence. Assumptions about other HIV/AIDS characteristics can also be entered for such variables as the survival period from HIV infection to AIDS death, the age and sex distribution of new infections the first year of the epidemic, and the perinatal transmission rate. A demographic projection must be prepared first, before AIM can be used. DemProj, one of the Spectrum system of policy models, is used to make the demographic projection; see the DemProj manual for more information. This projection is modified by AIM through AIDS deaths and the impact of HIV infection on fertility. The *Epidemiology* section of AIM calculates the number of HIV infections, AIDS cases, and AIDS deaths. This information is used in the *Impacts* section to calculate various indicators of demographic and social impact.

*AIM's focus is on generating information useful for policy and planning purposes.*

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.

## F. Why Make HIV/AIDS Projections?

*HIV/AIDS projections can illustrate the magnitude of the AIDS epidemic and the demographic, social and economic consequences.*

A key aspect of the policy process is recognizing that a problem exists and placing that problem on the policy agenda. HIV/AIDS projections can illustrate the magnitude of the AIDS epidemic and the demographic, social and economic consequences. This illustration also can show policymakers the impacts on other areas of development and the size of the impacts that could be expected without effective action. HIV/AIDS projections are also needed to plan the response. For example, AIM can project the number of people needing anti-retroviral therapy, which can serve as the basis for planning expanded access to treatment.

For most purposes, model users will require several alternative HIV/AIDS projections rather than a single projection, for two reasons. First, projections are based on assumptions about the future levels of fertility, mortality and migration. Because these are uncertain assumptions, it is often wise to consider low, medium and high variants of each of these assumptions so that the range of plausible projections can be determined. Second, when HIV/AIDS projections are used for policy dialogue, it is usually important to show how various assumptions about future rates of HIV prevalence would affect the projections. At a minimum, it is usually useful to prepare one projection that illustrates a likely future course for the epidemic and another that uses the same set of inputs but assumes that there is no AIDS epidemic. In this way, the consequences of the epidemic will be clearly demonstrated.

# II. Steps in Making an HIV/AIDS Projection

*AIM requires a population projection prepared with DemProj. This projection should be prepared first or at the same time as the AIM projection.*

There are six key steps in making most AIM projections. The amount of time spent on each step may vary, depending on the application, but most projection activities will include at least these six steps.

1. **Prepare a demographic projection.** AIM requires a population projection prepared with DemProj. This projection should be prepared first, or at the same time as the AIM projection. The first and last years of the DemProj projection will determine the span of the AIM projection. The HIV/AIDS projections will be more accurate if the projection is started at least a year or two before the start of the AIDS epidemic. Thus, if the first year in which HIV was detected in the population was 1981, the first year of the projection should be set to 1979 or 1980. The projection can start in the middle of the epidemic, but in that case the program needs to project in reverse the number and timing of HIV infections that occurred prior to the first year of the projection. This procedure will generally be less accurate than starting the projection before the first year of the epidemic. For a quick start, the EasyProj feature can be used within DemProj to create a population projection based on the estimates and projections of the United National Population Division.
2. **Collect data.** At a minimum, AIM requires an assumption about current and future adult HIV prevalence. For many other inputs, default values provided by the program can be used, or country-specific figures can be supplied. Country-specific figures are required to calculate many of the indicators of the impacts of AIDS. Since the projection will only be as good as the data on which it is based, it is worth the effort to collect and prepare appropriate and high-quality data before starting the projection.
3. **Make assumptions.** The full range of AIM indicators requires assumptions about a number of items such as the costs of care. These assumptions should be carefully considered and based on reasonable selection guidelines.

4. **Enter data.** Once the base year data are collected and decisions are made about projection assumptions, AIM can be used to enter the data and make an HIV/AIDS projection.
5. **Examine projections.** Once the projection is made, it is important to examine it carefully. This examination includes consideration of the various demographic and HIV/AIDS indicators produced as well as the age and sex distribution of the projection. Careful examination of these indicators can act as a check to ensure that the base data and assumptions were understood and were entered correctly into the computer program. This careful examination is also required to ensure that the consequences of the assumptions are fully understood.

*Once the base projection has been made, the program can be used to quickly generate alternative projections.*

6. **Make alternative projections.** Many applications require alternative HIV/AIDS projections. Once the base projection has been made, the program can be used to quickly generate alternative projections as the result of varying one or several of the projection assumptions.

# III. Projection Inputs

AIM requires data describing the characteristics of the HIV/AIDS epidemic, the health care system, and the various economic processes. Some of these data (e.g., adult HIV prevalence) must be specific for the area being studied, whereas others (e.g., perinatal transmission rate) can be based either on local data or on international averages when local data are unavailable. The purpose of this chapter is to describe the inputs required and their possible sources. Recommendations are presented for default values to use when local data are not available. Each of the required variables is discussed below.

## A. Demographic Projection

As noted several times previously, AIM requires that a demographic projection first be prepared using DemProj, another model in the Spectrum system. A complete description of the use of DemProj can be found in the DemProj manual, *DemProj, Version 4, A Computer Program for Making Population Projections*. Model users should keep two key points in mind when preparing a DemProj projection for use with AIM:

*Projections will be more accurate if the projection period includes the start of the epidemic.*

1. For accuracy, 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.
2. The life expectancy assumption entered into DemProj should be the life expectancy in the absence of AIDS. The DemProj manual contains several suggestions for making this assumption. 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—of young adults and children—caused by AIDS.

## B. Adult HIV Prevalence

### 1. Base Year Estimates

Adult HIV prevalence is the percentage of adults aged 15 to 49 who are infected with HIV. Thus, this estimate of prevalence refers to the entire adult population aged 15 to 49, not just a specific risk group.

HIV prevalence data usually come from blood surveys conducted among small population groups. In only a few cases have such surveys been done for entire countries (e.g., Uganda in 1987), although this number may increase as HIV prevalence is measured by future Demographic and Health Surveys. There are two major sources of surveillance data:

1. **National AIDS Control Program (NACP).** Generally the National AIDS Control Program or the HIV/AIDS unit in the Ministry of Health will be the best source of HIV surveillance information. In many countries, the NACP operates a sentinel surveillance system that regularly conducts surveys in a number of sites around the country. Other ad hoc surveys may be conducted among special populations.
2. **HIV/AIDS Surveillance Database.** The International Programs Center of the U.S. Bureau of the Census maintains an HIV/AIDS surveillance database that contains information from a large number of surveillance studies. The database contains information from published articles, international AIDS conferences, and other sources. The database is distributed both as hard copy and on computer diskette. For more information about the database or to obtain copies, contact:

    Health Studies Branch<br>
    International Programs Center<br>
    Population Division<br>
    U.S. Census Bureau<br>
    Washington, DC 20233-8860<br>
    E-mail: laura.m.heaton@census.gov

*Since AIM requires an estimate of HIV prevalence for the entire adult population, it is rarely possible to use surveillance data directly to make this estimate.*

Surveillance information will generally refer to small populations and various risk groups. Since AIM requires an estimate of HIV prevalence for all adults, it is rarely possible to use surveillance data directly to make this estimate. National estimates are usually based on surveillance data from groups of pregnant women, since they are more representative of the general population than other groups that are typically studied (e.g., patients with STDs [sexually transmitted diseases], commercial sex workers). Recent studies have shown that data from prevalence among pregnant women are representative of prevalence among all adults 15-49 in mature epidemics where heterosexual contact is the major means of transmission. However, even these data need to be adjusted for geographic location and urban/rural residence. Since surveillance data are not usually collected for the purpose of making national estimates, there may be questions about how representative the samples are. Fortunately, there are two sources of national estimates of HIV prevalence:

1. **UNAIDS (the Joint United Nations Programme on HIV/AIDS)**. Periodically UNAIDS prepares estimates of national HIV prevalence for most of the countries of the world. These estimates are based on careful consideration of the available surveillance data, by risk group; recent trends in HIV infection; and national population estimates (Schwartlander et al., 1999). The latest estimates are available from the UNAIDS website at http://www.unaids.org.
2. **U.S. Census Bureau.** The U.S. Census Bureau prepares demographic projections for all the countries in the world every two years. These projections include the impact of AIDS for the most severely affected countries. In order to make these projections, they first estimate national HIV prevalence using surveillance data from their HIV/AIDS database. These estimates are published in the documents reporting the population projections (McDevitt, 1999). (Earlier estimates and a detailed description of the methodology are available in *The Impact of HIV/AIDS on World Population*. Both publications are available from Population Studies Branch, International Programs Center, Population Division, U.S. Bureau of the Census, Washington, DC 20233-8860, Fax: 301-457-1539, e-mail: prowe@census.gov.

## 2. Future Projections

An AIM projection requires an estimate of future levels of HIV prevalence. Usually AIM is used to illustrate the future consequences of an epidemic. Therefore, it is not necessary to try to *predict* future prevalence. Rather, AIM can be used with plausible projections of future prevalence to show what would happen if prevalence followed the indicated path. In this case it is only necessary to have a plausible projection.

*When AIM is used to stimulate policy dialogue, it is often helpful to use a conservative projection of future prevalence.*

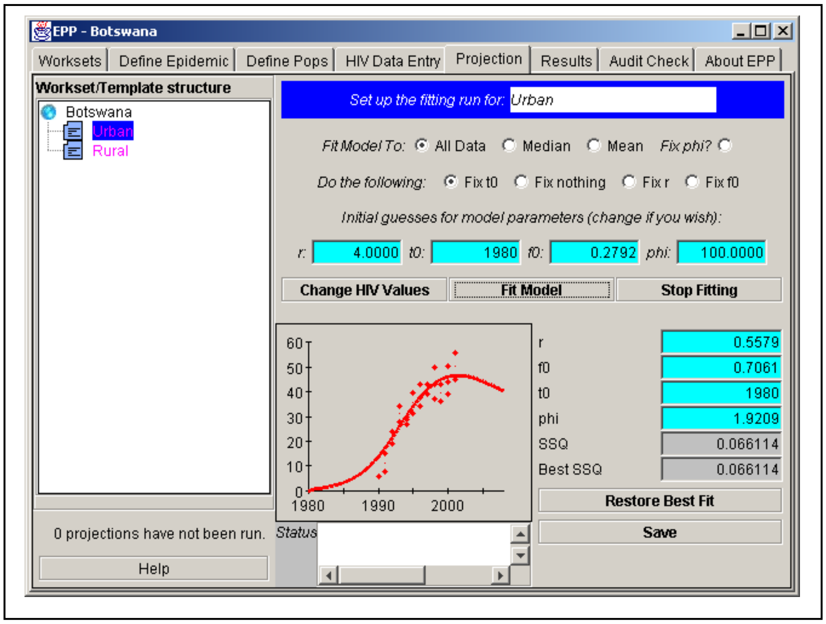
When AIM is used to stimulate policy dialogue, it is often helpful to use a conservative projection of future prevalence. This approach will avoid charges that the presentation is using the worst possible assumptions to make the case for AIDS interventions stronger and will allow the discussion to focus on other, more important issues.

Various approaches and tools outside of the Spectrum system are available to make HIV prevalence projections. The following sections describe several of these approaches. No matter which is used, all the AIM calculations rely on the assumption of future HIV prevalence. Care should be used to develop reasonable assumptions, and the effects of alternative assumptions should be examined.

### *Estimation and Projection Package - EPP*

UNAIDS established a Reference Group on Estimates, Models and Projections to provide advice on methods and assumptions in making national prevalence projections. In 2001 the Reference Group developed a new model, called the Estimation and Projection Package (EPP), for this purpose. EPP replaces EpiModel, which was used previously. EPP can be used to estimate national HIV prevalence. It uses surveillance data to fit an epidemic curve for various geographic areas. These curves are then aggregated to produce a prevalence estimate for the entire country. A sample EPP fit is shown in Figure 1. The output of EPP can be read directly into Spectrum. The EPP Model is available from UNAIDS or it can be downloaded from the Futures Group website at www.FuturesGroup.dom. More information is provided in the manual, "Estimating and Projecting National HIV Prevalence," available from UNAIDS or the Futures Group website.  EPP is primarily useful for estimating and projecting national prevalence in countries with generalized epidemics, primarily countries in sub-Saharan Africa plus a few other countries with high prevalence, such as Haiti.

**Figure 1. Sample EPP Projection**




For concentrated epidemic a different approach is required. These are countries where HIV infection is concentrated in groups engaging in high-risk behavior, such as commercial sex, sex between men and injecting drug use. For these countries, the UNAIDS Reference Group has a developed a spreadsheet model to estimate and project HIV prevalence. This model uses estimates of current and future prevalence among groups at higher risk and estimates about the number of people engaging in higher-risk behavior. The Concentrated Epidemic Spreadsheet is available from UNAIDS or it can be downloaded from the Futures Group's website. The prevalence estimate and projection produced with the Concentrated Epidemic Spreadsheet can be copied directly into Spectrum.

In addition to specifying adult HIV prevalence, it is also useful to specify the start year of the epidemic. The first year of the epidemic is the year in which the first cases of HIV occurred. This date is generally one or two years before the first AIDS cases were reported. If the AIM projection starts after the start year of the epidemic, then AIM uses this information to project in reverse the number of infections (to make an estimate of when past infections were acquired). The UN estimates of the beginning of the AIDS epidemic, by region, are shown in Table 1.

**Table 1: Start of AIDS Epidemic, by Region**

| Region | Start of Epidemic |
|---|---|
| Sub-Saharan Africa | Late 1970s - early 1980s |
| South and Southeast Asia | Late 1980s |
| Latin America | Late 1970s - early 1980s |
| North America, Western Europe, Australia, New Zealand | Late 1970s - early 1980s |
| Caribbean | Late 1970s - early 1980s |
| Central Europe, Eastern Europe, Central Asia | Early 1990s |
| East Asia, Pacific | Late 1980s |
| North Africa, Middle East | Late 1980s |

**Source:** *HIV/AIDS: The Global Epidemic,* UNAIDS and WHO, 1996.

## C. Progression from HIV Infection to AIDS Death

*The progression period describes the amount of time that elapses from the time a person becomes infected with HIV until he or she develops AIDS.*

The progression period describes the amount of time that elapses from the time a person becomes infected with HIV until he or she dies from AIDS. AIM uses the cumulative distribution of the progression period. This distribution is defined as the cumulative proportion of people infected with HIV who will die from AIDS, by the number of years since infection. For example, it might be that for all people infected in a certain year, 1 percent will die within one year, 3 percent will die within two years, 7 percent within three years, etc. The incubation period can be specified for up to 20 years. The cumulative percentage dying from AIDS by year 20 will be the percentage that ever dies from AIDS. Thus, if this value is equal to 95 percent, it implies that 5 percent of people infected with HIV will never die from AIDS. AIM uses separate progression periods for adult men, adult women and children.

### 1. Adult Incubation Period

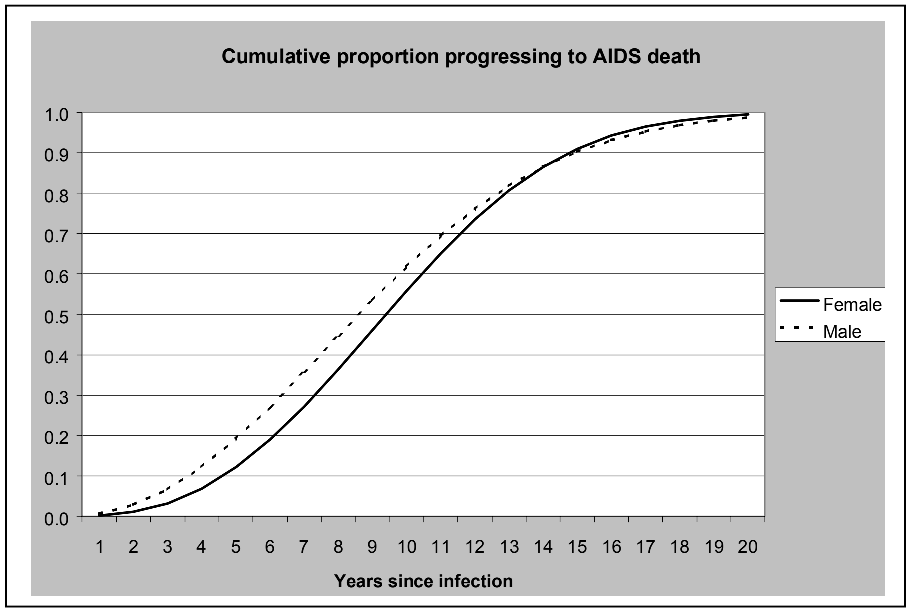
A number of studies have calculated the distribution of the incubation period from infection to AIDS for different groups of adults (Alcabes et al., 1994; Buchbinder et al., 1994, 1996; Chevret et al, 1992; Chiarotti et al., 1994; Downs et al., 1991; Hendriks et al., 1992, 1993; Hendriks, Satten et al., 1996; Law, 1994; Operskalski et al., 1995; Veuglers, 1994). Estimates of the median time from infection to AIDS range from 6.5 to 16.1 years, with most of the estimates at 9-10 years. Estimates of the mean time to AIDS generally are slightly longer. Differences are due to a variety of factors. Progression to AIDS occurs faster in older people and in those infected through male homosexual contact. Aside from these factors, the mode of infection does not seem to affect the progression to AIDS.

Most of the studies of progression to AIDS have been done in industrialized countries. Very little information is available from developing countries. A study in Masaka, Uganda began following a cohort of infected people in the early 1990s. That study indicates that the rate of progression to death in Uganda is similar to industrialized countries. There is evidence that older people progress to AIDS and death faster than younger people. As a result, women generally progress slower than men since they tend to be infected at a younger age (UNAIDS, 2001A). AIM has two default progression patterns available: fast (for developing countries) and slow (for industrialized countries). These patterns are based on the assumption that better health care leads to a somewhat longer survival period in industrialized countries. Thus, the median time from infection to death is assumed to be 9 years in developing countries (8.6 years for males and 9.4 years for females) and 10 years in industrialized countries. These survival periods refer to people who are not receiving treatment with anti-retroviral drugs. The effects of anti-retroviral drugs are considered in a separate section. The default patterns are shown in Table 2 and Figure 2. A pattern can be selected by clicking the appropriate button, or a custom pattern can be entered directly.

**Table 2: Cumulative Proportion Progressing from HIV Infection to Death AIDS, by Time Since Infection, for Adults**

| Years Since Infection | Fast | Fast | Slow | Slow |
|---|---|---|---|---|
| | Men | Women | Men | Women |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.03 | 0.01 | 0.02 | 0.01 |
| 3 | 0.07 | 0.03 | 0.05 | 0.03 |
| 4 | 0.12 | 0.07 | 0.10 | 0.05 |
| 5 | 0.19 | 0.12 | 0.15 | 0.10 |
| 6 | 0.27 | 0.19 | 0.22 | 0.15 |
| 7 | 0.36 | 0.27 | 0.29 | 0.22 |
| 8 | 0.45 | 0.36 | 0.37 | 0.30 |
| 9 | 0.54 | 0.46 | 0.45 | 0.38 |
| 10 | 0.62 | 0.56 | 0.53 | 0.47 |
| 11 | 0.69 | 0.65 | 0.61 | 0.56 |
| 12 | 0.76 | 0.73 | 0.68 | 0.64 |
| 13 | 0.82 | 0.81 | 0.74 | 0.72 |
| 14 | 0.86 | 0.86 | 0.79 | 0.79 |
| 15 | 0.90 | 0.91 | 0.84 | 0.84 |
| 16 | 0.93 | 0.94 | 0.88 | 0.89 |
| 17 | 0.95 | 0.96 | 0.91 | 0.93 |
| 18 | 0.97 | 0.98 | 0.93 | 0.95 |
| 19 | 0.98 | 0.99 | 0.95 | 0.97 |
| 20 | 0.99 | 0.99 | 0.97 | 0.98 |

**Figure 2: Cumulative Progression from HIV Infection to Death**




## 2. Child Incubation Period

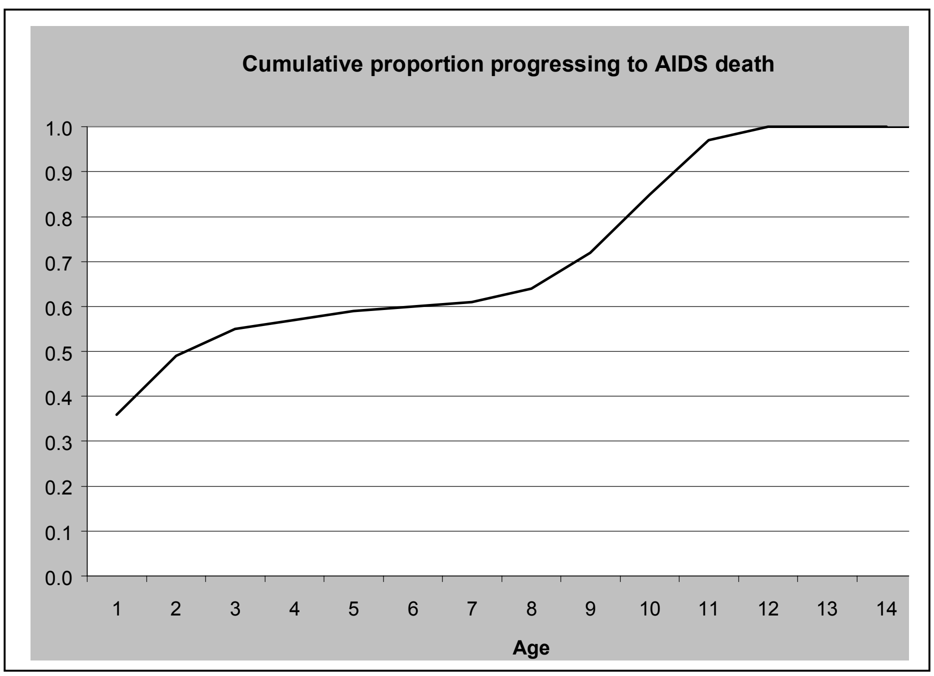
Children who are infected perinatally generally progress to AIDS faster than adults. Studies have reported median time from birth to AIDS to range from one year to 6.3 years (Auger et al., 1988; Commenges et al., 1992; Downs, Salamini, and Ancella Park, 1995; Jones et al., 1989; Lui et al., 1988; Oxtaby et al., 1992; Pliner, Weedon, and Thomas, 1996; Salamini et al., 1992). Several of these studies have found that some children (perhaps 40%) progress to AIDS within a few months, while the rest take considerably longer.

A UNAIDS review of available evidence (UNAIDS 2001B) suggests that the survival is best described by a rapid progression from infection to death for some children and much slower progression for others. The default pattern used in AIM is shown in Table 3 and Figure 3.

**Table 3: Cumulative Proportion Developing AIDS, by Time Since Birth**

| Years Since Birth | Cumulative Proportion |
|---|---|
| 1 | 0.36 |
| 2 | 0.49 |
| 3 | 0.55 |
| 4 | 0.57 |
| 5 | 0.59 |
| 6 | 0.60 |
| 7 | 0.61 |
| 8 | 0.64 |
| 9 | 0.72 |
| 10 | 0.85 |
| 11 | 0.97 |
| 12 | 1.00 |
| 13 | 1.00 |
| 14 | 1.00 |
| 15 | 1.00 |
| 16 | 1.00 |
| 17 | 1.00 |
| 18 | 1.00 |
| 19 | 1.00 |
| 20 | 1.00 |

**Figure 3: Cumulative Progression from Birth to AIDS**



## D. Age and Sex Distribution of Infections

*In most epidemics, there are more male than female infections early in the epidemic. As the epidemic matures, the numbers become more nearly equal.*

To calculate HIV incidence from the prevalence input, AIM needs to have some information on the distribution of infection by age and sex. This information is provided through two editors, one for the ratio of prevalence at each age group to prevalence in the 25-29 age group, and one for the ratio of female to male prevalence.

AIM has two default patterns, one for heterosexual epidemics and one for epidemics that are driven by transmission among men who have sex with men or injecting drug use. The pattern for the heterosexual epidemic is based on general population surveys from several African countries (Glynn, 2000; Wawer, 1997; Barongo, 1992; Kigadye, 1993; Fylkesnes, 2001; Fontanet, 1998). The default distributions are shown in Table 4.

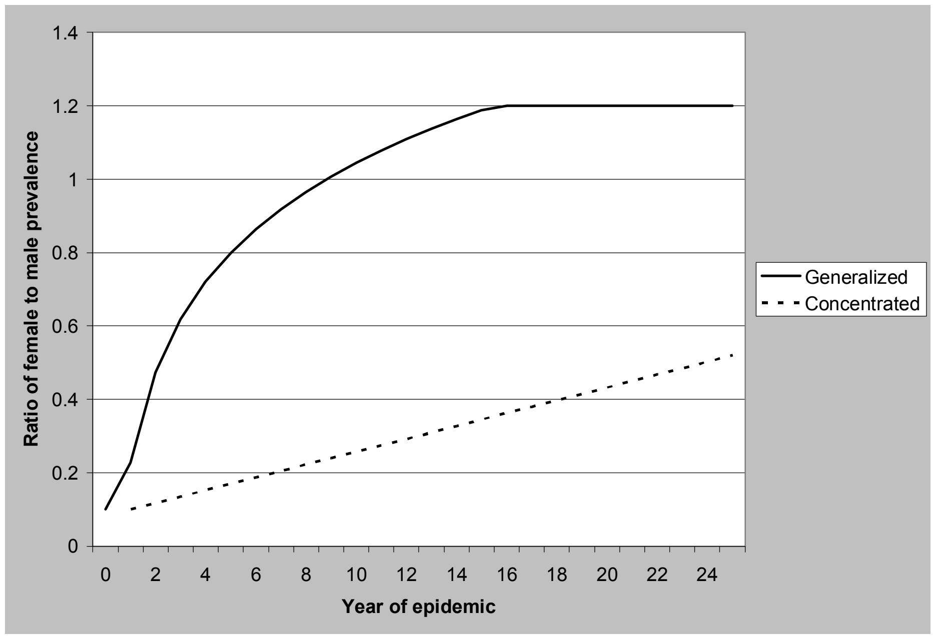
**Table 4: AIM Default Ratios of HIV Prevalence by Age and Sex**

| Age Group | Male | Female |
|---|---|---|
| 0-4 | 0.00 | 0.00 |
| 5-9 | 0.00 | 0.00 |
| 10-14 | 0.00 | 0.00 |
| 15-19 | 0.15 | 0.35 |
| 20-24 | 0.39 | 0.89 |
| 25-29 | 1.00 | 1.00 |
| 30-34 | 1.38 | 0.93 |
| 35-39 | 1.51 | 0.72 |
| 40-44 | 1.03 | 0.64 |
| 45-49 | 0.02 | 0.50 |
| 50-54 | 0.55 | 0.24 |
| 55-59 | 0.25 | 0.10 |
| 60-64 | 0.11 | 0.04 |
| 65-69 | 0.05 | 0.02 |
| 70-74 | 0.00 | 0.00 |
| 75-79 | 0.00 | 0.00 |
| 80+ | 0.00 | 0.00 |

In most epidemics, there are more male than female infections early in the epidemic. As the epidemic matures, the numbers become more equal and then, in heterosexual epidemics, there will eventually be more female than male infections. This pattern is especially noticeable in areas such as the Caribbean and Latin America, where the early infections were primarily among homosexual and bisexual men and the epidemic later spread to male and female heterosexuals. In many African countries today, female prevalence is significantly higher than male prevalence.

AIM has two default patterns for the ratio of female to male prevalence. The pattern for heterosexual epidemics is based on the same population surveys mentioned above. The pattern for epidemics driven by transmission among men who have sex with men and injecting drug users is based on the ratio of female to male reported AIDS cases in a number of countries. These patterns are shown in Figure 4 below.

**Figure 4. Default Patterns for the Ratio of Female to Male Prevalence**




## E. Mother-to-Child Transmission

The mother-to-child transmission rate is the percentage of babies born to HIV-infected mothers who will be infected themselves. Studies have found that this percentage ranges from about 13 to 32 percent in industrialized countries and 25 to 48 percent in developing countries (Bryson, 1996; Dabis et al., 1993). The higher rates have generally been found in studies in Africa, where a significant amount of transmission through breastfeeding may take place, and the lower figures have been found in Western Europe. AIM uses a default value of 32 percent, typical of developing countries. If country-specific studies are available, this figure can be changed by the user. It may also be changed for future years if the country implements programs to prevent mother-to-child transmission of HIV. This rate can also be changed through the use of the PMTCT module in Spectrum to estimate the effects of specific interventions to reduce mother-to-child transmission.

## F. TFR Reduction

*It is not clear how the total fertility rate might be affected by an HIV/AIDS epidemic.*

It is not clear how the total fertility rate might be affected by an HIV/AIDS epidemic. Some women who find that they are infected with HIV may want to have as many children as possible while they can, in order to leave descendants behind. Others may decide to stop childbearing upon learning that they are HIV positive in order to avoid leaving motherless children behind. Since the majority of people do not know if they are infected or not, knowledge of HIV infection is not likely to have a large effect on the desired fertility rate.

Age at marriage may also be affected and could, in turn, affect fertility rates. AIDS could lead to a lower age at marriage or first union if young women and their parents seek early marriage as a protection against the young woman having premarital sex with a number of different partners. This trend, in turn, could raise fertility rates if women are exposed longer to the possibility of pregnancy. Conversely, AIDS could lead to higher age at first intercourse as the dangers of unprotected sex become known. This trend would lead to lower fertility rates.

Gregson and colleagues have examined the question of the impact of HIV on fertility by examining potential changes in the proximate determinants of fertility (Gregson, 1994; Gregson et al., 1997). They found no clear evidence either way but concluded that the most likely result is that an HIV epidemic will slightly reduce fertility.

A study in Tanzania found weak evidence that adult mortality due to AIDS leads to reduced fertility rates (Ainsworth, Filmer and Semali, 1995). Two studies in Uganda found that HIV-infected women had lower fertility rates than HIV-negative women. One of these, in rural Rakai district (Gray et al., 1997) found that age-specific fertility rates for HIV-infected women were 50 percent less than those for women who were not infected. Another study among a rural population in Masaka (Carpenter et al., 1997) found that fertility rates were 20 to 30 percent lower among HIV-infected women. Since most women did not know their sero-status, the reduced fertility rates were most likely due to biological rather than behavioral factors. This finding suggests that fertility might be 20 to 50 percent lower among HIV-infected women.
In societies with substantial use of contraception, there might be a reduction in contraceptive use that would partially compensate for this effect. Fertility among young women who are HIV-positive is likely to be higher than for all women,

since all HIV-positive women are sexually active but not all young women are sexually active.

The default value in AIM is that fertility among 15-19 year old women is 50 percent higher among HIV-positive women than HIV-negative women and that fertility among women 20-49 is 20 percent lower among HIV-positive women than HIV-negative women.

## G. ARV Therapy

Anti-retroviral therapy (ARV) therapy can extend life and improve the quality of life for many people infected with HIV. ARV therapy has restored health to many people and continues to do so after many years. But ARV therapy does not help everyone. Some people have a good reaction initially but over time the virus becomes resistant to the drugs and the benefits diminish. Others experience such severe side effects that they cannot continue to take the drugs.

AIM can calculate the effects of ARV therapy based on an assumption about the proportion of those in need receiving ARVs. ARV therapy is assumed to delay progression to death as long as it is effective. However, some people will develop resistance to ARVs and others may have to stop treatment because of severe side effects. As a result, only a proportion of those on ARV therapy in one year continue the next year. When a person stops ARV therapy, s/he progresses to AIDS death quickly.

Since people with HIV will survive longer if they are on ARV therapy, introducing ARVs will tend to raise prevalence initially as new infections continue to occur and there are fewer deaths. In most cases the prevalence input will be derived from surveillance data collected when ARVs were not available, Thus, both the prevalence input, and the resulting incidence estimate, can be considered to represent the situation without ARV therapy. In that case, and if incidence remains the same, introducing ARVs will raise prevalence above the input projection. However, if ARVs are already being supplied to significant portions of the population, the historical surveillance data and, thus, the prevalence projection input will already include the effect of ARVs. In this case, the prevalence estimate should not be changed by ARV therapy; instead, incidence should be adjusted downward to compensate for the life-prolonging effects of ARVs.

These options are included in AIM through an input called "The effect of ARV on incidence." When the effect is set to 0, then incidence will be reduced to ensure that prevalence remains the same as the input projection. This is the appropriate setting for countries where ARVs are already widely available, such as Argentina, Brazil, Costa Rica, Cuba and Uruguay. When the effect is set to 1, then incidence remains the same and estimated prevalence will rise over the input projection. This is the appropriate setting for most countries where ARVs are not yet available to a significant number of people, such as sub-Saharan Africa.

## H. HIV/AIDS Parameters

There are two additional parameters that need to be specified for each AIM projection: the percentage of infants with AIDS who die in the first year of life, and life expectancy after AIDS diagnosis.

### 1. Percentage of Infants with AIDS Dying in the First Year of Life

AIM uses a distribution of the incubation period (discussed below) to calculate the number of people progressing from HIV infection to AIDS. This information can be used to calculate the number of infants infected perinatally that develop AIDS at each age. In order to calculate the impact on the infant mortality rate, it is necessary to know how many infants who develop AIDS die before their first birthday. This percentage is only used to determine the impact on the infant mortality rate; it does not affect any other aspect of the projections. The default value in AIM is 67 percent and should be used unless some country-specific information is available.

The impact of this factor on the infant mortality rate depends on the incubation period for children. If the incubation period assumptions specify that 25 percent of HIV-positive children develop AIDS in the first year of life, then using the default value for this parameter means that 16 percent (25 x 0.67) of infected infants will die before their first birthday. If the incubation assumption is higher or lower, then the percentage dying as infants will also change.

### 2. Life Expectancy After AIDS Diagnosis

Life expectancy after AIDS diagnosis is the average number of years a person will live after developing AIDS. In the developing world, this period ranges from 6 to 18 months. The default value in AIM is one year. Changes in this parameter generally have little effect on the overall projections.

## I. Orphans

AIM will estimate the number of AIDS and non-AIDS orphans caused by adult deaths. An orphan is defined as a child aged 0-15 who has lost at least one parent. These estimates are based on the time history of fertility and the age at death. 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 died). To estimate dual AIDS orphans, AIM needs to estimate the proportion of couples with both parents infected with HIV. This estimation is based on a regression equation using data from national population surveys in sub-Saharan Africa. To make the estimate more precise, two additional pieces of information are required: the percentage of women aged 15-19 who have not married, and the percentage of married women who are in monogamous unions. Both of these parameters are available from national population surveys for most countries. Table 5 shows values for these two indicators from various DHS reports.

Table 5. Percent of Women 15-19 Never Married and Percent of Married Women in Monogamous Unions from Various DHS Reports

| Country | Percent 15-19 never married | Percent of married women in monogamous unions |
|---|---|---|
| Benin 2001 | 76.1 | 54.2 |
| Botswana 1988 | 93.9 | |
| Burkina Faso 1998/99 | 65.2 | 45.3 |
| Burundi 1987 | 93.2 | 88.3 |
| Cameroon 1998 | 64.2 | 66.9 |
| CAR 1994/95 | 57.7 | 71.5 |
| Chad 1996/97 | 51.4 | 60.8 |
| Comoros 1996 | 88.5 | 74.7 |
| Cote d'Ivoire 1998/99 | 74.6 | 65.0 |
| Eritrea 1995 | 62.4 | 92.9 |
| Ethiopia 2000 | 70.0 | 86.4 |
| Gabon 2000 | 77.6 | 78.0 |
| Ghana 1998 | 83.6 | 77.3 |
| Guinea 1999 | 53.9 | 46.3 |
| Kenya 1998 | 83.3 | 83.7 |
| Liberia 1986 | 64.0 | 61.9 |
| Madagascar 1997 | 66.3 | 96.0 |
| Malawi 2000 | 63.2 | |
| Mali 1995/1996 | 50.3 | 55.7 |
| Mauritania 2000/01 | 72.3 | 88.4 |
| Mozambique 1997 | 52.9 | 71.5 |
| Namibia 1992 | 92.3 | 74.6 |
| Niger 1998 | 38.1 | 62.2 |
| Nigeria 1999 | 72.5 | 64.3 |
| Rwanda 1992 | 90.2 | 85.6 |
| Senegal 1997 | 71.0 | 51.4 |
| Sudan 1990 | 84.1 | 79.6 |
| Tanzania 1999 | 72.8 | |
| Togo 1998 | 80.1 | 57.2 |
| Uganda 2000/01 | 67.7 | 67.3 |
| Zambia 1996 | 72.7 | 82.9 |
| Zimbabwe 1999 | 77.3 | |

## J. Health Sector Impacts

*AIM can also calculate some of the impacts of AIDS on the health sector. For comparison purposes, it can also project the number of child cases of malaria and measles.*

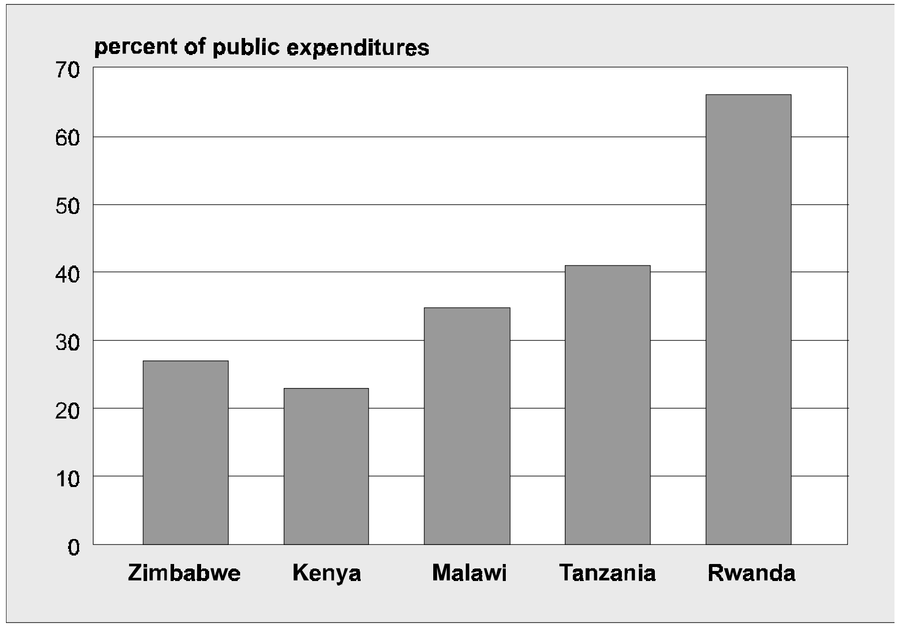
In addition to projecting the number of infections, AIDS cases, and deaths, AIM can also calculate some of the impacts of AIDS on the health sector.

As one illustration of the health sector impacts, AIM can display the proportion of all hospital beds that will be occupied by AIDS patients, given an assumption about the average length of hospitalization for AIDS patients. Since AIDS patients typically spend more time in hospitals than patients with other diseases, a large proportion of beds may be devoted to AIDS in a country with many AIDS cases.

AIM can also be used to illustrate the effect of AIDS on direct expenditures for medical care, and compare these expenditures with total health care spending. AIDS is an expensive disease, and families thus can spend a significant amount on treatment and drugs. The public health care system spends significantly more for the care of AIDS patients than for most other diseases because of lengthy hospital stays. Table 5 shows the average medical care costs for AIDS patients in a number of countries.

Direct spending on AIDS care is much less than it might be since many people with AIDS do not seek care from the public or commercial health care system. Many receive care only from family members or traditional healers. More people may seek professional care for AIDS in the future, however, as new treatments begin to emerge. A World Bank study has estimated the costs of AIDS care if all AIDS patients were to seek hospital care for AIDS and if the current expenditure per AIDS patient were to remain constant. The study found that costs would range from 23 to 66 percent of total public health care expenditures (Figure 5).

**Figure 5: Potential AIDS Treatment Costs as a Share of Total Public Health Expenditures**




**Source**: Ainsworth and Over, 1992.

For comparison purposes, it can also project the number of child cases of malaria and measles. For these calculations to be made, the following inputs are required.

- **Bed-capacity factor:** The average capacity utilization of hospital beds. A capacity factor of 100 percent means that every available bed is always occupied. A factor of 80 means that, on average, each bed is occupied 80 percent of the time during a year.
- **Bed-days/AIDS patient:** The average number of days that an AIDS patient stays in a hospital from diagnosis until death. This may include days spent during several different hospital stays. This figure has been estimated for different countries to range from 15 to 80 days.
- **Expenditure per AIDS patient:** The average direct costs of treating an AIDS patient from the time of diagnosis with AIDS until death. Table 5 presents estimates of the annual per-patient costs of AIDS care for a number of countries for various years from 1990 to 1993. Although the variation from country to country is quite large, in the majority of cases, annual expenditure per patient is around 100 to 200 percent of GNP per capita. AIM requires the extra cost of treating a patient from the time of AIDS until death; however, in countries without extensive treatment of AIDS

patients with combination therapies, the annual and lifetime costs will be similar.

**Table 6: Annual Medical Care Costs for AIDS Care, 1990-1993**

| Country | Medical Care Cost Per Year (US$) |
|---|---|
| Barbados | 4550 |
| Belgium | 21,900 |
| Canada | 25,447 |
| Chile | 1560 |
| France | 25,636 |
| Honduras | 711 |
| Italy | 10,505-27,764 |
| Kenya | 938 |
| Malawi | 210 |
| Mexico | 1430-7350 |
| Netherlands | 19,000 |
| New Zealand | 18,230 |
| Puerto Rico | 24,200 |
| Rwanda | 358 |
| South Africa | 1850-11,800 |
| Spain | 25,400-27,800 |
| Switzerland | 57,000 |
| Tanzania | 290 |
| Thailand | 658-1015 |
| United Kingdom | 28,200 |
| United States | 33,168 |
| Zambia | 396 |

**Source**: Mann and Tarantola, 1996, p. 392.

- **Hospital beds:** The number of hospital beds available from public, private and NGO facilities.
- **Malaria case fatality rate:** The proportion of disease episodes that end in death. The U.S. Centers for Disease Control and Prevention (CDC) estimates that in sub-Saharan Africa, about 1 percent of episodes are severe and that the mortality rate for severe cases is 25 percent. Thus, the case fatality rate there is 0.0025.
- **Malaria episodes/person/year:** The average number of episodes of malaria per year per child under the age of five. The CDC estimates that this rate is approximately three to six for sub-Saharan Africa.
- **Measles case fatality rate:** The proportion of children with measles who die from measles. The CDC estimates this value worldwide to be about 0.01 to 0.05.
- **Measles vaccine efficacy:** The proportion of children vaccinated against measles who will be protected by the

vaccine. The CDC estimates the vaccine efficacy to be about 80 percent.

- **Ministry of Health budget:** The total annual budget of the Ministry of Health. This figure is used to compare total public health expenditures with the expenditures on AIDS.
- **Percent AIDS hospitalized:** The percentage of people with AIDS who actually seek hospital care. The ratio of reported AIDS cases to estimated actual cases may provide a guide to the percentage that seek hospital care.
- **Percent pop. with latent TB:** The percentage of the adult population that harbors the *Mycobacterium tuberculosis* pathogen without developing tuberculosis. In sub-Saharan Africa, this rate is generally assumed to be around 50 percent.
- **Prop. 0-5 vaccinated for measles:** The proportion of children under five who are vaccinated against measles.
- **TB incidence with HIV (%):** The proportion of people with both TB infection and HIV infection who develop TB each year. Estimated to be 2.3 to 13.3 percent (Cantwell and Binkin, 1997).
- **TB incidence without HIV (%):** The expected adult incidence (per thousand) of tuberculosis each year in the absence of HIV infection. Estimated to be about 2.4 per thousand in Africa.

## K. Macroeconomic Impacts

The Excel version of AIM contains a section that illustrates the macroeconomic impacts of AIDS, which are difficult to assess. Since the full costs of AIDS may not be realized until 20 to 30 years after the peak in AIDS deaths, few studies have attempted to assess the macroeconomic impacts of AIDS today. There are studies that examine various components of that impact, such as the increase in health care expenditure. Other studies have used computer simulation models to project the future impact of the epidemic. The following pages summarize the evidence from many of these studies.

### 1. Effects on Labor Force

AIDS leads to the loss of workers in their most productive ages. A serious epidemic can cause the loss of a significant proportion of the trained labor force. An International Labor Organization (ILO) study estimated that AIDS might cause the labor force in Tanzania to be 20 percent smaller by 2010 than it would be without AIDS (ILO, 1995). Most of this reduction will be caused by experienced workers dying at ages 30 through 50.

In Malawi, the average period of employment is 25.3 years, but for those who are HIV-infected, it is only 9.7 years. Thus, each HIV adult infection causes the loss of 15.6 years of productive employment (Forsythe, 1992).

In the mining sector of Zambia, AIDS deaths have severely affected the trained professional workforce, leading to increased equipment breakdowns, accidents, and delays (Hanson, 1992). In the banking sector in Zambia a loss of trained bankers has led to the closing of a number of branch offices (Whiteside and Stover, forthcoming). Among agricultural workers on a sugar estate, 50 percent of absenteeism was due to HIV and tuberculosis.

The Confederation of Zimbabwe Industries (CZI) has estimated that the cost of replacing employees lost because of AIDS may eventually rise as high as 8 percent of GDP (*Southern African Economist,* 1997).

A survey in higher learning institutions in Swaziland found that almost 20 percent of students were infected with HIV. Most of them will die within 10 years of graduation. Thus, AIDS will reduce the number of trained people entering the labor force and reduce the positive macroeconomic benefits of investment in education (*Southern African Economist,* 1997).

### 2. Macro Models

Most studies have found that estimates of the macroeconomic impacts of AIDS are sensitive to assumptions about how AIDS affects savings rates and whether it affects the best-educated employees more than others. Few studies, however, have been able to incorporate the impacts at the household and firm level into macroeconomic projections.

Some studies have found that the macroeconomic impacts may be small, especially if there is a plentiful supply of excess labor and worker benefits are small. Other studies have found significant macroeconomic impacts. Studies in Tanzania, Cameroon, Zambia, Swaziland, Kenya and other sub-Saharan African countries have found that the rate of economic growth could be reduced by as much as 25 percent over a 20-year period.

An important study by Mead Over of the World Bank examined the macroeconomic impact of AIDS in 30 sub-Saharan African countries (Over, 1992). This study concluded that:

- If the only effect of AIDS is to reduce the size of the labor force, then the growth rate of GDP per capita will increase.
- If HIV prevalence is higher among the better-educated workers (their higher income and mobility lead to more casual sexual partners), then the negative effects of productivity losses will lead to a reduction in the growth rate of per capita income.
- If 50 percent of AIDS treatment costs are financed out of savings, then the reduced investment will further depress the economic growth rate.

*The net effect is likely to be a reduction in the annual growth rate of GDP of 0.8 to 1.4 percentage points per year and a 0.3 percentage point reduction in the annual growth rate of GDP per capita.*

A simulation model of the economy of Cameroon was used to examine the effects of AIDS on economic growth through increasing health care expenditures and the loss of human resources (Kambou, Devaraja, and Over, 1993). This model was one of the more detailed ones developed for examining the impact of AIDS. It included three agricultural sectors, five manufacturing sectors, and three service sectors. Labor was divided into three categories: unskilled rural labor, unskilled urban labor and skilled urban labor. The study found three mechanisms through which labor shortages affected the economy:

- AIDS directly reduces the number of workers available.
- A shortage of workers leads to higher wages, which leads to higher domestic production costs. Higher production costs lead to a loss of international competitiveness, which causes foreign exchange shortages.
- Lower government revenues and reduced private savings (because of greater health care expenditures and a loss of worker income) lead to less investment and slower economic growth.

*The study concluded that the annual growth rate of GDP could have been reduced by as much as two percentage points during the 1987-1991 period because of AIDS.*

A study of the macroeconomic impacts of AIDS in Zambia (Forgy and Mwanza, 1994) found that by 2000, the GDP will be 5 to 10 percent lower because of AIDS than it would have been if there were no AIDS affecting the population. The authors concluded that "…*without unprecedented infusions of free foreign aid to mitigate the effects of AIDS, the economy of Zambia will suffer considerable damage.*"

An assessment of the macroeconomic impacts of AIDS in Tanzania was undertaken by the Government of Tanzania, the World Bank, and the World Health Organization in 1991 (Cuddington, 1992). As part of the assessment, an economic model was used to examine the impacts of AIDS on reduced labor productivity and reduced investment. The study found several important impacts.

- Rising mortality rates will cause the labor force and the population to grow more slowly than before the AIDS epidemic.
- Illness and absenteeism among existing workers and the need to hire replacement workers for those who are too ill to work and who die from AIDS will lead to a reduction in worker productivity.
- Rising health care expenditures will lead to a fall in domestic savings, which will reduce capital investment.
- The overall impacts of AIDS on the macroeconomy will be small at first but will increase significantly over time.

*The study found that total GDP will be 15 to 25 percent smaller in 2010 because of the impact of AIDS.*

A recent study of the impact of AIDS on the economy of Kenya found that the impact could be substantial in the coming years (Hancock et al., 1996). This study used the MacroAIDS model (Cuddington and Hancock, 1994) to project the impact of AIDS through the year 2005. It found that:

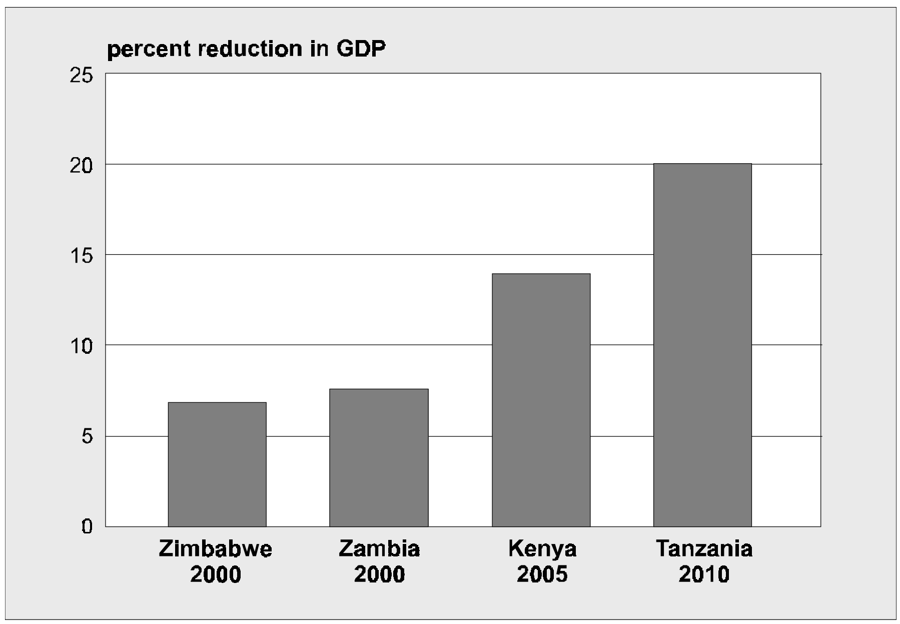
- The increased expenses of medical care for AIDS patients causes a significant drop in savings and capital accumulation. This leads to slower employment creation in the formal sector, which is particularly capital intensive.
- AIDS deaths to workers reduce the experience level of the labor force. The average age of workers drops from 34 to 25 years. This change has a negative effect on worker productivity.

- Reduced worker productivity and investment will lead to fewer jobs in the formal sector. As a result some workers will be pushed from high-paying jobs in the formal sector to lower-paying jobs in the informal sector.
- The amount of capital available per worker may actually rise somewhat in the formal sector due to the loss of jobs, but it will decline in the informal sector.

*As a result of these interactions, GDP will be 14 percent lower in 2005 than it would have been without AIDS. GDP per capita will be 10 percent less in 2005.*

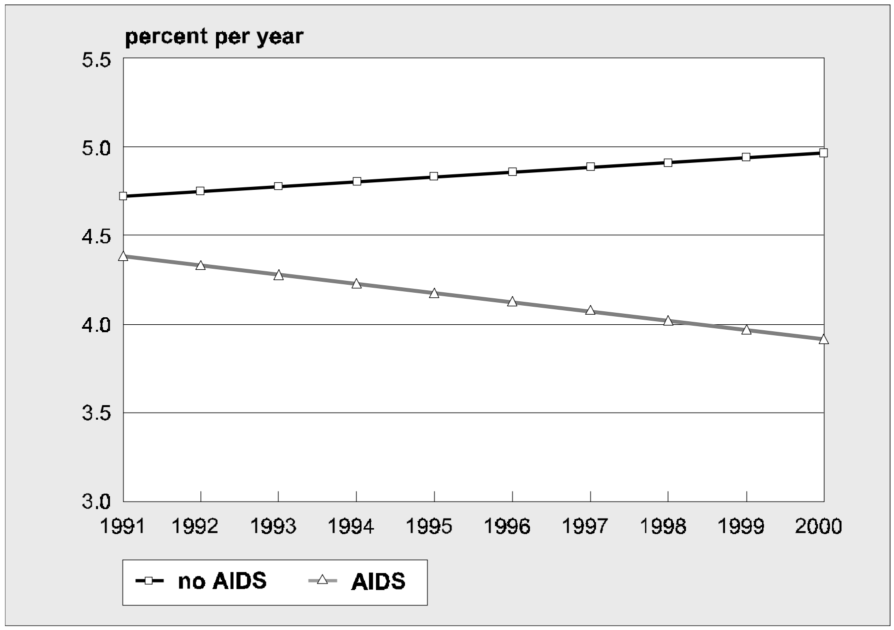
Figure 6 summarizes the reductions on GDP for four of the countries examined above.

**Figure 6: Percent Reduction in Future GDP as a Result of AIDS: Projections from Various Studies**



A computer simulation study of the impact of AIDS in Zimbabwe found that AIDS could lead to a serious reduction in economic growth rates and a large increase in the government deficit. This study found that the annual growth rate of GDP might be 25 percent lower by 2000 than it would have been without AIDS (Figure 7.)

**Figure 7: Projection of Annual Economic Growth Rates in Zimbabwe**




**Source**: Forgy, 1993.

## 3. Inputs

The Excel version of AIM includes a section illustrating the macroeconomic impacts of AIDS. It uses a simple production function that will capture some of the dynamics but not all of the detail of the more complex models described above. The inputs required to use this simple model are shown below.

- **Labor force participation rate:** The percentage of the population between the ages of 15 and 64 that is in the labor force. This figure is usually available from national statistical yearbooks or the Ministry of Labor.
- **Base year GDP.** The size of the gross domestic product, in millions of currency units, in the base year of the projection. This figure should be available from national statistical yearbooks or from the *World Development Report* or *IMF Statistics*.
- **Base year capital stock.** The total value of the capital stock (in millions of currency units) in the base year. This figure is often difficult to find. It may be estimated as two to three times the size of the GDP in the base year.
- **Average capital lifetime.** The average useful lifetime of capital such as infrastructure, buildings, machinery, etc. This figure may be estimated as 50 years unless better information is available.
- **Gross domestic investment as a percent of GDP.** The average level of gross domestic investment expressed as a percentage of GDP. This figure can be obtained from national accounts statistics, *World Tables* or *IMF Statistics*.
- **Rate of technical progress.** The annual rate of growth of GDP that is not due to increases in the size of the labor force or capital stock. These additional increases are assumed to be due to improvements in the quality of the labor force (better education, better management systems) and the quality of capital stock (better technology). The rate of technical progress is calculated as a residual. That is, it is the rate that is required to give the correct growth rate of GDP over some recent historical period given actual growth rates in labor and capital.
- **Elasticity of output to labor.** The percent increase in GDP that results from a 1 percent increase in the size of the labor force. This figure usually ranges from about 0.3 to 0.7. If the economy has a surplus of labor, then generally the elasticity will be less than 0.5, indicating that larger

increases in GDP are to be expected from growth in the capital stock than in the labor force.

- **Elasticity of output to capital.** The percent increase in the GDP that results from a 1 percent increase in the size of the capital stock. This figure usually ranges from about 0.3 to 0.7. If the economy has a surplus of labor, then generally the elasticity will be greater than 0.5, indicating that larger increases in GDP are to be expected from growth in the capital stock than in the labor force. The sum of the elasticities to labor and capital should be about 1.0. If they sum to 1.0, it means there are constant returns to scale (a 1 percent increase in capital and labor will yield a 1 percent increase in GDP). If they sum to less than 1.0, then there are declining returns to scale.
- **Percentage of AIDS care financed from savings.** The percentage of direct expenditures for AIDS care that is paid for by foregone savings. Some expenditure for AIDS care will come from reallocating consumption expenditures, and some will cause a reduction in savings. The larger the amount financed from savings, the larger the impact is likely to be on GDP growth.

# IV. Projection Outputs

AIM will calculate and display a number of indicators grouped under the headings E*pidemiology, Impacts* and *Orphans*. A complete list of indicators available and their definitions is given below.

## A. Epidemiology

- **Adult HIV incidence:** The percentage of uninfected adults who become infected in each year.
- **Adult HIV prevalence:** The percentage of adults (population aged 15 to 49) who are infected with HIV.
- **AIDS age distribution:** The number of people alive with AIDS, by age and sex. This information can be displayed as a table or a pyramid chart.
- **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.
- **HIV age distribution:** The number of infected people, by age and sex. This information can be displayed as a table or a pyramid chart.
- **HIV/AIDS summary:** A table with all the above indicators shown for a selection of years. All input assumptions are also shown on this table.
- **New AIDS cases:** The annual number of new AIDS cases.
- **Number infected with HIV:** The total number of people who are alive and infected with HIV.
- **Adults 15-49 summary:** A table showing indicators just for adults 15-49. It includes number infected, new infections, new AIDS cases and AIDS deaths.
- **Child summary:** A table showing indicators just for children under the age of 15. It includes number infected, new infections, AIDS cases and AIDS deaths.

## B. Impacts

- **AIDS care expenditure:** The total annual expenditure on care for people with AIDS.
- **AIDS orphans:** The number of children under the age of 15 whose mothers have died of AIDS. It is assumed that if the mother has AIDS, the father will have the fatal disease as well.
- **Child measles cases:** The annual number of cases of measles among children under the age of five.
- **Child measles deaths:** The annual number of deaths due to measles among children under the age of five.
- **Hospital bed-days needed:** The number of hospital bed-days needed for AIDS patients. A hospital bed-day is equivalent to one person occupying one hospital bed for one day.
- **Percent hospital bed-days:** The percentage of total available hospital bed-days that are required for AIDS care.
- **Percent of MOH budget for AIDS:** The percentage of the entire budget of the Ministry of Health spent on AIDS care.
- **TB cases:** The annual number of new tuberculosis cases.
- **Young adult (15-49) deaths:** The total number of annual deaths occurring to adults between the ages of 15 and 49, inclusive.
- **GDP**: The size of the gross domestic product. (Excel version only.)
- **Labor force size**: The number of people in the labor force. (Excel version only.)
- **GDP per capita**: The gross domestic product per capita. (Excel version only.)

## C. 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.
- **Summary by age**. A table showing orphans by type and single age.
- **Summary table**. A table showing all orphans by type and year.

# V. Program Tutorial: Spectrum Version of AIM

This tutorial covers the key steps in installing and running Spectrum and AIM.[2] It assumes you have an IBM-compatible computer running Windows 95 or higher and that you are familiar with the basic operation of Windows programs and terminology.

## A. Before You Get Started

You will need to collect data and make certain decisions before running the model. For example, you will need to decide the following at the very beginning:

- adult HIV prevalence, expressed in percentages, for the first year(s) of the projection and the goal for the final year
- the start year of the AIDS epidemic
- perinatal transmission rate (PTR); AIM uses a default value of 32 percent
- percentage of infants with AIDS dying in the first year; AIM's default value is 67 percent
- life expectancy after AIDS onset, in years; the default is one year
- ratio of fertility among HIV-infected women to uninfected women. AIM uses a default value of 1.5 for women 15-19 and 0.8 for 20-49.
- the HIV survival period for the cumulative percentage of adults and children dying from AIDS, by number of years since infection. Two default patterns are available for developing and industrialized countries.
- the age and sex distribution of prevalence.

Other data that you will need include:

- expenditures per AIDS patient
- percentage of AIDS patients hospitalized
- the Ministry of Health budget number of hospital beds
- the hospital bed capacity factor

[2] There are two versions of AIM: Spectrum and Excel. The Excel spreadsheet permits the user to customize equations and variables as appropriate for the country and region. A brief tutorial follows in Chapter 6.

- the number of hospital bed-days for each AIDS patient
- proportion of children under age five vaccinated for measles
- measles vaccine efficiency
- measles case fatality rate
- the number of malaria episodes per person per year
- malaria case fatality rate
- TB incidence without HIV infection, in percentages
- Percentage of the population with latent TB
- TB incidence within the HIV-infected population.

These inputs are all described in Chapter III of this manual.

## B. Installing the Spectrum Program

The Spectrum program is distributed on floppy diskettes; it is also available through the Internet at http://www.tfgi.com/software/software.htm.[3] However, it must be installed on a hard disk before it can be used. Spectrum will run on any computer running Windows 95 or higher. It requires about 3MB of hard disk space.

To install the Spectrum program, start by inserting the "Install" CD-ROM into your CD-ROM drive, or downloading the Spectrum install file from the internet at www.FuturesGroup.com. If you are installing from a CD-ROM, insert the CD-ROM into your CD-ROM drive and follow the instructions on the screen. If you are installing from a file you downloaded from the internet, simply double-click on the file and follow the instructions.

[3] To remove the Spectrum program from your hard disk, run the unwise.exe program located in the Spectrum directory.

## C. Creating a New Projection

### 1. Starting the Spectrum Program

To start Spectrum:

1. Click the "Start" button on the task bar.
2. Select "Programs" from the pop-up menu.
3. Select "Spectrum" from the program menu. Alternatively, you can use Windows Explorer to locate the directory c:\spectrum" and double click on the file named spectrum.exe."

### 2. Opening a Demographic Projection

*Before using AIM, you should use DemProj to prepare a demographic projection. DemProj is part of the Spectrum System of Policy Models; for more information, consult its manual.*

AIM in Spectrum requires a demographic projection prepared with DemProj. In a typical AIM application, the demographic projection calculates all the normal demographic processes (births, deaths, migration, aging). AIM influences the demographic projection by adding a number of AIDS deaths and, possibly, specifying a lower fertility rate because of the effects of HIV infection. All the population figures required by AIM (e.g., size of the adult population) are provided by DemProj. Therefore, before using AIM you should prepare a demographic projection using DemProj. For more information on DemProj, consult the DemProj Manual for Spectrum that is a companion to this one, *DemProj: A Computer Program for Making Population Projections*. One easy way to create a demographic projection is to use the EasyProj feature of DemProj. To use this feature, follow these steps:

1. Select "File" and "New projection" from the Spectrum menu.
2. In the "New projection" dialogue box, fill in the projection title, the first year of the projection and the last year of the projection. It is a good idea to set the first year of the projection to one or two years before the start of the HIV/AIDS epidemic.
3. Check the box next to "AIDS (AIM)" to include the AIM module.
4. Click the "File name" button and enter a file name for this projection.
5. Click the "EasyProj" button and select your country from the country list. This will read the demographic data

from a file based on the population estimates and projections from the United Nations Population Division.

6. Click "OK" to return to the dialogue box and click "OK" once more to complete the set-up process.

7. Select "File" and "Save as" from the Spectrum menu to save this projection.

The first step in preparing the AIM projection is to open the demographic projection. To do this,

1. Select "File" from the menu bar.

2. From the pull-down menu that appears, select "Open projection."

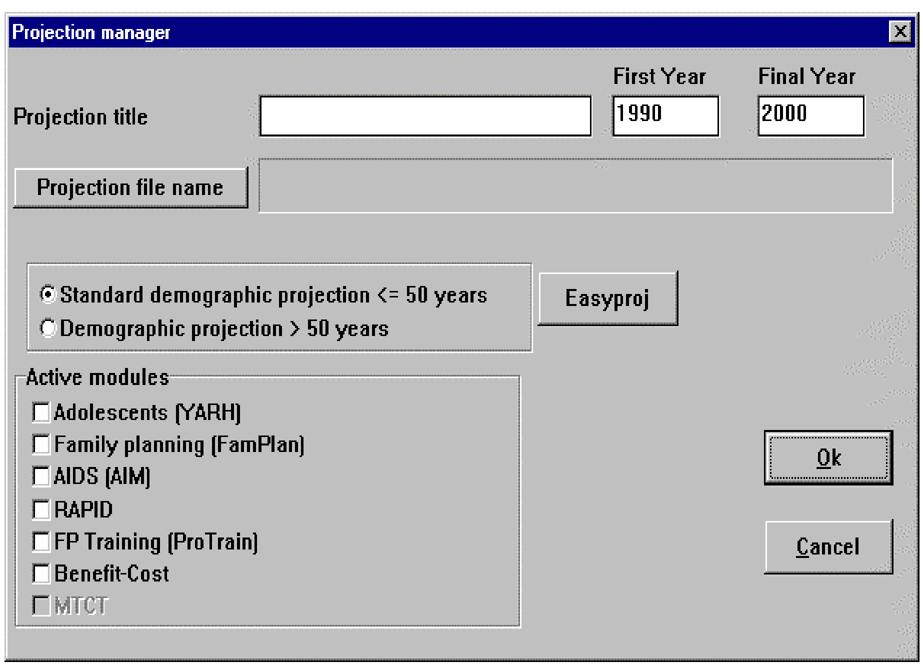
3. Select the projection file from the "Open" dialogue box and press "Ok." All pre-existing projections that can be loaded will be listed here.

### 3. Adding the AIM Module to the Projection

Once the demographic projection is open, you need to change the configuration to indicate that the AIDS module will be used as well. To do this, select "Edit" from the menu bar and "Projection" from the pull-down menu.

You will see the "Projection manager" dialogue box. It will look similar to the display shown below.

*If a box is shown in gray, you will not be able to change its contents. It means that a projection has been loaded, and the data must remain the same. If you want to create an entirely new projection, you should close the other projections, using "File" and "Close," and then select "File" and "New." Users may want to have several projections open in order to examine the effects of changing assumptions.*



The following information is displayed.

*Once all the information is entered for this dialogue box, click on the "Ok" button. You can always return to this screen and change some of the information by selecting "Edit" from the menu bar and then "Projection" from the pull-down menu.*

**Projection title:** This title will be printed at the top of all printed output and will be used to identify the projection if more than one projection is loaded at a time. You can change the title to reflect the projection you are about to prepare.

**Projection file name:** This is the name that will be used to store all data files associated with this projection. You cannot change the file name here. You can change it if you select "File" and "Save projection as" to save the projection to a new name.

*If you want to change the projection file name, the years, or the demographic projection interval, you will need to do so in DemProj. The options in the Projection manager were set when the demographic projection was created with DemProj.*

**First year:** This is the first year of the projection.

**Final year:** This is the final year of the projection.

**Demography.** The radio button labeled "standard demographic projection <= 50 years" will be selected by default. You cannot change this here because the demography module is required to make the AIDS projection.

**Active modules.** These radio buttons let you select other modules that will be used with the population projection. Initially none of them will be selected. You should select the "AIDS" module by clicking on the check box next to the name. This step will allow you to include the AIDS module in the projection.

Once all the information is entered for this dialogue box, click on the "Ok" button. You can always return to this screen and change some of the information later by selecting "Edit" from the menu bar and "Projection" from the pull-down menu.

**EasyProj.** EasyProj is a special feature that allows you to use data prepared by the United Nations Population Division and published in *World Population Prospects*. If you click on the EasyProj button, the program will prompt you to select a country and ask whether you want to use the UN low, medium, or high projection assumptions. Once you click "Ok," the program will load the base year population, the total fertility rate, and the male and female life expectancy from the United Nations estimates and projections. By default, the projection will assume zero net migration and will use the Coale-Demeny West model life table.

## D. Entering the Projection Assumptions

For readers who feel they need additional review or explanations of the terms found in this section, Chapter III and the glossary of this manual may be useful.

### 1. About the Editors

Both editors in AIM are similar. At the very top of the screen, the variable name appears. At the bottom of the screen are the special edit keys. "Duplicate" allows you to copy information from one cell, column, or row to another; "Interpolate" to enter a beginning and ending number and have the computer calculate the numbers for the intervening intervals; "Multiply" to multiply a cell, column or row by a specific number; and "Source" to write notes indicating the source of the data for future reference.

**To use the "Duplicate" button,**

1. Highlight (select) the range (column, row, or cells to be affected). The first cell in the range should be the value you want to copy.

2. 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).

3. Click on the "Duplicate" key to copy the value at the beginning of the range to all the other cells in the range.

**To use the "Interpolate" button,**

1. Enter the beginning and ending values in the appropriate cells.

2. Highlight the entire range from beginning to end.

3. Click on the "Interpolate" key to have the values interpolated and entered into each of the empty cells.

**To use the "Multiply" button,**

1. Highlight the range (column, row, or cells to be affected).

2. Enter the multiplier in the dialogue box.

3. Click "Ok" to accept. The entire range will be multiplied by the designated number.

**To use the "Source" button,**

1. Click on the "Source" button to open a small word processor 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.

This 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 and printed whenever you print the projection summary. It is **strongly** recommended that you use this feature to avoid later confusion.

When you have finished entering all the necessary data for the component into the editor,

1. Click the "Ok" button to return to the "AIDS" dialogue box.

2. Click the "Close" button to complete the editing process.

The "Cancel" button allows you to exit the editor without making any changes to the data.

## 2. Epidemiology

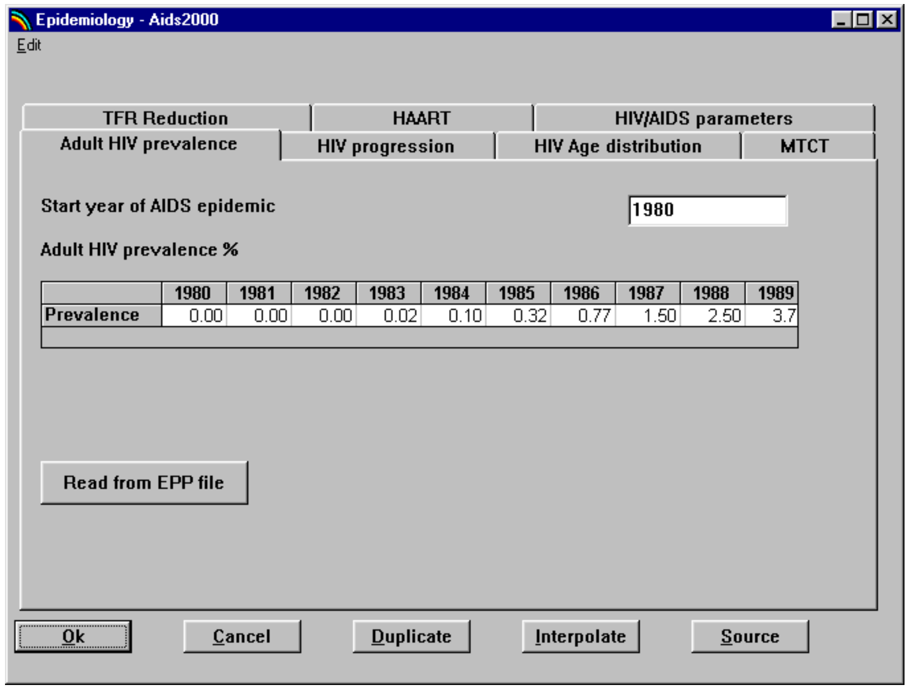
To enter the assumptions for the AIDS projection,

1. Choose "Edit" from the menu bar.

2. Choose "AIDS (AIM)" from the pull-down menu.

3. Choose "Epidemiology" from the "AIDS" dialogue box. This step will display an editor like the one shown below.

For each of the inputs required for the projection, there is a tab near the top of the screen.




1. To enter data for any of these assumptions, click on the appropriate tab to display the editor for that variable.

2. Then click anywhere inside the editor to make it active.

### *Adult HIV Prevalence*

To enter the assumptions for the adult HIV prevalence,

1. Click anywhere inside the editor to make it active.

2. Enter the estimated and projected adult HIV prevalence for each year of the projection. This is the only assumption that must be entered to make an AIM projection.

3. To create a "No AIDS" projection, set HIV prevalence to zero for every year. AIM and DemProj will make a projection showing what the situation would be if there were no AIDS epidemic.

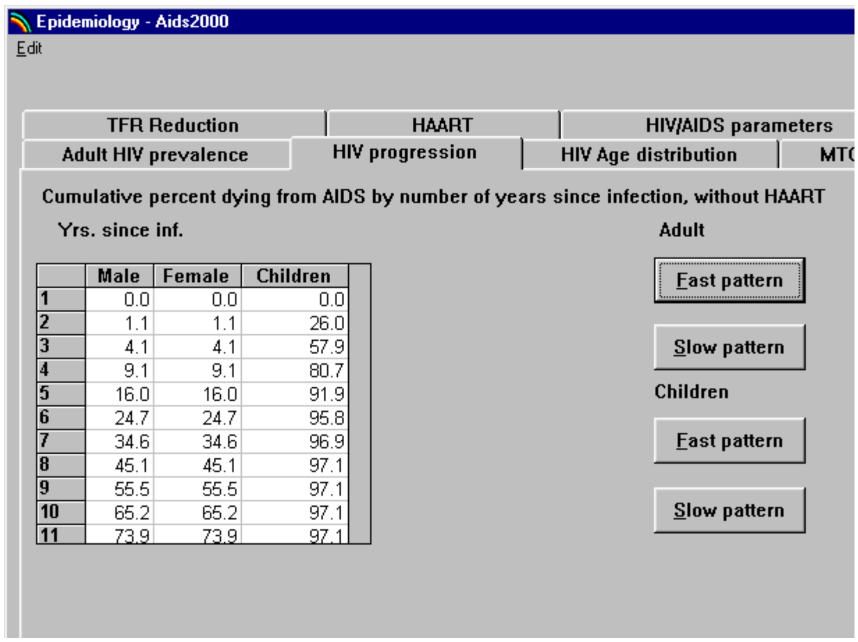
4. To import a prevalence projection from the Epidemic Projection Package (EPP), click on the button labeled "Read from EPP." This will display a File Open dialog box that will allow you to browse to and select any prevalence projection file produced by EPP. The file will have the extension .spt.

5. Enter the first year of the epidemic in the box in the upper right. This is generally one to two years before the year of the first reported AIDS case.

When you have entered the information on adult HIV prevalence, click the “HIV/AIDS parameters” tab to move to the next editor.

### *HIV Progression*

AIM requires a distribution of the progression period, described as the cumulative percentage of HIV-infected individuals dying from AIDS by the number of years since they acquired the infection.  The editor for this data entry is shown below.

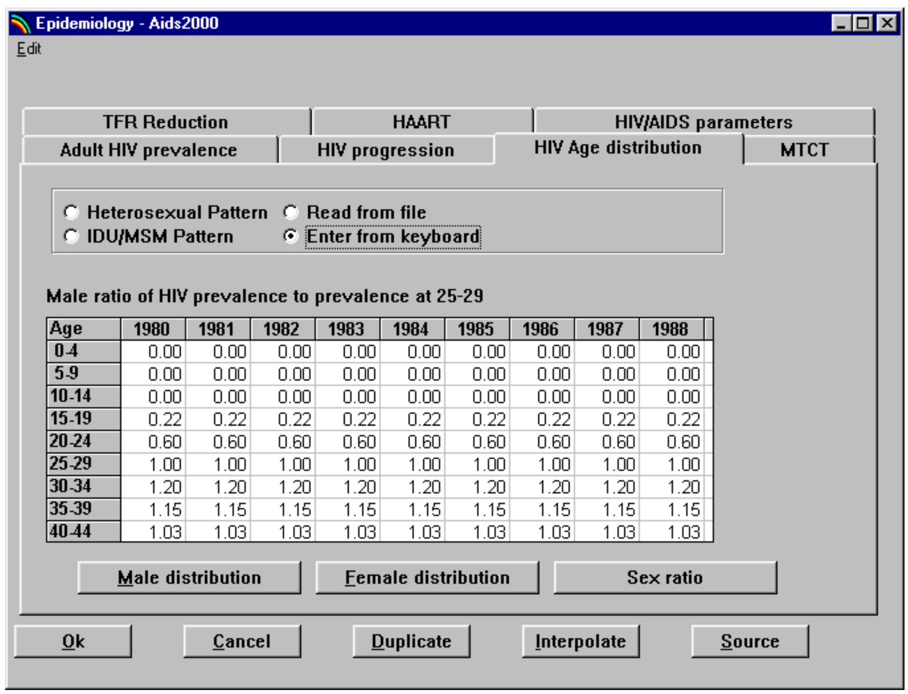



You may enter your own data or choose from the default patterns to the right of the editor.  These buttons provide several default distributions for both adults and children. Click on the desired option, and the corresponding distribution will be entered into the editor.

When you have entered the information on the HIV incubation period, click the “HIV age distribution” tab to move to the next editor.

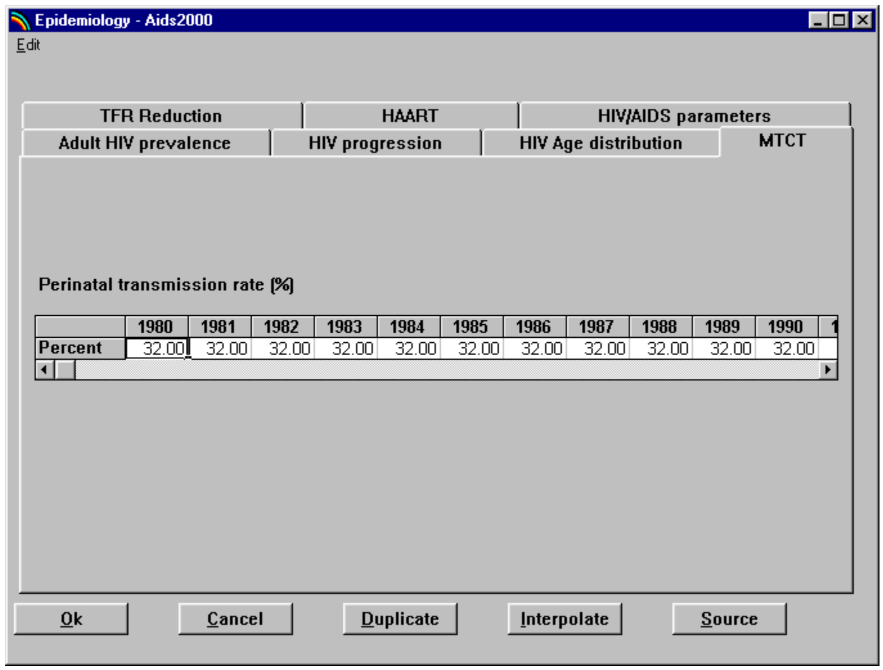
### *Age Distribution of HIV Prevalence*

In the editor for the age distribution of HIV prevalence, enter the ratio of HIV prevalence at each age to the prevalence at age 25-29. This information is entered once for males and once for females. Click the “Male” or “Female” button to move between these editors. Click the “Sex ratio” button to display the editor for the ratio of female to male prevalence. AIM provides two typical patterns that you can use, one for generalized epidemics, “Heterosexual pattern,” and one for concentrated epidemics where HIV spread is primarily through injecting drug use or men who have sex with men, “IDU/MSM pattern.” If you click on either of these buttons the corresponding pattern will be entered. You can then click on “Enter from keyboard” to see the pattern. If you want to use a pattern from another Spectrum projection, click on “Read from file” and you will be prompted to select the projection file.



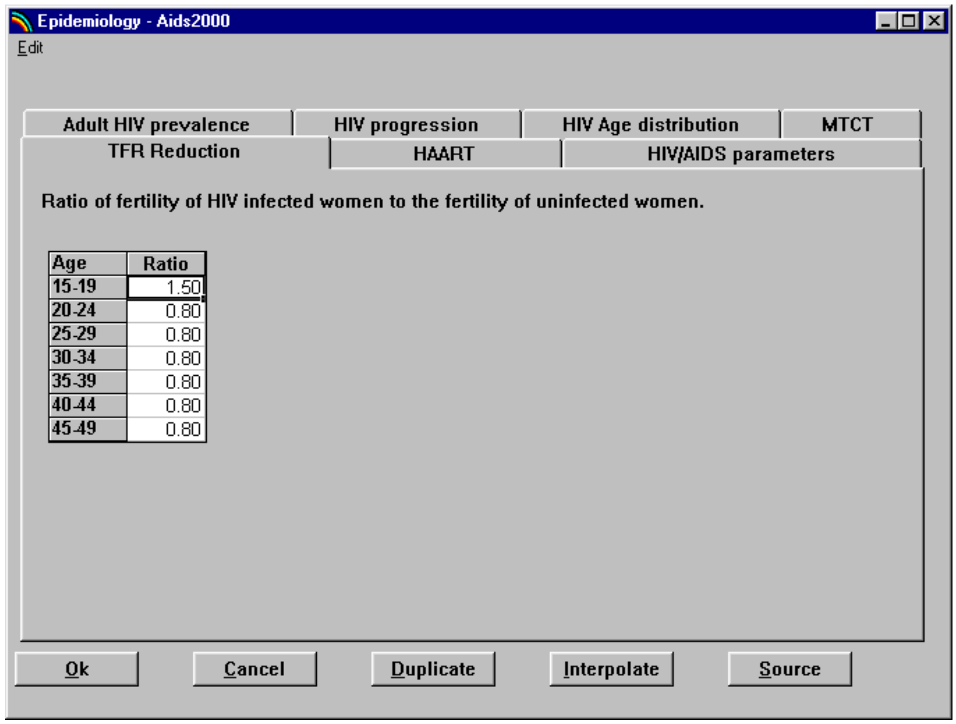
### *MTCT*

The next editor is MTCT. This editor specifies the percentage of babies born to HIV-infected mothers who will be infected. The default value used by UNAIDS is 32 percent. This value may change over time to reflect changes due to programs to prevent mother-to-child transmission.



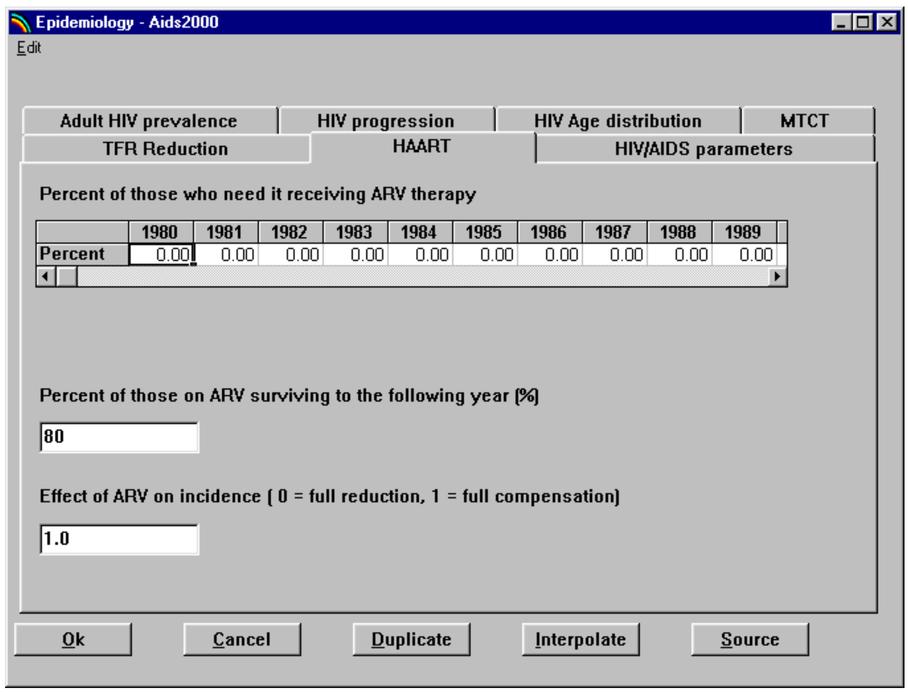
### *TFR reduction*

The next editor specifies the ratio of fertility among women who are HIV-positive to those who are HIV-negative. The default values are a 50 percent increase for women 15-19 (due to a higher proportion of HIV-positive women being sexually active) and a 20 percent reduction for all other women.



### *ARV Therapy*

The next editor describes programs to provide anti-retroviral therapy to those with HIV infection. You should first specify the percent of those who need ARVs who receive them. AIM assumes that people need ARVs two years before they would die from AIDS if they did not receive ARV therapy. You can also specify the effect of ARV therapy in terms of the percent of those on ARVs that survive to the next year. In the last box in the editor, you can specify the effect of ARVs on HIV incidence. In most of the world, ARVs are relatively new. The surveillance data used to estimate and project prevalence are not influenced by ARV therapy. In this case, you should set this parameter to 1. For countries that have been providing ARVs for some time, the prevalence projection is assumed to already incorporate the effects of ARV treatment. In this case you should set the parameter to 0.



### *HIV/AIDS Parameters*

This editor is used to set the variables for the HIV/AIDS epidemic; users may choose to enter their own data or accept the defaults for all the variables but the start year of the epidemic. It will look similar to the next screen.

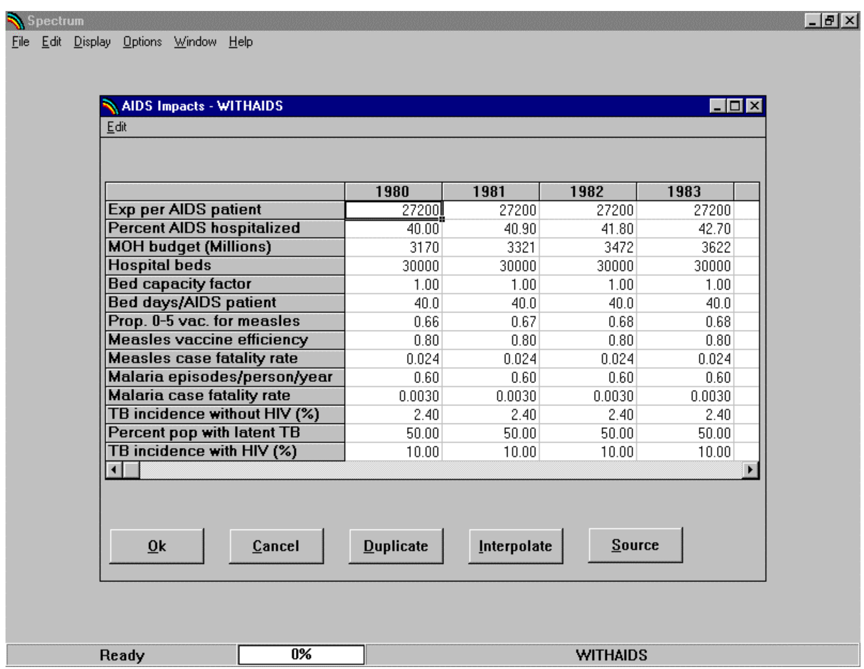
Enter the values for the start year of the epidemic, the percentage of infants with AIDS dying in the first year of life, and the average life expectancy after AIDS onset. AIM has default values of 67 percent for the infants with AIDS dying in their first year and one year average life expectancy after the onset of AIDS.

When you have entered the information on the HIV/AIDS parameters, click the "HIV/incubation period" to move to the next editor.

## 3. Impacts

To enter the impact assumptions for the AIDS projection,

1. Choose "Edit" from the menu bar.
2. Choose "AIDS (AIM)" from the pull-down menu.
3. Select "Impacts" from the "AIDS" dialogue box. This step will display an editor like the one shown below.



This screen contains a single section with all the assumptions displayed at once. For variables such as measles vaccine efficacy and the incidence of tuberculosis with and without HIV infections, default values are already filled in. Values for the other variables should be entered. Default values can be changed if better information is available. It is not necessary to enter information for all variables in order to make the projection. If no information is entered, then zeros will be displayed for the corresponding output indicators.

1. Click somewhere inside the editor to make the scroll bar appear.

2. Scroll to the right or left to see all the years and enter the data.

### 4. Orphans

AIM needs two additional parameters to calculate AIDS orphans. These are the percentage of women 15-19 that have never been married and the percentage of married women 15-49 that are in monogamous unions. These parameters are required to estimate dual AIDS orphans. For many countries they can be obtained from DHS reports. Values for many countries are given in Table 4.

### 5. Leaving the Editors

Once you have entered all the necessary information,

1. Leave the editors by clicking on the "Ok" button. When you click the "Ok" button, the program will record your changes and return to the "AIDS" dialogue box.

2. Click on "Close" to keep your work, and you will return to the main program. If you decide that you do not want to keep the changes you have just made, click the "Cancel" button in any editor. This action will exit the AIDS editors and restore all inputs to their values before you entered the AIDS editors. Any changes you made during the current editing session will be lost.

### 6. Saving the Input Data

Once you have entered the projection assumptions, it is a good idea to save the data onto your hard disk. To do this, select "File" from the menu bar and "Save projection" from the pull-down menu. The data will be saved using the file name you specified earlier.

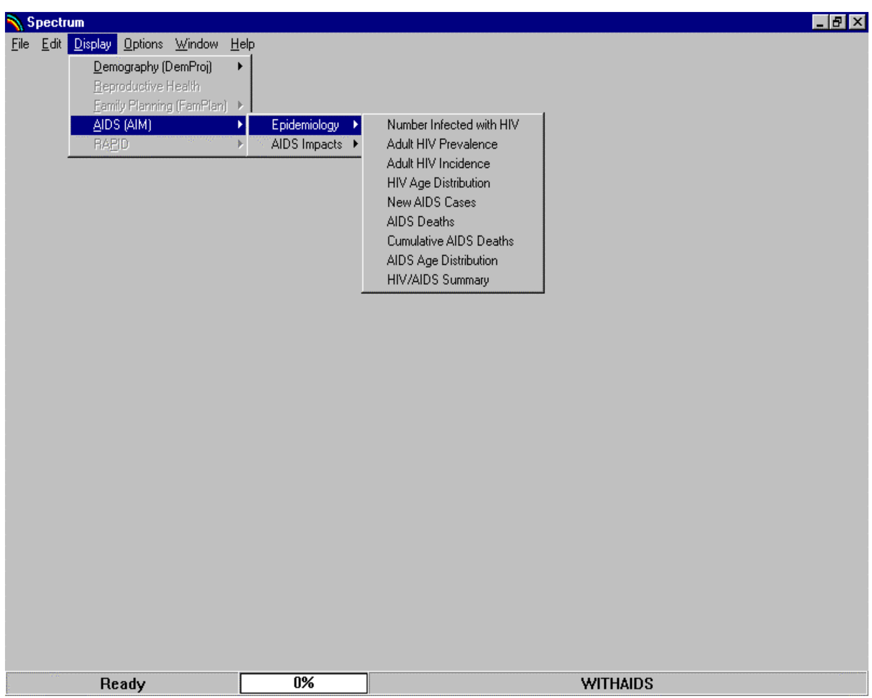
## E. Making the Projection

Whenever you enter data for a new projection or edit the assumptions, Spectrum will note that the data have been changed. The next time you try to display an indicator, it will inform you that the data may have changed and ask if you want to recalculate the projection. Normally, you should answer "Yes" to this question. Spectrum will then make the projection. This step may take only a few seconds or much longer, depending on the length of the projection and the number of modules being used. Once the projection is made, you will not be asked if you want to project the population again, unless you edit the assumptions.

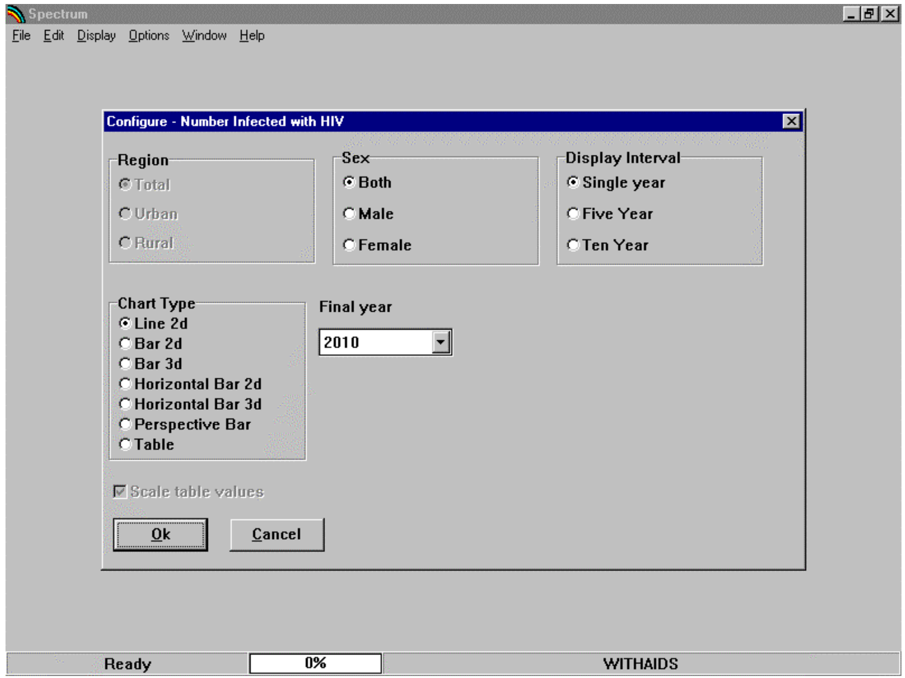
## F. Examining the Output

To see the results of the projection, select "Display" from the menu bar. From the pull-down menu select "AIDS." You will then see another menu showing the three categories of indicators available:

- Epidemiology
- AIDS Impacts
- Orphans

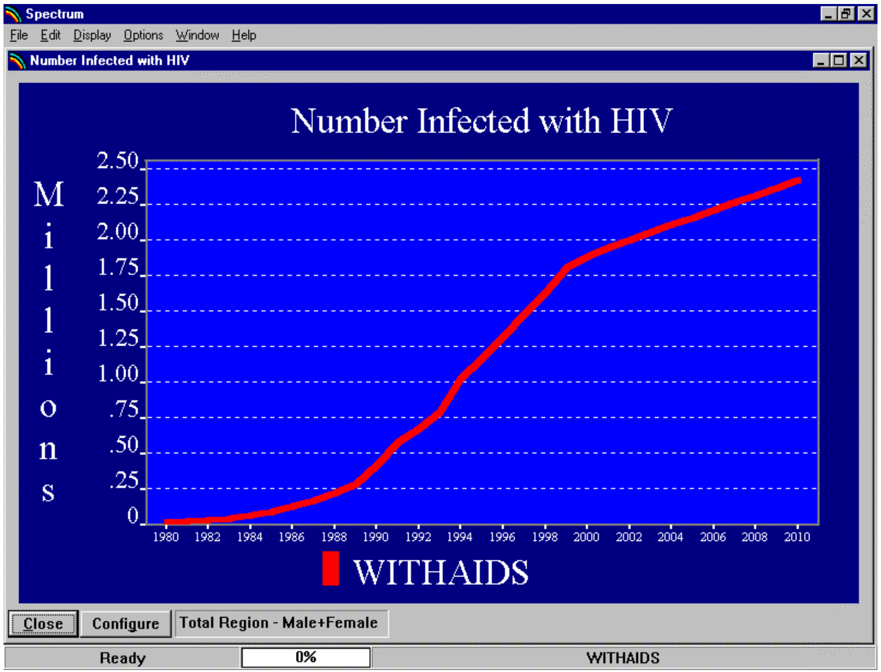


Choose one of these categories (the Epidemiology screen is shown above) and you will see one final menu listing the indicators available in that category. Select one of the indicators. Then you will see the display dialogue box. It will look similar to the one shown below.




The exact choices available will depend on the indicator you have selected. For "Number infected with HIV," sex can be set to "Both," "Male," or "Female." 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. Normally the display will show all the years in the projection. However, if you want to see only part of the projection, you can change the final year by selecting a new final display year from the "Final year" list box.

Once you are satisfied with the type of display, click the "Ok" button and the display will appear. It will look similar to the display shown below.




All the projections that are currently in use will be displayed on the same graph.

You can change the configuration of the display by clicking the "Configure" button. You can also change the type of display by placing the mouse pointer anywhere inside the chart and clicking with the right mouse button.

To close the display, click on the "Close" button. You do not have to close the display immediately. You can choose to display another indicator and it will appear on top of the first display. The first display will be covered but it will still be there. You can return to any previous display that you have not closed by choosing "Window" from the menu bar and selecting the name of the display from the pull-down menu. From the "Window" selection you can also choose to tile or cascade all the existing display windows.

### 1. 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 one another)
- Three-dimensional perspective bar charts.

To print the active chart, select "File" from the menu bar and "Print" from the pull-down menu.

### 2. 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 by using the PgUp and PgDn keys or by using the mouse.

To print a table, select "File" from the menu bar and "Print" from the pull-down menu.

### 3. Displaying All Age Groups

If you wish to see the number of people with AIDS by age and sex, choose "Display," "AIDS (AIM)," "Epidemiology," and then "AIDS age distribution."

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.

### 4. Summary Tables

The final choice in each section is a summary table showing all the indicators and input assumptions. 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. To print a table, select "File" from the menu bar and "Print" from the pull-down menu.

## G. Saving the Projection

It is always a good idea to save the projection whenever you make a change to any assumptions. To save the projection without changing the name, choose "File" from the menu bar and "Save projection" from the pull-down menu.

To save the projection with a different name, choose "File" from the menu bar and "Save projection as" from the pull-down menu. You will then have a chance to specify a new file name for the projection. Normally when you save the projection with a new name, you should also change the projection title. This step will avoid confusion if you have both projections loaded at the same time.

## H. Opening an Existing Projection

If you have already created an AIM projection or are using a projection provided by someone else, you can immediately load that projection.

1. Select "File" from the menu bar.

2. Select "Open projection" from the pull-down menu.

3. Select the file you wish to use and click the "Ok" button to open the projection.

You can open more than one projection at a time. Simply repeat these steps to load a second or third projection. When you have more than one projection loaded, all projections will be displayed in the graphs and tables. The number of projections you can load at any one time is determined by the amount of available memory in your computer.

When you have more than one projection loaded, you will be asked to choose a projection when performing certain tasks, such as editing assumptions. The program will display a list of the projection names and you may choose the appropriate one from the list.

## I. Closing a Projection

To close a projection that has already been opened,

1. Choose "File" from the menu bar and
2. "Close projection" from the pull-down menu. If you have more than one projection loaded, you will be asked to select which projection should be closed.

Closing a projection merely removes it from the computer's memory; it does not erase it from the hard disk. You can open that projection again at any time.

# VI. Program Tutorial: Excel Version of AIM

A special spreadsheet version of the AIM module has also been created for use with the Spectrum system. This version is intended to allow counterparts to design and develop their own socioeconomic impact equations, using the demographic projections created through the Spectrum system. This version offers a great deal of flexibility to modify equations and add new ones. It does assume that the user is familiar with Microsoft Excel.

Population projections made with DemProj are used in the spreadsheet version of AIM. To save a DemProj file in a form suitable for use with the spreadsheet versions of AIM,

1. Select "File" from the menu bar.

2. Select "Export" from the pull-down menu.

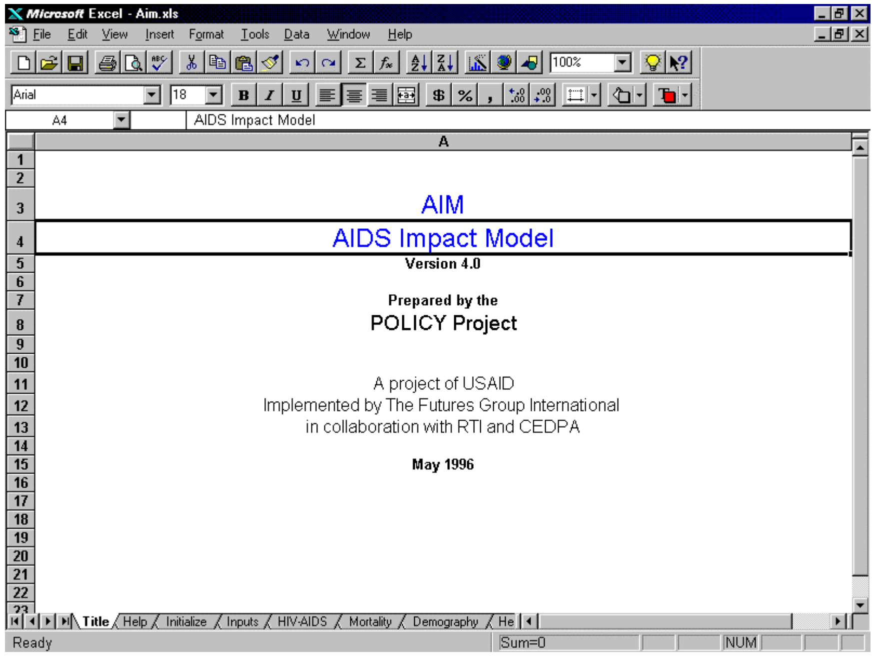
3. Select "Demography," then "AIM." After you specify the file name, the projection will be saved in a special format that can be read into the spreadsheet versions of AIM.

## A. Loading the AIM Excel Spreadsheet

First start the Microsoft Excel program. Next, you need to open the AIM Excel spreadsheet. To do this,

1. Select "File" and "Open" from Excel.

2. Select the file titled "AIM.XLS" from your disk; if you installed Spectrum on your C drive, you will find the file in c:\spectrum\excel. The file will automatically load, and you will see the introduction screen.

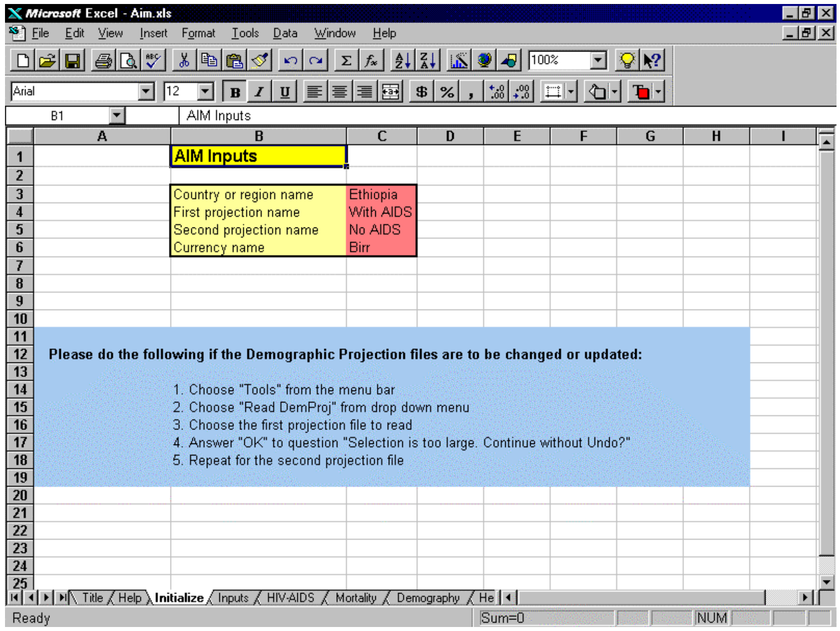



At the bottom of the screen are tabs allowing you to navigate through the spreadsheet (e.g., Title, Help, Initialize, Inputs, etc.). You can move through the spreadsheet by clicking on the appropriate tab.

## B. Initializing the Projection

Once the file has been loaded, it is necessary to enter certain basic information about the spreadsheet and read the appropriate demographic data files into the spreadsheet. This process is called "initialization" and must be done the first time data for a country are being analyzed. Once a file has been initialized and saved, it will only be necessary to initialize it again if the demographic data files change.

The initialization screen appears as follows:




At the top of the initialization screen, you can enter the name of the country or region, the label for the two projections that will be used (one constructed with AIDS data and one without), and the name of the currency. These values are entered in the red cells.

In the middle of the screen are instructions for loading demographic projection files into the file. To read the population projections into the spreadsheet, follow these steps:

1. Choose “Tools” from the Excel menu bar.
2. Choose “Read DemProj files” from the pull-down menu.
3. Select the first projection from the file dialogue box. Normally this will be the “With AIDS” projection; the file will usually be in c:\spectrum\data\ and will have an extension of .amx.
4. Answer “Ok” if the following question appears: “Selection is too large. Continue without undo?”
5. The second time the file dialogue box appears, select the second projection. Normally this will be the “No AIDS” projection.

Once these steps are completed, the population projections from DemProj and the epidemiology projections from AIM will be read into the spreadsheet. It can then be used to examine the socioeconomic impacts.

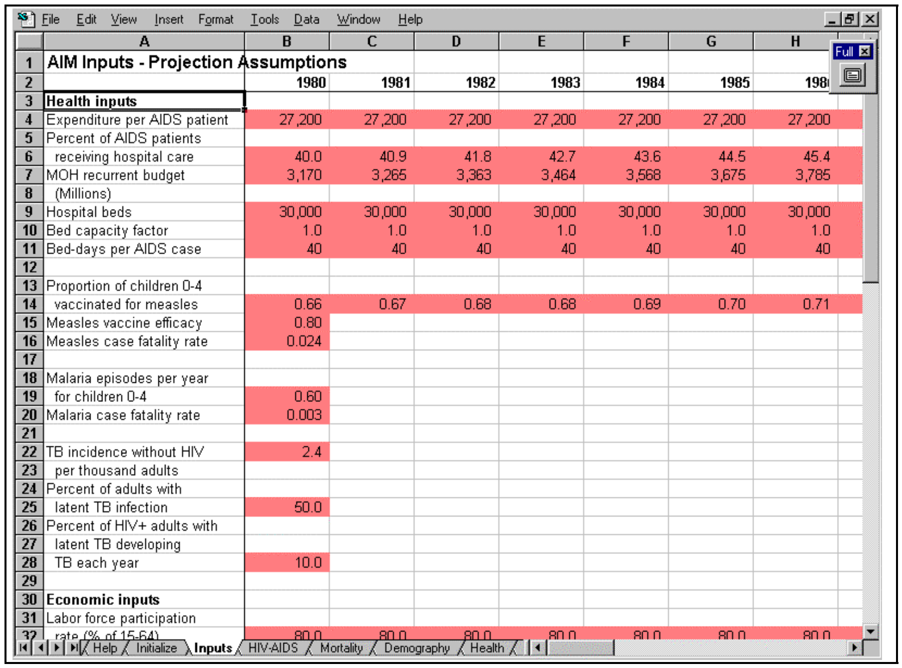
The procedure described above may not work in all cases. It uses the Excel macro language and, therefore, may not work in all versions of Excel. If it does not work you can accomplish the same thing with the following steps:

1. Choose “File” and “Open” from the Excel menu bar.
2. At the bottom of the File Open dialog box, change the entry in the list box labeled “Files of type” to “All files (*.*).”
3. Locate the directory where you saved the data file that you “exported” from Spectrum to an AIM file. Once you are in the correct directory, you should see one or more files with the extension “.amx”; for example, “withaids.amx.”
4. Select the file that has the AIDS projection you want to use in AIM and click on the "Open" button.
5. You will now see a dialog box for the “File Import Wizard - Step 1 of 3.” Click the “Next” button twice and then click the “Finish” button. This will cause Excel to read the data from the AIDS file into a new Excel spreadsheet.
6. Repeat steps 1-5 to read the second file that you exported from Spectrum, the projection with no AIDS.
7. From the “Window” command on the Excel menu, select the data file that has the AIDS projection in it, for example “withaids.amx.”
8. Click on the small square above the label for row 1 and to the left of the label for column A. This will select the entire spreadsheet.
9. Now select “Edit” and “Copy” from the Excel menu to copy the contents of the spreadsheet to the Windows clipboard.
10. Return to the AIM spreadsheet by selecting “Windows” from the Excel menu and “aim.xls” from the pull-down menu.
11. Select the worksheet called “DemProj-A” and place the cursor in cell A1, the cell in the upper left-hand corner.
12. Select “Edit” and “Paste” from the Excel menu. This will paste the data from the Spectrum projection file into this worksheet.
13. Repeat steps 7-12 for the projection file with no AIDS, for example “noaids.amx.” After copying the data to the clipboard (step 9), move to the worksheet called “DemProj-B” and paste the data into this spreadsheet (steps 11 and 12).

14. You have now successfully copied the Spectrum projections into the Excel spreadsheet and can proceed with the rest of this tutorial.

## C. Entering Assumptions

The Excel version of AIM requires the same input assumptions to calculate impact as the Spectrum version, but additional inputs are required to project the economic impacts. These are entered in the worksheet labeled "Inputs." When you select the "Inputs" tab, you will see a display like the one shown below.



File Edit View Insert Format Tools Data Window Help

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | AIM Inputs - Projection Assumptions | | | | | | | |
| 2 | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 198 |
| 3 | **Health inputs** | | | | | | | |
| 4 | Expenditure per AIDS patient | 27,200 | 27,200 | 27,200 | 27,200 | 27,200 | 27,200 | 27,200 |
| 5 | Percent of AIDS patients | | | | | | | |
| 6 | receiving hospital care | 40.0 | 40.9 | 41.8 | 42.7 | 43.6 | 44.5 | 45.4 |
| 7 | MOH recurrent budget | 3,170 | 3,265 | 3,363 | 3,464 | 3,568 | 3,675 | 3,785 |
| 8 | (Millions) | | | | | | | |
| 9 | Hospital beds | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| 10 | Bed capacity factor | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 11 | Bed-days per AIDS case | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| 12 | | | | | | | | |
| 13 | Proportion of children 0-4 | | | | | | | |
| 14 | vaccinated for measles | 0.66 | 0.67 | 0.68 | 0.68 | 0.69 | 0.70 | 0.71 |
| 15 | Measles vaccine efficacy | 0.80 | | | | | | |
| 16 | Measles case fatality rate | 0.024 | | | | | | |
| 17 | | | | | | | | |
| 18 | Malaria episodes per year | | | | | | | |
| 19 | for children 0-4 | 0.60 | | | | | | |
| 20 | Malaria case fatality rate | 0.003 | | | | | | |
| 21 | | | | | | | | |
| 22 | TB incidence without HIV | 2.4 | | | | | | |
| 23 | per thousand adults | | | | | | | |
| 24 | Percent of adults with | | | | | | | |
| 25 | latent TB infection | 50.0 | | | | | | |
| 26 | Percent of HIV+ adults with | | | | | | | |
| 27 | latent TB developing | | | | | | | |
| 28 | TB each year | 10.0 | | | | | | |
| 29 | | | | | | | | |
| 30 | **Economic inputs** | | | | | | | |
| 31 | Labor force participation | | | | | | | |
| 32 | rate (% of 15-64) | 80.0 | 80.0 | 80.0 | 80.0 | 80.0 | 80.0 | 80.0 |

Help / Initialize / Inputs / HIV-AIDS / Mortality / Demography / Health

Values for each of the variables are entered into the orange cells. In most cases, you can enter a value for the first and last years and the spreadsheet will automatically interpolate between them. Of course, you can replace any of these interpolated cells with your own values if you wish.

## D. Viewing Results

Once the DemProj files have been read into the spreadsheet and the assumptions have been entered, you can view the results. The projections are located in worksheets labeled:

- HIV/AIDS
- Mortality
- Demography
- Health
- Economy
- Orphans

The worksheet "Charts" displays most of the indicators in chart format.

In each display worksheet, you can see the calculations for each projection (e.g., With AIDS and No AIDS). Immediately below the results in blue are documented the equations used to calculate these results. In order to change an equation you need to edit the formula in the cell that displays the results. You can insert additional indicators into the spreadsheet by following the format shown for the existing indicators.

## E. Saving

Be sure to save your new AIM spreadsheet. In order to preserve the original, general version of the AIM spreadsheet, it is a good idea to save your new spreadsheet with a different name. To do this, choose "File" from the Excel menu, then choose "Save" from the pull-down menu.

# VII. Preparing AIM Presentations

One of the main uses of the AIM module is to prepare the projections required for an AIM presentation. The presentation itself is usually prepared using software such as PowerPoint. The presentation may be in the form of a computer slide show, color slides, color transparencies, or some other appropriate medium.

AIM presentations for different countries, regions, and topics will be different. The content will depend on the goal of the presentation activity, the data available, and the level of knowledge and interests of the intended audience.

Although each AIM presentation is unique, there is a core set of points that will be included in most presentations. Some of the information required for these points is derived from the AIM projections, some is based on current country-specific data (such as the number of reported AIDS cases), and some is drawn from the general literature on AIDS. A template AIM presentation in PowerPoint is available from our website. Users are encouraged to use this sample only as a starting point and to modify it as necessary for their applications.

One good source of ideas for AIM presentations is presentations that have been prepared by other countries and programs. Copies of AIM presentations and AIM booklets can be obtained from the AIDS control programs in Kenya, Ethiopia, Ghana, Madagascar and Zimbabwe.

An example of a typical AIM presentation—which roughly follows the template—is included as Appendix A to this manual. The appendix also contains a number of charts that have been used in several AIM applications and a description of the main points addressed by each chart.

For more information on customizing AIM presentations to your purposes and audiences, please contact the POLICY Project at the address shown in Chapter I.

# VIII. Methodology

## A. Epidemiology

The AIDS projections in AIM are based on an approach suggested by James Chin and Jonathan Mann of the Global Programme on AIDS, WHO (Chin and Lwanga, 1989) and adapted for spreadsheet calculations by David Sokal of Family Health International and John Stover of the Futures Group. The approach is based on the fact that a certain proportion of those infected with HIV at time *t* are assumed to develop AIDS by time *t+n*. Thus, if we know the number of people infected by year and we know the proportion progressing to AIDS by time since infection, we can determine the number of new AIDS cases each year. This approach is used in both the EpiModel and AIDSproj programs discussed in Section III B. This methodology has been adapted for AIM via development of an age-specific version and incorporation of a more exact calculation of AIDS deaths and non-AIDS deaths. The complete methodology is described below.

### 1. Adult Population

The number of adults is the sum of the population aged 15 to 49.

$$adults_t = \sum_{a,s} Pop_{a,s,t} ,$$

where

a = 15 to 49

s = males, females

## 2. HIV-infected Adults

The number of adults infected with HIV is the sum of the infected population for each age from 15 to 49.

$$HIV\_adults_t = \sum_{a,s} HIV\_Pop_{a,s,t}$$

where

$a$ = 15 to 49

$s$ = males, females

## 3. Target Number of HIV-Prevalent Cases

The number of HIV-infected adults at time $t$ that matches the assumed prevalence level is the number of adults multiplied by the assumed prevalence:

$$Target\_HIV_t = adults_t \bullet prevalence_t.$$

## 4. New Adult HIV Infections

The number of new adult HIV infections in any year is calculated as the target number minus the number of adults already infected:

$$New\_adult\_HIV_t = Target\_HIV_t - HIV\_adults_t.$$

If some new infections (that are not acquired perinatally) are assumed to occur to children under the age of 15, then given the assumed level of adult prevalence, the number of new infections among adults needs to be increased by the proportion of new infections that will occur to children:

$$New\_adult\_HIV_t = ( Target\_HIV_t - HIV\_adults_t ) \\ / \; Percent\_New\_HIV\_Under15.$$

## 5. New HIV Infections by Age and Sex

The new HIV infections are distributed by age and sex according to the distribution entered as an input assumption:

$$New\_HIV_{a,s,t} = New\_adult\_HIV_t \bullet Percent\_new\_infections_{a,s,t}.$$

## 6. Surviving HIV Infections

Some number of persons with new infections at time *t* who survive into future years will be subject to death due to AIDS and death due to non-AIDS causes. The number surviving is first adjusted by non-AIDS deaths:

$$HIV\_infection_{a,s,t,y} = HIV\_infection_{a-1,s,t-1,t} \bullet ( 1 - mortality\_rate_{a,s,t}),$$

where

HIV_infection$_{a,s,t,y}$ = the number of persons who survive HIV infections in age group *a*, of sex *s*, at time *t*, who were initially infected in year *y*.

Survivors of HIV infections are further reduced by the number of people who die due to AIDS:

$$HIV\_infection_{a,s,t,y} = HIV\_infection_{a,s,t,y} - AIDS\_deaths_{a,s,t,y}.$$

The total number surviving with HIV in any year is the sum of those surviving to that year from cohorts of infection from all previous years:

$$HIV\_infection_{a,s,t} = \sum_y HIV\_infection_{a,s,t,y} .$$

## 7. New AIDS Cases

The number of new AIDS cases in time *t* is calculated as the sum of the number of people progressing to AIDS in time *t* who were infected in the 20 years before time *t*.

$$New\_AIDS_{a,s,t} = \sum_y NewHIV_{a,s,y} \bullet Prop\_progressing\_to\_AIDS_{t-y} ,$$

where *y* varies from *t*-20 to *t*.

## 8. AIDS Deaths

AIDS deaths are simply the number of new AIDS cases lagged by the life expectancy after AIDS:

$$AIDS\_deaths_{a,s,t} = New\_AIDS_{a,s,t-ALE}.$$

If the AIDS life expectancy (ALE) is not entered as an integer number of years, then the deaths are distributed between the two years proportionally. For example, if the life expectancy after AIDS were assumed to be 1.5 years, then half of the new AIDS cases would be assumed to die one year later and half two years later.

## 9. Perinatal Infections

The number of infected children is determined by the number of infected babies born. The number of infected babies is a function of the perinatal transmission rate (PTR), fertility, and the percentage of mothers who are infected:

$$HIV\_births_t = PTR \bullet TFR_t \bullet \sum_a ASFP_{a,t} \bullet HIV\_infection_{a,f,t},$$

where

| | | |
|---|---|---|
| $HIV\_births_t$ | = | the number of infected births at time $t$ |
| PTR | = | perinatal transmission rate |
| $TFR_t$ | = | total fertility rate at time $t$ |
| $ASFP_{a,t}$ | = | the age-specific fertility proportion, or the proportion of lifetime births that occur during age $a$ and at time $t$ |
| $HIV\_infection_{a,f,t}$ | = | the number of infected females at age $a$ and time $t$ |

Children progress from HIV to AIDS to death in a manner similar to adults; however, the time to progress from HIV to AIDS is much shorter for children.

## 10. AIDS Orphans

The definition of an AIDS orphan used in AIM is a child under the age of 15 who has lost its mother to AIDS.

First we calculate the number of children under the age 15 whose mothers are still alive:

$$CEB15_t = \sum_{1=t-14}^{t} \sum_{a1=15}^{49} TFR_{t1} \bullet ASFP_{a1} \bullet POP_{a1,f,t1}$$

where

| | | |
|---|---|---|
| $CEB15_t$ | = | number of women under age 15 whose mothers were living at time *t* |
| $POP_{a1,f,t1}$ | = | women currently living who were age *a1* at time *t* |
| $TFR_{t1}$ | = | total fertility rate at time *t* |
| $ASFP_{a1}$ | = | percentage of lifetime births which occurred to age group *a1* |

In this equation, births are summed across the reproductive ages of currently living women, for each of the 15 preceding years.

Next we calculate the number of children under the age of 15 who have not died from AIDS and who were ever born to females who died from AIDS:

$$ACEB15_{a,t} = \sum_{a1-15}^{64} TFR_{t-a} \bullet ASFP_{a1-a,t-a} \bullet FAD_{a1,t} \bullet [1 - PTR \bullet PropHIV_a],$$

where

| | | |
|---|---|---|
| $ACEB15_{a,t}$ | = | The number of children under the age of 15 of age *a* who have not died from AIDS who were ever born to females who died from AIDS at time *t* |
| $TFR_{t-a}$ | = | TFR *a* years earlier |
| $FAD_{a1,t}$ | = | The number of female AIDS deaths occurring at age *a1* at time *t* |
| $PropHIV_a$ | = | The proportion of women who would be HIV positive *a* years before death. |

This equation is similar to the first one for CEB except that it counts only children born to women who died of AIDS at time *t* rather than children born to all women. This figure is further adjusted to remove those children who have died from AIDS. The expression *1-PTR* is the proportion of infants who are not infected if the mother is infected. The variable *PropHIV* accounts for the fact that the women may not have been infected during the entire 15 years. $PropHIV_a$ is the proportion of women who died from AIDS at time *t* who were HIV-positive *t-a* years earlier. This proportion is essentially the same as the cumulative proportion of people who develop

AIDS by time since infection, but shifted by one year to account for the lag from AIDS to death.

The first two equations described above determine the number of children ever born. They need to be adjusted to account for the fact that some of these children will have died before year $t$ from causes other than AIDS. This step is accomplished by dividing the number of children alive today by the number of children ever born. This adjustment factor accounts for non-AIDS mortality. Therefore, the number of new orphans, created in year $t$ by female deaths in that year, becomes:

$$New\_AIDS\_orphans_{a,t} = ACEB15_{a,t} \bullet \frac{Pop_{a,t}}{CEB15_{a,t}}.$$

The total number of AIDS orphans in any year is increased by newly created orphans and decreased by child deaths and by children becoming older than 15. For any particular age $a$, the number of orphans at time $t$ will equal the number of new orphans created in that year plus the number of orphans aged $a\text{-}1$ at time $t\text{-}1$ who survive to year $t$. Thus, the equation for the total number of orphans at age $a$ is:

$$AIDS\_orphans_{a,t} = New\_AIDS\_orphans_{a,t} + AIDS\_orphans_{a-1,t-1} \bullet SR_{a-1,t-1}$$

where:

$SR_{a,t}$ = The survival ratio from age $a\text{-}1$ $t\text{-}1$ to age $a$ $t$.

The survival ratio in this equation is the survival ratio for all children calculated from the non-AIDS life expectancy and a model life table. This figure may underestimate orphan mortality if children who have lost their mother do not receive the same quality of care as children who remain with their natural mothers.

## B. Health

### 1. AIDS Treatment Costs

To calculate the total AIDS treatment costs, first the model multiplies the lifetime cost of treating AIDS patients by the number of AIDS patients who seek care from the public health system. This figure is then divided by the average post-AIDS life expectancy.

$$ATC_t = \frac{AIDS_t \bullet \frac{PercHosp_t}{100} \bullet LifetimeCost}{ALE},$$

where:

| | | |
|---|---|---|
| $ATC_t$ | = | AIDS treatment costs |
| $AIDS_t$ | = | Number of people at time $t$ who have AIDS |
| $PercHosp_t$ | = | Percentage of AIDS patients seeking care from the public health system at time $t$ |
| LifetimeCost | = | Lifetime cost of treating an AIDS patient |
| ALE | = | Average life expectancy after developing AIDS. |

### 2. Percent of Ministry of Health Expenditures on AIDS

Ministry of Health expenditures overall—independent of HIV/AIDS treatment and intervention—are a direct input to AIM supplied by the user.

The percentage of Ministry of Health expenditures required to care for AIDS patients is calculated as the AIDS treatment costs divided by total Ministry of Health expenditures:

$$MOHexp\%_t = \frac{ATC_t}{MOHexp_t},$$

where:

| | | |
|---|---|---|
| $MOHexp_t$ | = | Total expenditures by the Ministry of Health at time $t$ ($t=0$ in the base year). |

### 3. Number of Hospital Beds Required for AIDS Patients

The number of hospital beds required is calculated by multiplying the number of AIDS patients using the public health system by the average number of days hospitalized.

$$AIDSbeds_t = (AIDS \bullet \frac{PercHosp}{100}) \bullet Bed\text{-}Days,$$

where

| | | |
|---|---|---|
| AIDSbeds | = | The number of hospital bed- days required for AIDS patients |
| BedDays | = | The average number of days occupying a bed (bed-days) per year per hospitalized AIDS patient. |

### 4. Total Number of Hospital Bed-Days

The total number of hospital bed-days available is a function of the number of beds and the rate at which they are used.

$$HospBedDays = Beds \bullet CapacityFactor \bullet 365,$$

where

| | | |
|---|---|---|
| Beds | = | Number of hospital beds available |
| CapacityFactor | = | The average capacity utilization of hospital beds. |

For comparison with AIDS, AIM can calculate annual occurrence of several diseases in the child (age 0-4) and adult populations.

### 5. Child Malaria Cases

$$MalariaCases_t = Pop_{0-4,t} \bullet MalariaCaseRate_t,$$

where

| | | |
|---|---|---|
| $MalariaCases_t$ | = | The annual number of child cases of malaria at time *t* |
| $Pop_{0-4,t}$ | = | The population of children aged four and under at time *t* |
| $MalariaCaseRate_t$ | = | The average number of episodes of fever per child per year at time *t*. |

### 6. Child Measles Cases

The number of child cases of measles per year is calculated by first determining the number of children susceptible to measles. This is the number of children between the ages of zero and four multiplied by the proportion who are susceptible (usually 100 percent). Some children are not vaccinated. In this case, all susceptible children will develop measles; thus, the expression *1-PropVac* determines the proportion of children who will develop measles because they are not vaccinated. Most children who are vaccinated will not develop measles, but the vaccine is not 100 percent effective. Thus, the expression *PropVac • (1-Eff)* determines the proportion of children who will get measles even though they received the vaccination. Since children contract measles only once in their lifetime, the entire equation is multiplied by 1/5, to calculate the annual rate of measles among all children aged 0-4 (a child could develop measles in any of the five years from age zero to four, but in only one of those years).

$$Measles_t = Pop_{0-1,t} \bullet PropSus \bullet [1-PropVac) + PropVac \bullet (1-Eff)] \bullet 1/5,$$

where:

| | | |
|---|---|---|
| $Measles_t$ | = | The number of child measles cases per year at time *t* |
| PropSus | = | The proportion of children susceptible to measles |
| PropVac | = | The proportion of children vaccinated against measles |
| Eff | = | The proportion of vaccinated children who are protected from measles infection |

### 7. Child Malaria Deaths

$$MalariaDeaths_t = MalariaCases_t \bullet MalariaCFR_t ,$$

where

| | | |
|---|---|---|
| $MalariaDeaths_t$ | = | The annual number of child deaths from malaria at time *t* |
| MalariaCFR | = | The case fatality rate for malaria |

### 8. Child Measles Deaths

$$MeaslesDeaths_t = Measles_t \bullet MeaslesCFR,$$

where

| | | |
|---|---|---|
| $MeaslesDeaths_t$ | = | The annual number of child deaths from measles at time $t$ |
| MeaslesCFR | = | The case fatality rate for measles |

### 9. Number of Cases of Non-HIV Tuberculosis

$$Non\_HIV\ TB_t = Tbincidence \bullet \sum_{a=15}^{80+} Pop_{at}\ ,$$

where

| | | |
|---|---|---|
| Non-HIV $TB_t$ | = | The annual number of cases of tuberculosis (TB)that are not related to HIV infection, at time $t$ |
| TBincidence | = | The normal incidence of TB cases in the adult population. |

### 10. Number of Cases of HIV-Related Tuberculosis

$$HIV\_TB_1 = PercTB \bullet HIV\_Tbincidence \bullet \sum_{a=15}^{80+} HIV\_Pop_{a,s,t}\ ,$$

where

| | | |
|---|---|---|
| $HIV\_TB_t$ | = | The annual number of TB cases that are related to HIV infection, at time $t$ |
| PercTB | = | The percentage of the adult population with latent TB infection |
| HIV_TBincidence | = | The proportion of HIV- positive individuals developing TB each year. |

## C. Economy

Several of the economic factors in AIM are strongly related to aspects of the labor force. The following Indicators are calculated in the Excel version of AIM but are not currently in the Spectrum version.

### 1. Labor Force

$$LF_{s,t} = \sum_{a=15}^{69} Pop_{a,s,t} \bullet LFPR_{a,s,t},$$

where

| | | |
|---|---|---|
| $LF_{s,t}$ | = | Size of the labor force by sex at time $t$ |
| $LFPR_{a,s,t}$ | = | Labor force participation rate by age and sex at time $t$ |

### 2. Experience Level of the Labor Force

The average experience level of the labor force is calculated as the average age of workers minus the average age at entrance to the labor force.

$$AvgLFexp_{s,t} = AvgLFage_{s,t} - AvgStartAge_{s,t}$$

$$AvgLFexp_{s,t} = \frac{\sum_{a=15}^{69} a \bullet pop_{a,s,t} \bullet LFPR_{a,s,t}}{\sum_{a=15}^{69} Pop_{a,s,t} \bullet LFPR_{a,s,t}}$$

$$AvgStartAge_{s,t} = \frac{\sum_{a=15}^{69} a \bullet Pop_{a,s,t} \bullet (LFPR_{a,s,t} - LFPR_{a-1,s,t})}{\sum_{a=15}^{69} Pop_{a,s,t} \bullet (LFPR_{a,s,t} - LFPR_{a-1,s,t})},$$

where

| | | |
|---|---|---|
| $AvgLFexp_{s,t}$ | = | The average number of years of experience in the labor force for those currently in the labor force, for males and females, at time $t$ |
| $AvgStartAge_{s,t}$ | = | The average age of entry into the labor force by sex and at time $t$ |

*AvgStartAge* is only calculated for those ages where $LFPR_{a,s,r,t}$ is greater than $LFPR_{a-1,s,t}$; in other words, only for those ages where there are still net labor force entrants.

### 3. Number of Productive Years of Life

The number of productive years of life for an individual is defined to be the number of years between the ages of 15 and 64 that the individual spends in the labor force. This figure would be 49 for all individuals if everyone survived to age 65 and everyone was in the labor force for the entire time. Since few people are in the labor force this entire period, and since some people will die before reaching age 65, the average number of productive years of life for an entire population is much less than 49. AIDS increases the death rate to the population under the age of 65 and, therefore, reduces the average number of productive years of life.

$$ProdYears_{s,t} = \sum_{a=15}^{64} Surv_{a,s,t} \bullet LFPR_{a,s,t},$$

where

| | | |
|---|---|---|
| ProdYears | = | The average number of productive years of life for an individual |
| $Surv_{a,s,t}$ | = | The proportion of people who survive from birth to age *a* |

### 4. Gross Domestic Product

The size of the gross domestic product, with and without AIDS, can be projected in the Excel version of AIM. GDP is calculated with a Cobb-Douglas production function that expresses the size of GDP as a function of the size of the labor force, the amount of capital stock, and the rate of technical progress.

$$GDP_t = Constant \bullet (1 + RTP)^t \bullet Capital_t^{\,a} \bullet LF_t^{\,b}$$

where

| | | |
|---|---|---|
| GDP | = | gross domestic product |
| Constant | = | a constant multiplier |
| RTP | = | annual rate of technical progress |
| Capital | = | the value of the capital stock |
| a | = | elasticity of output to capital |
| LF | = | the size of the labor force |
| b | = | elasticity of output to labor. |

The constant multiplier is calculated from the GDP equation to provide the correct GDP value in the base year:

$$Constant = GDP_1 \;/\; ( Capital_1^a \bullet LF_1^b ) .$$

The size of the capital stock is calculated as the amount of capital in the previous year plus gross domestic investment (GDI) minus depreciation:

$$Capital_t = Capital_{t-1} + GDI_t - depreciation_t .$$

Depreciation is the value of the capital stock divided by the average lifetime of capital:

$$Depreciation_t = Capital_{t-1} \;/\; Average\ lifetime\ of\ capital.$$

Gross domestic investment is calculated as the GDP multiplied by the percent of GDP that is invested each year minus the amount of savings diverted from investment to expenditures for AIDS care:

$$GDI_t = GDP_{t-1} \bullet \%GDI - AIDS_t \bullet ExpenditurePerAIDS \bullet PercentFromSavings,$$

where

| | | |
|---|---|---|
| %GDI | = | the percent of GDP that is gross domestic investment |
| AIDS | = | the number of new AIDS cases |
| ExpenditurePerAIDS | = | the health care expenditure per AIDS patient |
| PercentFromSaving | = | the percentage of AIDS care financed from savings. |

## 5. Gross Domestic Product Per Capita

Gross domestic product per capita is calculated as the GDP divided by the size of the population:

$$GDP/cap_t = GDP_t \;/\; population_t .$$

## D. Orphans

The orphan calculations are based on estimates of 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. This equation has been developed using data from Africa and may not be appropriate for other regions of the world. Full details of the methodology used here are provided in "Orphan numbers on populations with generalized epidemics," by Nicholas C. Grassly and Ian M. Timeus, forthcoming. Copies are available from Dr. Grassly at n.grassly@ic.ac.uk

# IX. References

Note: Abstracts from the various International Conferences on AIDS are available from the World Wide Web site for the AIDS Education Global Information System (AEGIS), http://www.aegis.com. The site is searchable by key words or phrases. Full papers can be obtained as noted on each abstract.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# X. Glossary of Terms

Most of the definitions were obtained from the United Nations World Wide Web site: http://www.unaids.org/

Click on the ribbon to enter the site, then *Human Interest*, then *ABC's of HIV/AIDS*.

**Adult.** In AIM, an adult is defined as a person aged 15 or older.

**AIDS.** The abbreviation for the acquired immune deficiency syndrome, a disabling and fatal disease caused by the human immunodeficiency virus (HIV).

**Epidemiology.** The study of the incidence, distribution, and determinants of an infection, disease, or other health-related event in a population. Epidemiology can be thought of in terms of who, where, when, what, and why. That is, who has the infection/disease, where are they located geographically and in relation to each other, when is the infection/disease occurring, what is the cause, and why did it occur?

**HIV.** The human immunodeficiency virus is the virus that causes AIDS. Two types of HIV are currently known: HIV-1 and HIV-2. Worldwide, the predominant virus is HIV-1. Both types of virus are transmitted by sexual contact, through blood, and from mother to child, and they appear to cause clinically indistinguishable AIDS. However, HIV-2 is less easily transmitted, and the period between initial infection and illness is longer in the case of HIV-2.

**HIV Infection.** Infection with the human immunodeficiency virus (HIV). HIV infection is primarily a sexually transmitted infection, passed on through unprotected penetrative sex. The virus can also be transmitted through blood transfusions, through the use of unsterilized injection equipment or cutting instruments, and from an infected woman to her fetus or nursing infant.

**HIV Sentinel Surveillance.** The systematic collection and testing of blood from selected populations at specific sites—for example, pregnant women attending prenatal clinics—for the purpose of identifying trends in HIV prevalence over time and place.

**Incubation Period.** The time interval between infection and the onset of AIDS.

**Interpolation.** Given two numbers that serve as boundary points, it is possible to estimate the values that lie at intervals between the two points. For example, if the HIV prevalence rate for a country or region was actually measured only in 1985 and in 1995, by assuming even increments from year to year, it is possible to interpolate a TFR for each intervening year. Spectrum uses a linear form of interpolation so that the difference between each annual value is the same. Other nonlinear forms of interpolation are also possible but are not used in Spectrum.

**Life Expectancy.** The average number of years a newborn can expect to live, based on the mortality and conditions of the time.

**Model.** Computer system designed to demonstrate the probable effect of two or more variables that might be brought to bear on an outcome. Such models can reduce the effort required to manipulate these factors and present the results in an accessible format.

**Module.** Synonym for "model."

**Orphan.** In this manual, an orphan is defined as a child under the age of 15 whose mother has died of AIDS. It is assumed that if the mother has AIDS, the father will have the fatal disease as well.

**Perinatal and Perinatal Transmission.** Pertaining to or occurring during the periods before, during, or shortly after the time of birth; that is, before delivery from the 28$^{th}$ week of gestation through to the first seven days after delivery. The transmission of HIV from an infected woman to her fetus or newborn child is referred to as perinatal transmission.

**Prevalence.** The proportion of a defined population with the infection, disease, or other health-related event of interest at a given point or period of time.

**Seroprevalence (HIV, STD).** The percentage of a population from whom blood has been collected that is found, on the basis of serology, to be positive for HIV or other STD agents at any given time.

**Sentinel Surveillance.** See HIV Sentinel Surveillance.

# XI. Acronyms and Abbreviations

| | |
|---|---|
| **AIDS** | acquired immune deficiency syndrome |
| **AIDSCAP** | AIDS Control and Prevention Project (USAID-funded) |
| **AIDSTECH** | AIDS Technical Support Project (USAID-funded) |
| **AIM** | AIDS Impact Model |
| **CDC** | U.S. Centers for Disease Control and Prevention |
| **FHI** | Family Health International |
| **GDP** | gross domestic product |
| **GNP** | gross national product |
| **HIV** | human immunodeficiency virus |
| **ILO** | International Labor Organization |
| **MOH** | Ministry of Health |
| **NACP** | national AIDS control program |
| **PTR** | perinatal transmission rate |
| **STD** | sexually transmitted disease |
| **TFR** | total fertility rate |
| **TB** | tuberculosis |
| **UNAIDS** | Joint United Nations Programme on HIV/AIDS |
| **USAID** | United States Agency for International Development |

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