HIV Vaccine
Version 1
A Model for Examining the Effects of an HIV Vaccine

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Spectrum System of Policy Models

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I. Introduction

A. Description of the Spectrum System

1. Components

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

- **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 in order for consumers and/or nations to reach their goals of contraceptive practice or desired fertility. This model also includes the Post-Abortion Care module, or PAC, which examines the costs of providing post-abortion care and the resulting impact on the maternal mortality ratio.

- **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.

- **Condom Requirements (CR)** – A program to forecast national condom requirements for both family planning and HIV/AIDS prevention, focusing on the critical groups at risk in the population.

- **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.

\(^1\) The terms “model” and “module” are used interchangeably in the Spectrum manuals to refer to the computer programs within the system.
• **Safe Motherhood Model (SMM)** – A program to assist in allocating effectively the resources associated with reducing the maternal mortality ratio.

• **Prevention of Mother-to-Child Transmission (PMTCT)** – A program to evaluate the costs and benefits of programs to reduce mother-to-child transmission of HIV.

• ** Allocate** – A program to improve priority setting and resource allocation for reproductive health.

• **HIV Vaccine** – A model to explore the impact of potential HIV vaccines on the HIV epidemic.

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, CR, RAPID, SMM, PMTCT, Allocate and HIV Vaccine.

Each component has a similarly functioning interface which 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 relevant to entities as small as local providers of primary health care services and as large as international development assistance agencies. The “what if” refers to factors that can be changed or influenced by public policy.

Models are commonly computerized when analysts need to see the likely result of two or more forces that might be brought to bear on an outcome, such as a population’s illness level or its degree of urbanization. Whenever at least three variables are involved (such as two forces and one outcome), a computerized model can both reduce the burden of manipulating those variables and present the results in an accessible way. 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 actions. Modeling can show the economic efficiency of a set of actions (i.e., whether certain outcomes are achieved more effectively than under a different set of actions), or simply whether the cost of a single set of actions is acceptable for the benefits gained.

• the recognition of interrelatedness. Modeling can show how making a change in one area of population dynamics (such as migration rates) may necessitate changes in a number of other areas (such as marriage rates, timing of childbearing, etc.).

• the need to discard monolithic explanations and policy initiatives. Modeling can demonstrate that simplistic explanations may bear little relationship to how the “real world” operates.

• the utility of “door openers.” A set of policies under consideration may not be acceptable to all stakeholders. Modeling can concentrate on favored goals and objectives and demonstrate how they are assisted by the proposed policies.

• that few things in life operate in a linear fashion. A straight line rarely describes social or physical behavior. Most particularly, population growth, being exponential, is so far from linear that its results are startling. Modeling shows that all social sectors based on the size of population groups are heavily influenced by the exponential nature of growth over time.

• that a population’s composition greatly influences its needs and its well being. How a population is composed—in terms of its age and sex distribution—has broad-ranging consequences for social welfare, crime rates, disease transmission, political stability, etc. Modeling demonstrates the degree to which a change in age and sex distribution can affect a range of social indicators.

• the effort required to “swim against the current.” A number of factors can make the success of a particular program harder to achieve; for example, the waning of breastfeeding in a population increases the need for contraceptive coverage. Modeling can
illustrate the need for extra effort—even if simply to keep running in place.

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 a tutorial, information on the methodology behind the model, a glossary, and a bibliography.

More information about the Spectrum System of Policy Models is available from:

Futures Institute
41-A New London Turnpike
Glastonbury, CT 06033
Telephone: (860)657-5300

E-mail: JStover@FuturesInstitute.org
http://www.FuturesInstitute.org
D. What is HIV Vaccine?

Efforts continue to scale-up coverage of HIV/AIDS prevention interventions and develop and introduce new interventions such as male circumcision and microbicides. Controlling the AIDS epidemic is likely to require all of these efforts and more. An HIV vaccine could be a vital piece in the strategy to defeat AIDS.

The HIV Vaccine model can be applied to country data to estimate the impact of an HIV vaccine for individual countries. The model is designed to include all of the important modes of vaccine action and to incorporate other prevention interventions. The model can be applied to explore the impact of vaccines under various scenarios. It can be used to answer such questions as:

- How many HIV infections can be averted if a vaccine is provided?
- What is the impact on the number of HIV infections averted if certain characteristics of a vaccine vary (degree vs. take, efficacy, etc.)?
- What is the impact of a vaccine taking into account the impact of other prevention interventions?
- What is the cost per HIV infection averted?

HIV Vaccine is a tool that can be used to answer some of these questions. The model is designed to rely on available data and to reproduce the key dynamics of the HIV epidemic. The model simulates the adult population between the ages of 15 and 49, split into five risk groups: High risk (sex workers and their clients), Medium risk (those with casual sex partners), Low risk (those faithful to one partner), Injecting drug users (IDU), and Men who have sex with men (MSM – males only). The sexually active and IDU population are exposed to the risk of infection each year. The probability of transmission depends on characteristics such as number of partners, HIV and STI prevalence, condom use, stage of infectiousness, and type of contact.

For the medium risk and high risk populations HIV prevalence among sex partners is assumed to be the prevalence of the opposite sex in the same risk group. For MSM it is prevalence in the MSM risk group. Although people in these risk groups may have contacts with those in lower risk groups, those contacts are ignored as they are not likely to add much to the overall risk of infection. For low risk groups, however,
contacts with other risk groups are a major source of new infection. Therefore, for low risk groups the partner prevalence is a weighted average of the prevalence of all risk groups. The weights are the proportion of contacts with each risk group. These are estimated from the number of people in each risk group and the percentage that are married.

For IDU the model estimates new infections based on the force of infection, which is an input. New IDU infections are estimated as the product of the susceptible population, prevalence among all IDU (male and female combined) and the force of infection. Not all IDU share needles, therefore the susceptible population is the uninfected who share needles.

A person newly infected with HIV is in the Primary Infection category and remains in this category for one year. People in the Primary Infection category are more infectious than those in other stages. An infected person passes out of the Primary Infection stage to enter the Asymptomatic Stage where they remain for 6 years and have a low level of infectiousness. An infected person then moves to the Symptomatic Infection Stage where they remain for 2 years before dying from AIDS. Infectiousness is also elevated for people in the Symptomatic Stage.

An HIV vaccine can be either prophylactic or therapeutic. A prophylactic vaccine reduces susceptibility to HIV infection, while a therapeutic vaccine both reduces infectiousness and slows the progression to AIDS death.

A general schematic of the model can be seen below:
F. Why Use HIV Vaccine?

The HIV Vaccine model is intended to (1) support planning at the national level for implementation of an HIV vaccine, when available, and (2) create a better dialogue between all stakeholders regarding priorities in HIV/AIDS policies.

The HIV Vaccine model does not provide all of the answers. It is intended to assist planners in understanding the effects of an HIV/AIDS vaccine. The model can help planners understand how a vaccine could lead to reductions in HIV infections.

The HIV Vaccine model is intended for use by national programs to explore the effects of different vaccine profiles on national goals. It is generally implemented by a multi-disciplinary team composed of participants with various areas of expertise (demography, epidemiology, health finance, planning) representing different aspects of society (government, civil society, private sector, donors). A technical team works together to implement the model for the first time. The model is then used in interactive workshops with planners and stakeholders to explore the effects of different vaccine configurations on health outcomes. Through this interaction participants gain a better understanding of the dynamics of impact. This prepares them to develop realistic budgets and goals that reflect their priorities.
II. Steps in Implementing *HIV Vaccine*

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

1. **Prepare a demographic projection.** *HIV Vaccine* requires a population projection prepared with DemProj. This projection should be prepared first or at the same time as the *HIV Vaccine* projection. The first year and final year of the DemProj projection will determine the span of the *HIV Vaccine* projection; the DemProj manual contains instructions on the steps associated with this module.

2. **Determine the period of the projection.** Population projections start at some base year and continue for a certain number of years into the future. The base year is often selected on the basis of data availability and is usually the year of the most recent census or large-scale survey. The number of years to project is determined by the use of the projection. Planning activities generally focus on short-term projections (five years), while projections used for policy dialogue often use a longer time horizon (10-30 years). Because an HIV vaccine is not likely to implemented for some time, the period of the projection for this model will probably have a longer time horizon.

3. **Collect data.** Data to be collected for the *HIV Vaccine* module include HIV/STI prevalence, sexual behavior, and information about vaccine profiles. Each of the inputs for the *HIV Vaccine* module is described further in the chapter below. Since the projection will only be as good as the data on which it is based, it is worth the effort to ensure that appropriate and high-quality data are collected and prepared before starting the projection. (A special feature of DemProj called EasyProj allows you to make a projection quickly using data from the United Nations *World Population Prospects*.)
4. **Make assumptions.** Assumptions about trends in sexual behavior, vaccine profile and interventions such as circumcision rates and coverage of antiretroviral therapy (ART) are necessary to implement the HIV Vaccine module. These assumptions should be carefully considered and based on reasonable selection guidelines.

5. **Enter data.** Once all of the data are collected and decisions are made about projection assumptions, HIV Vaccine can be used to enter the data and make a projection.

6. **Examine projections.** Once you make a projection, it should be examined carefully. This scrutiny includes consideration of the various demographic indicators produced, as well as the distribution of HIV infections in the projection among risk groups. 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.

7. **Make alternative projections.** Many applications require alternative population projections. Once the base projection has been made, the program can be used to generate alternative projections quickly by varying one or more of the projection assumptions. Examples are given in the Tutorial section below.

8. **Conduct workshop.** In most applications the model will be used in a workshop with decision makers. The workshop will be an interactive session where participants will try out different scenarios and observe the consequences. As various options are tested with the model the participants will gain a better understanding of the benefits involved with different scenarios and the amount of funding required to achieve the goals.
III. Inputs for *HIV Vaccine*

There are two main sections to this chapter, describing required inputs for both the DemProj and *HIV Vaccine* modules.

As discussed above, the DemProj module must be completed before the *HIV Vaccine* module can be implemented. A more thorough discussion of all of the inputs necessary can be found in the DemProj manual, which is available at:

www.futuresinstitute.org

A. DemProj

Data requirements for DemProj include:

- Base year population
- Fertility data
- Mortality data
- International migration data
- Current population for both urban and rural settings (if so desired)

For some of the required variables, such as for patterns of age-specific fertility rates, model life tables, and the sex ratio at birth, default values are provided.

Note that, instead of following the process above, it is possible to utilize a feature in DemProj called “EasyProj.” EasyProj uses the data from the most recently available United Nations population projections to provide default values for all of the data necessary to make a demographic projection for a particular country, using either the low, medium, or high projection assumptions as published by the United Nations *World Population Prospects*. Country-specific default assumptions provided by EasyProj include base year population, fertility data (including age-specific fertility rates), mortality data, and international migration data. Details of utilizing “EasyProj” are contained in the DemProj manual.
Another alternative is to begin with the “EasyProj” default projection values, and then edit selected assumptions as necessary.

B. HIV Vaccine

There are four sets of data that are required to implement HIV Vaccine, each described below: Epidemiology, Behavior, Interventions, and Vaccines. Many of the variables have default values entered, which are based on scientific data, although any of the default values can be changed.

1. Epidemiology

Relative infectiousness by stage

There are four stages of HIV infection in the model, each of which affects transmission rates in different ways. The impact on transmission rates is expressed as a multiple of the base transmission rate, that is, the transmission rate that exists after taking into account the mode of transmission (described below). A person newly infected with HIV is in the Primary Infection Stage and remains in this category for one year. People in the Primary Infection category are more infectious than those in other stages, increasing the probability of transmission by a factor of 8. An infected person passing out of the Primary Infection Stage to enter the Asymptomatic Stage remains there for 6 years. They have a low level of infectiousness, where the transmission rate is identical to the base transmission rate, i.e. the default value is 1. An infected person then moves to the Symptomatic Infection Stage where they remain for 2 years before dying from AIDS. Infectiousness is also elevated for people in the Symptomatic Stage, with a default value of 4.2 People are considered to be eligible for ART when they are in the Symptomatic Stage. If they receive ART then their progression to death is reduced by some proportion (specified in the inputs to the model). A person on ART is assumed to have the same infectiousness as a person in the Asymptomatic Stage, that is, the default multiplier is 1.3

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Note that adults in the Symptomatic Stage are still considered to be sexually active. This may overstate HIV transmission if many people in this stage have reduced sexual activity due to illness.

**HIV transmission rates per act**

Note that all of the multipliers for transmission are calculated relative to the base female to male transmission rate.

**Transmission of HIV per act (Female to Male):** The transmission rate when the female is HIV positive and the male is HIV negative. The default value is 0.0011, from Ron Gray et al., "Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1 discordant couples in Rakai, Uganda," *Lancet* 357, April 14, 2001, pps. 1149-1153.

**Transmission Multiplier for male to female:** The transmission rate when the male is HIV positive and the female is HIV negative. The default value for this is 1, that is, there is no additional impact depending on whether the transmission takes place female to male, or male to female.

**Transmission multiplier for STI:** The transmission rate when at least one of the partners has either an ulcerative or a non-ulcerative sexually transmitted infection (STI). The default value is 6, which is an average of a range of 2.2 - 11.3 for ulcerative STIs, and a range of 2-4 for non-ulcerative STIs, based on: Galvin and Cohen, "The Role of Sexually Transmitted Diseases in HIV Transmission" *Nature Reviews Microbiology* Volume 3, January 2004, pps. 33-42.

**Transmission multiplier for MSM contacts:** The transmission rate when one of the males is HIV positive, while the other male is HIV negative. The default value is 10, based on: Vittinghoff E, Douglas J, Judson F, McKirnan D, MacQueen K, Buchbinder SP. Per-Contact Risk of Human Immunodeficiency Virus Transmission between Male Sexual Partners *American Journal of Epidemiology* 150:3:306-31. Note that only one transmission rate is used between two males; no attempt is made to differentiate between anal insertive or anal receptive transmission rates.

**Condom efficacy:** This variable reflects the efficacy of condom use during actual, consistent use. Thus it incorporates consideration of improper use of the condom by an individual, as well as whether or not the condom itself fails. The user may change the default value of 0.8 (80 percent), if desired.
Reduction in male susceptibility when circumcised (1-100%): The reduction in the probability that a male becomes infected because he is circumcised. The default value for this is 60%, based on Auvert B, Taljaard B, Lagarde E, Sobngwi-Tambekou J, Rémi Sitta, and Puren A. “Randomized, Controlled Intervention Trial of Male Circumcision for Reduction of HIV Infection Risk: The ANRS 1265 Trial,” PLoS Medicine, 2005 November; 2(11): e298.

Reduction in male infectiousness when circumcised (0-100%): The reduction in the probability that a male infects someone else because he is circumcised. Currently, there are no scientific studies that have measured this reduction; the default value is 30%, which assumes that the reduction in infectiousness is half of the reduction in susceptibility.

Proportion of adults on ART surviving to the following year (0-1): The default value for this is 0.9, or 90 percent. Numerous studies have measured adherence, and the values range between 60-90 percent, depending on the support system, initial CD4 count, side effects, complexity of the regimen, etc. See C Orrell, “Antiretroviral adherence in a resource-poor setting,” Current HIV/AIDS Report, 2005 Nov;2(4):171-6 for a recent review of studies.

Size of initial pulse of infection (0-0.01): The initial force of infection for HIV transmission, used to fit the epidemic curve. The default value is 0.001.

Epidemic Start Year: The first year of the epidemic is the year in which the first cases of HIV occurred. This date is generally a few years before the first AIDS cases were reported. The UN estimates of the beginning of the AIDS epidemic, by region, are shown in Table 1.

<table>
<thead>
<tr>
<th>Region</th>
<th>Start of Epidemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>Late 1970s - early 1980s</td>
</tr>
<tr>
<td>South and Southeast Asia</td>
<td>Late 1980s</td>
</tr>
<tr>
<td>Latin America</td>
<td>Late 1970s - early 1980s</td>
</tr>
<tr>
<td>North America, Western Europe, Australia,</td>
<td>Late 1970s - early 1980s</td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td>Caribbean</td>
<td>Late 1970s - early 1980s</td>
</tr>
<tr>
<td>Central Europe, Eastern Europe, Central Asia</td>
<td>Early 1990s</td>
</tr>
<tr>
<td>East Asia, Pacific</td>
<td>Late 1980s</td>
</tr>
<tr>
<td>North Africa, Middle East</td>
<td>Late 1980s</td>
</tr>
</tbody>
</table>

HIV/STI Prevalence by risk group: The sexual behavior data required for the model must be specific to various risk group categories. The model uses six categories of sexual behavior for males, and five categories of sexual behavior for females:

- Not sexually active (male and female)
- Low risk heterosexual (male and female)
- Medium risk heterosexual (male and female)
- High risk heterosexual (male and female)
- Injecting drug user (male and female)
- Men who have sex with men (male only)

Although the definition of these risk groups may vary by country, one way of defining these risk groups is as follows. The MSM group consists of those men who have sex with other men. Those men and women in the high risk group either have many partners per year, such as sex workers (SWs), or are clients of SWs. Men and women in the medium risk group are those who have more than one sexual partner per year, but do not engage in commercial sex. For example, someone who is married but has casual sex with one or two other partners throughout the year would be in the medium risk category. Finally, the low risk category contains men and women who have only one sexual partner per year.

Note that men and women should be classified by their highest risk group, that is, the highest group into which the individual falls. For example, an MSM who also has heterosexual partners is classified in the MSM group. Note that the risk groups are mutually exclusive, i.e. an individual cannot be in more than one risk group. For the purposes of this model people become potential IDU at the same age as they become sexually active.

Data on HIV prevalence rates by risk group do exist for some countries; the best source for identifying such data is the US Census Bureau data base, available at:

http://www.census.gov/ftp/pub/ipc/www/hivaidsn.html

Prevalence of STIs is specified as the proportion of the adult population with an STI infection. Ulcerative STIs include syphilis, chancroid and herpes simplex virus-2. Non-ulcerative STIs include gonorrhea and chlamydia. One possible source for such data is the US Census Bureau data base, cited above. In addition, sometimes detailed data for sexual behavior and STI rates are available from country-specific
surveys, such as Demographic and Health Surveys (DHS), or other surveys available nationally.

2. Behavior

Behavior: Percent of population in each group: The percent of adult males/females that is in each risk group category, as described immediately above. Although some of these statistics might be available in a DHS, such as percent of men reporting casual sex, others might not be readily available, such as percent of men in the MSM category. Other possible data sources include studies in the published literature.

Average duration of behavior: The average amount of time, in years, that a person spends in a particular risk group. Once assigned to a specific risk group a person remains in that risk group until one of the following happens:

- Reduced risk. The person ceases high risk behavior and moves to the low risk group. This movement is calculated from the average duration of time in a risk group (an input to the model). This could be “lifetime” in which case the person stays in that risk group for life, or a certain number of years that defines the average duration in the risk group. This movement is particularly important for female sex workers, since they may be sex workers for only a short period, 5 to 10 years, of their adult life.
- Aging. Once a person reaches the age of 50 they are removed from the model population. The model assumes that the same proportion of the population reaches age 50 in each risk group in a particular year. In reality, of course, risk groups will have different age distributions.
- Non-AIDS death. At any time, every person has some probability of dying from a cause other than AIDS. The model assumes that this probability is constant across all risk groups.
- AIDS death. People who become infected with HIV may die from AIDS and be removed from the model population.

Injecting drug user/Force of infection (males/females): For IDU the model estimates new infections based on the force of infection, which is an input. New IDU infections are estimated as the product of the susceptible population, prevalence among all IDU (male and female combined) and the force of infection. This number will vary between 0 and 1.
Injecting drug user/Percent of IDU sharing needles: The percent of injecting drug users who share needles. The default value is 30%, although studies show that this percentage varies widely. Not all IDU share needles, therefore the susceptible population is the uninfected who share needles.

Percent of acts protected by condom use (by risk group): This input requires an estimate of total condom use by risk group category. Current condom use will vary by risk group, and sometimes by gender, as well. When condom use by gender is available, the user could input the average of reported condom use by men and women. That is, it may be that SWs report condom use of 50%, but SW clients report only 20% condom use. In this case, an average of the two rates could be used. Note also that when types of condom use are available, such as consistent vs. occasional use, the consistent condom use reported should be used.

Number of partners (by risk group and gender): The number of sexual partners per year will vary by risk category, and by gender. These data are most likely to be found in a national survey such as a DHS.

Number of sex acts per partner per year. This is the number of sex acts per partner per year. The statistics for this category vary by risk group category and gender, and are specific to the category. For low risk couples that will usually be 50-120. For those with more than partner the number of acts per partner will usually be less. For high risk females with a large number of partners, the number of acts per partner will be low (1-5). For example, a value of “5” in the high-risk category for females implies that a female in that category has 5 sex acts with each SW client per year. Below is a summary of data on coital frequency compiled from selected DHS reports, for sexually active married women:

**Table 1. Coital frequency**

<table>
<thead>
<tr>
<th>Country</th>
<th>Monthly Frequency</th>
<th>Equivalent: # Acts/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Sexually Active Married Women</td>
<td>Users of Coitus-Dependent Methods</td>
</tr>
<tr>
<td>DHS I Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>8.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Bolivia</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Burundi</td>
<td>8.1</td>
<td>--</td>
</tr>
<tr>
<td>Colombia</td>
<td>5.8</td>
<td>5.0</td>
</tr>
<tr>
<td>Country</td>
<td>Age (males)</td>
<td>Age (females)</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>5.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Ecuador</td>
<td>5.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Ghana</td>
<td>2.6</td>
<td>2.1</td>
</tr>
<tr>
<td>Guatemala</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Kenya</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Mexico</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Peru</td>
<td>5.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>5.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Sudan</td>
<td>6.5</td>
<td>--</td>
</tr>
<tr>
<td>Thailand</td>
<td>4.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Uganda</td>
<td>7.2</td>
<td>--</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>5.5</strong></td>
<td><strong>5.1</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DHS II Data</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil (NE)</td>
<td>6.5</td>
<td>6.9</td>
<td>83</td>
</tr>
<tr>
<td>Cameroon</td>
<td>4.4</td>
<td>5.2</td>
<td>62</td>
</tr>
<tr>
<td>Colombia</td>
<td>4.7</td>
<td>4.4</td>
<td>53</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>7.1</td>
<td>7.1</td>
<td>85</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4.2</td>
<td>4.6</td>
<td>55</td>
</tr>
<tr>
<td>Kenya</td>
<td>4.4</td>
<td>5.1</td>
<td>61</td>
</tr>
<tr>
<td>Madagascar</td>
<td>5.5</td>
<td>6.1</td>
<td>73</td>
</tr>
<tr>
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<td>6.1</td>
<td>73</td>
</tr>
<tr>
<td>Namibia</td>
<td>4.6</td>
<td>--</td>
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</tr>
<tr>
<td>Niger</td>
<td>4.1</td>
<td>--</td>
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</tr>
<tr>
<td>Nigeria</td>
<td>4.4</td>
<td>3.3</td>
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<tr>
<td>Paraguay</td>
<td>6.5</td>
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<td>5.8</td>
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<tr>
<td>Rwanda</td>
<td>8.1</td>
<td>--</td>
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<tr>
<td>Tanzania</td>
<td>5.1</td>
<td>4.8</td>
<td>58</td>
</tr>
<tr>
<td>Zambia</td>
<td>7.5</td>
<td>5.7</td>
<td>68</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>5.5</strong></td>
<td><strong>5.5</strong></td>
<td><strong>66</strong></td>
</tr>
</tbody>
</table>

**Age at first sex (males/females):** The age at which sexual intercourse first occurred, for both males and females. These data are usually available in the DHS.

**Percent of deaths replaced by increased recruitment (by risk group category and gender):** A constant distribution to risk groups means that the percentage of the population in the highest risk groups will fall over time as these groups are subject to higher mortality from AIDS than lower risk groups. To compensate for this, the model allows for replacement recruitment. If replacement recruitment is set to 100% for a high risk group, then the fraction of those newly sexually active that are allocated to that risk group will rise in order to maintain that risk group as a constant percentage of the
adult population. If replacement recruitment is set to 50% then recruitment will rise to replace half of the deficit. If replacement is set to 0% then there is no change in the fraction of those newly sexually active allocated to that risk group. Note that one limitation of this approach is that replacement occurs solely from those newly sexually active, whereas in actual epidemics someone from any risk group might adopt high risk behavior at any time.

**Percent married (by risk group and gender):** The percent that are married in each risk group, and by gender. Some of these data are available in the DHS, otherwise studies in the literature will have to be used. These data are used to calculate the transmission rate for low risk groups. For low risk groups the partner prevalence is a weighted average of the prevalence of all risk groups, where the weights are the proportion of contacts with each risk group. These, in turn, are estimated from the number of people in each risk group and the percentage that are married.

3. Interventions

**Percent of males circumcised (0-100%):** The percent of adult males (aged 15-49) that are circumcised. A good source for this is the DHS.

**Percent of adults in need of ART receiving it (0-100%):** The percent of all adults that are in need of ART that are actually receiving treatment. People are considered to be eligible for ART when they are in the Symptomatic Stage, that is, during the last two years of life before dying from AIDS. This input specifies the coverage rate for ART, or the percent of adults that are supplied with ART. One source for this statistic is the coverage survey sponsored by UNAIDS and others, found at:


4. Vaccines

**Parameters:** HIV vaccines affect the dynamics of the model in several ways. A preventive vaccine reduces susceptibility to infection. If the vaccine action is set to "Take" in the model then a certain portion of those vaccinated (determined by the vaccine efficacy) are fully protected from acquiring HIV. The portion not protected is fully exposed to the risk of infection. In a "Degree" type vaccine, all those who are vaccinated are exposed to a risk of infection that is reduced by the efficacy of the vaccine. By way of illustration consider a group of 100 people who are vaccinated with a vaccine with 50% efficacy. In "Take"
action, the vaccine would work in 50 of the 100 people and fully protect them, while it would fail to work in the other 50 people and provide no protection. In "Degree" action the vaccine would have an effect in all 100 people. It would not fully protect them but would reduce their chance of becoming infected by 50%. From a public health perspective the two types of action may produce similar results in general populations, but of course the individual results would be quite different. For very high risk populations "degree" vaccines that just reduce the probability of infections may not provide enough protection to avert many infections.

A preventive vaccine may also reduce infectiousness. The model calculates the reduction in the average probability of transmission resulting from the efficacy and coverage of the vaccine and applies this to all contacts with susceptible populations.

A disease-modifying vaccine slows the progression to AIDS death. The model implements this by lengthening the asymptomatic period for those vaccinated. It does not affect the length of the primary or symptomatic stages.

Finally, a vaccine may lose effectiveness after a certain number of years; this can be specified by the parameter "Vaccine Duration."

Coverage (percentage of population vaccinated): Vaccination may be targeted in several ways. Coverage may apply to all adults in which case all risk groups have the same coverage, or vaccination may be targeted to specific risk groups by specifying different coverage levels for each risk group. Once the type of coverage is selected with the radio button, the correct screen will appear for the appropriate coverage rates to be entered. Note that coverage does not begin until 2010, as it is assumed that a vaccine will not become available until then.

Cost Per Person Fully Vaccinated: The cost to provide a full course of vaccination to one person.

Targeting: This is a radio button to select whether a vaccination program will vaccinate everyone, or whether the program will include testing, so that only HIV-negative individuals are vaccinated. If testing does occur, then the cost per person fully vaccinated (above) should reflect the increased cost associated with counseling and testing costs. In all cases, we assume that the vaccine is effective only
when the recipient is HIV-negative. People who are HIV+ when vaccinated receive no benefit.

**Behavior change reversal:** This input describes the degree to which people revert to previously risky behavior as a result of vaccine availability, such as increasing the number of partners or decreasing condom use. Adults who think they are protected from HIV, because they are vaccinated or because their potential partners are vaccinated, may revert to earlier levels of risky behavior if the vaccination program does include a strong component supporting safer behaviors. There is little information to indicate whether behavioral disinhibition would be important with vaccination programs. It is included in the model so that possible effects can be explored.

Disinhibition can be applied to those who are vaccinated or to all adults. A value of 100% implies that disinhibition causes behavior to return to levels at the beginning of the epidemic. With lower levels of disinhibition partial reversion would take place. If behaviors have not changed since the start of the epidemic, with a value of 0%, then this component will have no effect.
IV. Projection Outputs

There are many different outputs available for HIV Vaccine. Most of the outputs can be displayed in three different ways: total; by one risk group at a time, labeled “by single risk group”; and by more than one risk group, up to and including all risk groups at the same time, labeled “by all risk groups.” The risk groups that are available for display are the six sexual behavior groups:

- Not sexually active
- Low risk heterosexual
- Medium risk heterosexual
- High risk heterosexual
- Injecting drug user
- Men who have sex with men

- **Model fitting:** This screen is used to fit the HIV prevalence rates that are provided as input to an overall epidemic pattern. This screen is described further in the tutorial section below.
- **Population:** Total size of the population available by single risk group and by all risk groups (note: total size of the population can be displayed using DemProj outputs)
- **New HIV Infections:** The number of new HIV infections in the current year, also available by single risk group and by all risk groups.
- **HIV Incidence:** The percentage of uninfected people who become infected in each year.
- **Current HIV Infections:** The number of people who are currently alive and infected with HIV, also available by single risk group and by all risk groups
- **HIV Prevalence:** The percentage of people who are infected with HIV, also available by single risk group and by all risk groups
- **AIDS Deaths:** The annual number of deaths due to AIDS, also available by single risk group and by all risk groups.
• **Population currently vaccinated:** The total number of people vaccinated is the cumulative number of people vaccinated who are still alive and in the 15-49 population minus those whose vaccination protection has waned (as determined by the average time of protection).

• **Annual number of people vaccinated:** The annual number of people vaccinated, also available by single risk group and by all risk groups.

• **Infections averted:** The annual number of HIV infections averted due to all interventions.

• **Cumulative infections averted:** The cumulative number of HIV infections averted due to all interventions.

• **Deaths averted:** The annual number of AIDS deaths averted due to all interventions.

• **Cumulative deaths averted:** The cumulative number of AIDS deaths averted due to all interventions.

• **Total cost:** Annual cost of vaccinations, the product of the annual number of people vaccinated and unit cost.

• **Cumulative cost per infection averted:** The cumulative costs of the vaccination program divided by the cumulative number of HIV infections averted.

• **Cumulative cost per death averted:** The cumulative costs of the vaccination program divided by the cumulative number of AIDS deaths averted.

• **Summary table:** Summary output of all of the outputs described above, displayed using all risk groups.
V. Program Tutorial

This tutorial covers the key steps in installing and running Spectrum and the HIV Vaccine module. It assumes that you have an IBM-compatible computer running Windows 98 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, to set the projection parameters, you will need to decide

- The first year of the projection (usually the latest year for which you have population data)
- The last year of the projection
- Characteristics of the HIV vaccine
- Behavioral data
- Epidemiological data

The data you will need are described in Chapter III above, and include information about Epidemiology, Behavior, Interventions, and Vaccines.

B. Installing the Spectrum program

The Spectrum program is distributed on floppy diskettes, CD-ROMS or through the Internet at http://www.FuturesInstitute.org. It must be installed on a hard disk before it can be used. Spectrum will operate on any computer running Windows 98 or later version. It requires about 10MB of hard disk space.

To install the Spectrum program, follow the directions below.\(^4\)

**Installing from floppy diskettes:** Insert the first diskette into your disk drive. Select “Start” from the task bar. Then select “Run” from the pop-up menu. In the dialogue box that appears, type the file name “a:\SpecInstall.exe” and press “Ok.” (If the install disk is in floppy disk drive b, then use the

\(^4\) To remove the Spectrum program from your hard disk, run the unwise.exe program located in the Spectrum directory.
file name “b:\SpecInstall.exe”). Follow the instructions on the screen to complete the installation.

**Installing from a CD-ROM.** Insert the CD-ROM into your CD-ROM drive. The installation program should start automatically. If it does not, Select “Start” from the task bar, then select “Run” from the pop-up menu. In the dialogue box that appears, click on Browse, and find the file SpecInstall.exe. Then press “Ok.”

**Installing from the internet.** Start your internet browser and go to www.FuturesInstitute.org. Click on “Software” and then “Spectrum”. Next click on “Spectrum download (single executable file). From the dialogue box that appears next, select “Save”. Select a location for the file. Once the file has been downloaded, click on that file and the follow the instructions.

**C. Creating a New Projection**

1. **Starting the Spectrum Program**

To start Spectrum:

a. Click the “Start” button on the task bar.

b. Select “Programs” from the pop-up menu.

c. 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.”

1. **Opening a Demographic Projection**

**HIV Vaccine** in Spectrum requires a demographic projection prepared with DemProj. In a typical **HIV Vaccine** application, the demographic projection calculates all the normal demographic processes (births, deaths, migration, aging). **HIV Vaccine** influences the demographic projection by adding the number of AIDS deaths. All of the population figures required by **HIV Vaccine** (e.g., size of the adult population) are provided by DemProj. Therefore, before using **HIV Vaccine** 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**.

The first step in preparing the **HIV Vaccine** 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 HIV Vaccine Module to the Projection

Once the demographic projection is open, you need to change the configuration to indicate that the **HIV Vaccine** 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.

![Projection manager Dialogue Box](image)

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.

If you want to use EasyProj, see below.

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.

**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.

**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.** The check boxes let you select other modules that will be used with the population projection. Initially none of them will be selected. You should select the “HIV Vaccine” module by clicking on the check box next to the name. This step will allow you to include the HIV Vaccine module in the projection.

**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, age-specific fertility rates, migration statistics, and the male and female life expectancy from the United Nations estimates and projections.

To use this feature, follow these steps:

1. In the “New projection” dialogue box, fill in the projection title, the first year of the projection and the last year of the projection.

2. Click the “File name” button and enter a file name for this projection.

3. 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.

4. Click “OK” to return to the dialogue box and click “OK”
once more to complete the set-up process.

5. Select “File” and “Save as” from the Spectrum menu to
save this 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.

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

The editors in HIV Vaccine 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. Entering the Epidemiology Assumptions

To enter the epidemiological assumptions for the HIV Vaccine projection,

1. Choose “Edit” from the menu bar.

2. Choose “HIV Vaccine” from the pulldown menu. This section assumes that the DemProj module has been implemented in Spectrum, with the relevant years and scale of analysis properly specified. It also assumes a working knowledge of Spectrum and its editor; thorough documentation of the Spectrum modules and system itself can be found in the relevant manuals. A dialogue box like the one shown below will be displayed.

First, select the button labeled “Epidemiology.” The screen should look like this:
For each of the sets of 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 set of variables.
2. Then click anywhere inside the editor to make it active.

The screen above contains variables that affect HIV transmission in the model. Each of them has a default value, usually based on scientific evidence, and both the variables and their sources are explained in detail in Chapter III.

If the epidemic start year needs to be changed, click on the arrow in the dialogue box. At that point, a drop-down menu will appear that looks like the following.
Move the cursor to the desired year, and click on that year. The new epidemic start year will be entered.
HIV Prevalence

Click on the tab labeled “HIV Prevalence” to move to this dialogue box.

The inputs required here, HIV prevalence by risk group, as well as possible sources, are described in detail in Chapter III. Click on any of the cells to activate the editor. The first year will be the first year of the projection that was specified earlier, while the last year is the current calendar year. The model will calculate the predicted prevalence.

If prevalence data are only available for certain groups, or certain years, enter those data and leave the rest zero. For example, if data are available for high-risk heterosexual women (sex workers) for only 1991 and 1995, enter those data only, and the rest of the row will remain zero. Note that the rows labeled “Total” pertain to gender-specific prevalence, while the last row contains total HIV prevalence for all adults.

These prevalence rates will be used to fit the epidemic, that is, to test whether the behavioral inputs and transmission rate values accurately portray the epidemic. The fitting of the epidemic will be described further below.
Click on the tab labeled “STI Prevalence” to move to the dialogue box above.

Similar to the input screen for HIV prevalence, STI prevalence data are entered beginning in the first year of the projection. Unlike HIV prevalence, however, STI prevalence data must be entered for the entire projection time period, and all of the cells must be filled in, i.e. there should not be any zeroes (unless the STI prevalence rate is zero percent).

For the base projection, before any prevention interventions take place that might decrease STI prevalence rates, one approach for predicting future STI prevalence rates is to keep the rates fixed at current levels. For alternative scenarios, where interventions include STI treatment, these rates can then be lowered in the future to see the impact of lower STI prevalence on HIV prevalence.

After this screen is completed, click “OK” to close out of the “Epidemiology” set of input screens.
3. Entering the Behavior Assumptions

1. Choose “Edit” from the menu bar.

2. Choose “HIV Vaccine” from the pulldown menu.

3. Select the button labeled “Behavior.”

The following screen will be displayed.

Enter the percent of the population in each risk group, along with the average duration in the specific risk group, in years. Note that the “Total” cells calculate automatically.
Injecting drug behavior

As described in Chapter III above, new IDU infections are estimated as the product of the susceptible population, prevalence among all IDU (male and female combined) and the force of infection. The susceptible population is defined as the number of IDU sharing needles. This force of infection can vary by gender, and should be between 0 and 1.

The data need to be input for all of the years of the projection; the impact of interventions to decrease needle-sharing behavior can be approximated by changing the percentage of IDU sharing needles over time.
Condom Use

Enter the percent of acts protected by consistent condom use for the four sexual transmission risk groups for all years.

The impact of prevention interventions to increase consistent condom use can be represented here by increasing the percent of those using condoms consistently in future years.
Enter the number of sexual partners per year, by risk group and gender, for the years in the projection.

The impact of prevention interventions on reducing number of sexual partners can be represented by a decrease in number of partners in the future.
Number of Sex Acts per Partner

Enter the number of sex acts per partner per year, by gender and risk group category for all of the years of the projection. As it states on the input screen, this is the number of sex acts per partner per year, and for low-risk couples it will be between 50-120. Representative coital frequency statistics are shown in Table 2 in Chapter III.
Age at First Sex

Enter the age at first sex for both males and females, for the full time period of the projection.
As discussed in Chapter III, the initial distribution of the population into risk groups will not remain constant over time, as higher-risk groups face higher mortality rates due to AIDS deaths. The inputs here specify whether the initial distribution should be maintained by increasing the recruitment into a risk group category, which would imply a recruitment rate of 100%; whether it should be allowed to change completely, which would imply a recruitment rate of 0%; or whether the replacement rate should be somewhere between these two extremes.
Percent Married

Enter the percent married for each of the risk groups, by gender. These data are assumed to remain constant over time.

After this screen is completed, click “OK” to close out of the “Behavior” set of input screens.
4. Entering the Assumptions about Interventions

1. Choose “Edit” from the menu bar.

2. Choose “HIV Vaccine” from the pulldown menu.

3. Select the button labeled “Interventions.”

The following screen will be displayed.

Enter the percent of the male adult population that is circumcised, for the entire time period of the projection. This can be changed over time to reflect the impact of increased circumcision due to interventions.
Enter the percent of adults who are in need of ART who are actually receiving the treatment over time. Those in need of ART are defined as those who would die of AIDS in two years. The availability of treatment can change over time.

After this screen is completed, click “OK” to close out of the “Interventions” set of input screens.
4. Entering the Vaccine Assumptions

1. Choose “Edit” from the menu bar.

2. Choose “HIV Vaccine” from the pulldown menu.

3. Select the button labeled “Vaccines.”

The following screen will be displayed.

Enter the assumptions regarding the various parameters of the HIV vaccine scenario – the reduction in susceptibility and infectiousness, the increase in progression time to AIDS, and the duration of the vaccine. All of these assumptions are explained in detail in Chapter III.

To choose the type of vaccine action on susceptibility, click on the arrow to the right-hand side of the box. A drop-down menu will appear, and either “Take” or “Degree” can then be selected. The default setting for type of vaccine action is “Take.”
Enter the percentage of the population that will be vaccinated, beginning in 2010. Coverage may also vary by sex and risk group; click on the radio button next to that choice and the following screen will appear to enter the data:
Cost

Enter the unit cost for fully vaccinating one person for the entire time period. This should include consideration of counseling and testing costs, if appropriate. The cost of a vaccine can increase or decrease over time by varying the cost that is entered.
**Targeting**

Select the radio button that represents the testing strategy that will be followed – either vaccinating all of the population, or vaccinating only HIV-negative individuals, which would require HIV testing.
Behavior Effects

As described more completely in Chapter III, people’s behavior may change due to the availability of an HIV vaccine. People’s behavior may become more risky because of disinhibition effects from either receiving the HIV vaccine or knowing that partners may have received it. The behavior may become less risky due to effective counseling. If behaviors have not changed, then the values should be left equal to zero, that is, there is no effect.

After this screen is completed, click “OK” to close out of the “Interventions” set of input screens. Then click on “Close” to close out of the data editor completely.

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. Fitting the Model

To fit the model, select “Display” from the menu bar. From the pull-down menu select “HIV Vaccine.” You will then see another menu showing the categories of indicators available:

- Model Fitting
- Population
- New HIV Infections
- Current HIV Infections
- AIDS Deaths
- Vaccinations
- Benefits
- Costs
- Summary

Select “Model Fitting,” and you will see one final menu listing “Model Fitting.” Select this, and the following screen will appear.
When the radio button for “Sex” is set to “Both,” the only population category available for examination is “Adults,” which displays HIV prevalence for all adults. If either “Male” or “Female” is selected, any risk group can be displayed by clicking on it. This screen is shown below.

Returning to the screen where “Both” is selected, click on “OK” and a screen like the following will be displayed.
The green triangles display the HIV prevalence rates that were entered for “Adults” earlier. The red line displays the model-estimated HIV prevalence level for Adults over time, based on the initial HIV prevalence rates and the various factors affecting transmission, including behavioral information.

The initial task is to fit the entered HIV prevalence data to an epidemic pattern. There are a number of parameters that affect the fit, including:

1. Base transmission rate
2. Various multiples of the transmission rate (stage of infection, type of transmission)
3. Circumcision rate
4. STI prevalence rates
5. Behaviors (condom use and number of partners, sex acts per partner)
6. Size of initial pulse of infection
7. Force of infection for IDU
8. Needle sharing behavior

The overall epidemic pattern is affected by the base transmission rate, initial pulse of infection, STI prevalence rates, and other factors.
rates, circumcision rates, and the behavior data. Changing these variables will have the most impact on pattern for the fitted epidemic.

Other parameters have an impact on specific risk groups, such as needle sharing behavior and the multiplier for MSM transmission. When these variables are changed, it is best to examine the fitted pattern in the particular risk group involved to see the impact of the change.

Once the epidemic pattern has been fit, the other outputs from the model can be displayed.

G. Examining the Output

To see the other results of the projection, again select “Display” from the menu bar. From the pull-down menu select “HIV Vaccine.” You will then see the same menu as before:

Choose one of these categories 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 “Population by Risk Group,” 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 Risk Groups

If you wish to see the number of people in each risk group, choose "Display," "HIV Vaccine," "Population," and then "Population by All Risk Groups."

You can display one risk group by clicking on that particular risk group and then clicking "OK." Alternatively, you can display a combination of risk groups by clicking on the initial risk group and then dragging the mouse to include as many groups as desired. For example, to see data for all risk groups, click on "Not sexually active" and drag the mouse through to the last risk group, "Men who have sex with men." Then click on "OK," and the following screen will 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.

H. 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.

I. 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.

J. 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. Methodology

Equations in the HIV Vaccine Model

The model defines two sexes (designated by the subscript $s$),

0. Total
1. Male
2. Female

six population risk groups (designated by the subscript $r$),

0. All risk groups
1. Never sexually active
2. Low risk (in a monogamous heterosexual sexual relationship)
3. Medium risk (has casual sexual partners)
4. High risk (commercial sex worker or client)
5. IDU (injecting drug user)
6. MSM (men who have sex with men)

four HIV disease states (designated by the subscript $h$),

0. All HIV states
1. Not infected
2. Primary infection
3. Asymptomatic infection
4. Symptomatic infection

and four vaccination states (designated by the subscript $v$),

0. All vaccination states
1. Not vaccinated
2. Vaccinated and fully protected (take)
3. Vaccinated and partially protected (degree)
4. Vaccinated but with no protection
A. State Variables

\( P_{s,r,h,v,t} \) = population by sex (s), risk group (r), HIV status (h) and vaccination status (v) at time (t)

1. Population not sexually active

a. Unvaccinated
   (Risk group, r, = Not active [1]; disease status, h, = Not infected [1]; vaccination status, v, = Not vaccinated [1])

\[
P_{s,1,1,1,t} = P_{s,1,1,1,t-1} \]
\[
+ P15s_t \quad \{ \text{New 15-year olds} \}
\]
\[
- P_{s,1,1,1,t-1} / (AFS_{s,t} - 15) \quad \{ \text{Becoming sexually active} \}
\]
\[
- u_{t,t} * P_{s,1,1,1,t-1} \quad \{ \text{Non-AIDS mortality} \}
\]
\[
- a_{s,t} * P_{s,1,1,1,t-1} \quad \{ \text{Aging past 49} \}
\]
\[
- V_{s,1,1,1,t} \quad \{ \text{New vaccinations} \}
\]
\[
+ \sum_{v=2..4} P_{s,1,1,v,t-1} / d \quad \{ \text{Waning vaccine protection} \}
\]

b. Vaccinated
   (Risk group, r, = Not active [1]; disease status, h, = Not infected [1]; vaccination status, v, = Take [2], Partial [3], No Protection [4])

\[
P_{s,1,1,v,t} = P_{s,1,1,v,t-1} \]
\[
+ V_{s,1,1,v,t} \quad \{ \text{New vaccinations} \}
\]
\[
- P_{s,1,1,v,t-1} / (AFS_{s,t} - 15) \quad \{ \text{Becoming sexually active} \}
\]
\[
- u_{t,t} * P_{s,1,1,v,t-1} \quad \{ \text{Non-AIDS mortality} \}
\]
\[
- a_{s,t} * P_{s,1,1,v,t-1} \quad \{ \text{Aging past 49} \}
\]
\[
- P_{s,1,1,v,t-1} / d \quad \{ \text{Waning vaccine protection} \}
\]
2. Sexually active and HIV-population

a. Unvaccinated
   1) Low risk heterosexual population
      (Risk group, \( r = \) Low risk \([2]\); disease status, \( h = \) Not infected \([1]\); vaccination status, \( v = \) Not vaccinated \([1]\))

\[
P_{s,2,1,1,t} = P_{s,2,1,1,t-1} + P_{s,1,1,1,t-1} / (AFS_{s,t} - 15) * R_{s,1,t} \quad \{\text{Becoming sexually active}\}
+ \sum_{r=3..5} P_{s,r,1,1,t-1} / b_{sr} \quad \{\text{Adopting low risk behavior}\}
- u_{s,t} * P_{s,2,1,1,t-1} \quad \{\text{Non-AIDS mortality}\}
- a_{s,t} * P_{s,2,1,1,t-1} \quad \{\text{Aging past 49}\}
- b_{s,2,1,1,t-1} \quad \{\text{New HIV infections}\}
- V_{s,2,1,1,t} \quad \{\text{New vaccinations}\}
+ \sum_{v=2..4} P_{s,2,1,v,t-1} / d \quad \{\text{Waning vaccine protection}\}
\]

2) Medium risk, high risk, IDU and MSM
   (Risk group, \( r = \) Medium \([3]\), high \([4]\), IDU \([5]\) and MSM \([6]\); disease status, \( h = \) Not infected \([1]\); vaccination status, \( v = \) Not vaccinated \([1]\))

\[
P_{s,r,1,1,t} = P_{s,r,1,1,t-1} + P_{s,r,1,1,t-1} / (AFS_{s,t} - 15) * R_{s,1,t} \quad \{\text{Becoming sexually active}\}
- u_{s,t} * P_{s,r,1,1,t-1} \quad \{\text{Non-AIDS mortality}\}
- a_{s,t} * P_{s,r,1,1,t-1} \quad \{\text{Aging past 49}\}
- P_{s,r,1,1,t-1} / b_{sr} \quad \{\text{Adopting low risk behavior}\}
- b_{s,r,1,1,t-1} \quad \{\text{New HIV infections}\}
- V_{s,r,1,1,t} \quad \{\text{New vaccinations}\}
- P_{s,r,1,1,t-1} / d \quad \{\text{Waning protection}\}
\]

b. Vaccinated
   1) Low risk heterosexual population
      (Risk group, \( r = \) Low risk \([2]\); disease status, \( h = \) Not infected \([1]\); vaccination status, \( v = \) Take \([2]\), Partial \([3]\), No Protection \([4]\))

\[
P_{s,2,1,v,t} = P_{s,2,1,v,t-1} + P_{s,1,1,v,t-1} / (AFS_{s,t} - 15) * R_{s,1,t} \quad \{\text{Becoming sexually active}\}
+ \sum_{r=3..5} P_{s,r,1,v,t-1} / b_{sr} \quad \{\text{Adopting low risk behavior}\}
- u_{s,t} * P_{s,2,1,v,t-1} \quad \{\text{Non-AIDS mortality}\}
- a_{s,t} * P_{s,2,1,v,t-1} \quad \{\text{Aging past 49}\}
\]
2) Medium risk, high risk, IDU and MSM
(Risk group, \( r \), = Medium [3], high [4], IDU [5] and MSM [6];
disease status, \( h \), = Not infected [1]; vaccination status, \( v \), = Not vaccinated [1])

\[
\begin{align*}
P_{s,r,1,v,t} &= P_{s,r,1,v,t-1} \\
&\quad + \frac{P_{s,r,1,v,t-1}}{(A_{FS,t} - 15)} \cdot R_{s,1,t} \\
&\quad - u_{s,t} \cdot P_{s,r,1,v,t-1} \\
&\quad - a_{s,t} \cdot P_{s,r,1,v,t-1} \\
&\quad - \frac{P_{s,r,1,v,t-1}}{b_{s,r}} \\
&\quad - I_{s,r,1,v,t-1} \\
&\quad + V_{s,r,1,v,t} \\
&\quad - \frac{P_{s,r,1,v,t-1}}{d}
\end{align*}
\]

3. Primary HIV infection

a. Unvaccinated

1) Low risk heterosexual population
(Risk group, \( r \), = Low risk [2]; disease status, \( h \), = Primary infection [2]; vaccination status, \( v \), = Not vaccinated [1])

\[
\begin{align*}
P_{s,2,2,1,t} &= P_{s,2,2,1,t-1} \\
&\quad + \sum_{r=3}^{5} \frac{P_{s,r,2,1,t-1}}{b_{s,r}} \\
&\quad - u_{s,t} \cdot P_{s,2,2,1,t-1} \\
&\quad - a_{s,t} \cdot P_{s,2,2,1,t-1} \\
&\quad + I_{s,2,2,1,t-1} \\
&\quad - V_{s,2,2,1,t} \\
&\quad + \sum_{v=2}^{4} \frac{P_{s,2,2,v,t-1}}{d} \\
&\quad - S_{s,2,2,1,t}
\end{align*}
\]

2) Medium risk, high risk, IDU and MSM
(Risk group, \( r \), = Medium [3], high [4], IDU [5] and MSM [6];
disease status, \( h \), = Primary infection [2]; vaccination status, \( v \), = Not vaccinated [1])

\[
P_{s,r,2,1,t} = P_{s,r,2,1,t-1} \\
- u_{s,t} \cdot P_{s,r,2,1,t-1} \\
- a_{s,t} \cdot P_{s,r,2,1,t-1}
\]
b. Vaccinated
1) Low risk heterosexual population
(Risk group, \( r \), = Low risk [2]; disease status, \( h \), = Primary infection [2]; vaccination status, \( v \), = Take [2], Partial [3], No Protection [4])

\[
P_{s,2,2,v,t} = P_{s,2,2,v,t-1} + \sum_{r=3..5} P_{s,2,1,t-1} / b_{sr} \]

{Adopting low risk behavior}

\[
- U_{s,t} * P_{s,2,2,v,t-1}
- \sum_{v=2..4} P_{s,2,2,v,t-1} / d
- S_{s,2,2,v,t}
\]

{None-AIDS mortality}

{Aging past 49}

{New HIV infections}

{New vaccinations}

{Waning vaccine protection}

{Progression to asymptomatic stage}

2) Medium risk, high risk, IDU and MSM
(Risk group, \( r \), = Medium [3], high [4], IDU [5] and MSM [6]; disease status, \( h \), = Primary infection [2]; vaccination status, \( v \), = Take [2], Partial [3], No Protection [4])

\[
P_{s,r,2,v,t} = P_{s,r,2,v,t-1} \]

{Non-AIDS mortality}

{Aging past 49}

{Adopting low risk behavior}

{New HIV infections}

{New vaccinations}

{Waning protection}

{Progression to asymptomatic stage}

4. Asymptomatic stage of infection

a. Unvaccinated
1) Low risk heterosexual population
(Risk group, \( r, = \) Low risk \([2]\); disease status, \( h, = \) Asymptomatic infection \([3]\); vaccination status, \( v, = \) Not vaccinated \([1]\))

\[
P_{s,2,3,1,t} = P_{s,2,3,1,t-1} + \sum_{r=3..5} P_{s,r,3,1,t-1} / b_{s,r} \quad \text{(Adopting low risk behavior)}
- U_{s,t} * P_{s,2,3,1,t-1} \quad \text{(Non-AIDS mortality)}
- A_{s,t} * P_{s,2,3,1,t-1} \quad \text{(Aging past 49)}
- S_{s,2,2,1,t-1} \quad \text{(Progression from primary stage)}
- V_{s,2,3,1,t} \quad \text{(New vaccinations)}
+ \sum_{v=2..4} P_{s,2,3,v,t-1} / d \quad \text{(Waning vaccine protection)}
- S_{s,2,3,1,t} \quad \text{(Progression to symptomatic stage)}
\]

2) Medium risk, high risk, IDU and MSM
(Risk group, \( r, = \) Medium \([3]\), high \([4]\), IDU \([5]\) and MSM \([6]\); disease status, \( h, = \) Asymptomatic infection \([3]\); vaccination status, \( v, = \) Not vaccinated \([1]\))

\[
P_{s,r,3,1,t} = P_{s,r,3,1,t-1} - U_{s,t} * P_{s,r,3,1,t-1} \quad \text{(Non-AIDS mortality)}
- A_{s,t} * P_{s,r,3,1,t-1} \quad \text{(Aging past 49)}
- P_{s,r,3,1,t-1} / b_{s,r} \quad \text{(Adopting low risk behavior)}
+ S_{s,r,2,1,t-1} \quad \text{(Progression from primary stage)}
- V_{s,r,3,1,t} \quad \text{(New vaccinations)}
- P_{s,r,3,1,t-1} / d \quad \text{(Waning protection)}
- S_{s,r,3,1,t} \quad \text{(Progression to symptomatic stage)}
\]

b. Vaccinated
1) Low risk heterosexual population
(Risk group, \( r, = \) Low risk \([2]\); disease status, \( h, = \) Asymptomatic infection \([3]\); vaccination status, \( v, = \) Take \([2]\), Partial \([3]\), No Protection \([4]\))

\[
P_{s,2,3,v,t} = P_{s,2,3,v,t-1} + \sum_{r=3..5} P_{s,2,3,1,t-1} / b_{s,r} \quad \text{(Adopting low risk behavior)}
- U_{s,t} * P_{s,2,3,v,t-1} \quad \text{(None-AIDS mortality)}
- A_{s,t} * P_{s,2,3,v,t-1} \quad \text{(Aging past 49)}
+ S_{s,2,2,v,t-1} \quad \text{(Progression from primary stage)}
+ V_{s,2,3,v,t} \quad \text{(New vaccinations)}
\]
2) Medium risk, high risk, IDU and MSM
(Risk group, \( r \), = Medium [3], high [4], IDU [5] and MSM [6];
disease status, \( h \), = Asymptomatic infection [3]; vaccination
status, \( v \), = Take [2], Partial [3], No Protection [4])

\[
\begin{align*}
\text{Ps,3,v,t} &= \text{Ps,3,v,t-1} \\
&- u_{t} * \text{Ps,3,v,t-1} \\
&- \sum_{v=2..4} \text{Ps,2,3,v,t-1} / d \\
&- S_{t,2,3,v,t} \\
\end{align*}
\]

{Waning vaccine protection}

{Progression to asymptomatic stage}

5. Symptomatic stage of infection

a. Unvaccinated
1) Low risk heterosexual population
(Risk group, \( r \), = Low risk [2]; disease status, \( h \), = Symptomatic
infection [4]; vaccination status, \( v \), = Not vaccinated [1])

\[
\begin{align*}
\text{Ps,2,4,1,t} &= \text{Ps,2,4,1,t-1} \\
&+ \sum_{v=3..5} \text{Ps,3,4,1,t-1} / b_{sr} \\
&- u_{t} * \text{Ps,2,4,1,t-1} \\
&- \sum_{v=2..4} \text{Ps,2,4,1,t-1} / d \\
&- S_{t,2,4,1,t} \\
\end{align*}
\]

{Adopting low-risk behavior}

{Non-AIDS mortality}

{Aging past 49}

{Progression from asymptomatic}

{New vaccinations}

{Waning vaccine protection}

{Progression to AIDS death}

2) Medium risk, high risk, IDU and MSM
(Risk group, \( r \), = Medium [3], high [4], IDU [5] and MSM [6];
disease status, \( h \), = Symptomatic infection [4]; vaccination
status, \( v \), = Not vaccinated [1])

\[
\text{Ps,4,1,t} = \text{Ps,4,1,t-1}
\]
b. Vaccinated

1) Low risk heterosexual population
(Risk group, \( r = \) Low risk [2]; disease status, \( h = \) Symptomatic infection [4]; vaccination status, \( v = \) Take [2], Partial [3], No Protection [4])

\[
P_{s,2,4,v,t} = P_{s,2,4,v,t-1} + \sum_{r=3}^{5} P_{s,2,4,1,t-1} / b_{sr} - U_{s,t} * P_{s,2,4,v,t-1} - A_{s,t} * P_{s,2,4,v,t-1} - P_{s,2,4,v,t-1} / b_{sr} + S_{s,2,3,v,t-1} + V_{s,2,4,v,t} - \sum_{v=2}^{4} P_{s,2,4,v,t-1} / d - S_{s,2,4,v,t}
\]

\{Adopting low risk behavior\}
\{Aging past 49\}
\{Non-AIDS mortality\}
\{Progression from asymptomatic stage\}
\{New vaccinations\}
\{Progression to AIDS death\}
\{Waning protection\}

2) Medium risk, high risk, IDU and MSM
(Risk group, \( r = \) Medium [3], high [4], IDU [5] and MSM [6]; disease status, \( h = \) Symptomatic infection [4]; vaccination status, \( v = \) Take [2], Partial [3], No Protection [4])

\[
P_{s,r,4,v,t} = P_{s,r,4,v,t-1} - U_{s,t} * P_{s,r,4,v,t-1} - A_{s,t} * P_{s,r,4,v,t-1} - P_{s,r,4,v,t-1} / b_{sr} + S_{s,r,3,v,t-1} + V_{s,r,4,v,t} - P_{s,r,4,v,t-1} / d - S_{s,r,4,v,t}
\]

\{Non-AIDS mortality\}
\{Adopting low risk behavior\}
\{Progression from asymptomatic stage\}
\{Waning protection\}
\{Progression to AIDS death\}

B. Transmission equations
Is,r,h,v,t = New HIV infections in sex s, risk group r, disease stage h, vaccination status v and time t.

For sexual transmission:

\[
\text{Is,r,h,v,t} = P_{s,r,1,v,t} \times \left[ 1 - \text{PartPrevs}_{s,r,h,v,t} \right] \times \left[ 1 - r \times r\text{Mult}_{s,t} \right] \times \left[ (\text{MC}_{s,t} \times \text{MCred} + (1 - \text{MC}_{s,t})) \right] \times \left[ 1 + (\text{STIm} - 1) \times \text{STIprev}_{s,t} \right] \times \left[ 1 - \text{Cs}_{s,t} \times \text{Ceff} \right] \times \left[ 1 - \text{V%}_{s,r,h,v,t} \times \text{Veff}_{v} \right] \times \left[ 1 - \text{PartPrevs}_{s,r,h,v,t} \right] \]

where

- PartPrev = HIV prevalence in partner population
- MCred = the reduction in the probability of acquiring HIV infection due to male circumcision (MCsus)
- MCinf = when s = male, the reduction in the probability of an infected male transmitting HIV to a sexual partner (MCinf) when s = female
- STIprev = prevalence of a sexually transmitted infection
- V% = proportion of the susceptible population that is vaccinated
- acts = number of sexual acts per partner
- partners = Number of partners per year

For IDU transmission

\[
\text{Is,5,h,v,t} = P_{s,5,1,v,t} \times \text{IDUPrev}_{s,5,h,v,t} \times r\text{Mult} \]

where

- IDU = Susceptible IDU population
- IDUPrev = Prevalence among IDU
- Mult = Multiplier for stage of infection
* $F_{s,t}$  
* $(1 - V\%_{s,r,h,v,t} \ast VES_v)$

\[ r_{Mult} = \left( \sum_{s=1}^{2} \sum_{r=1}^{6} \sum_{h=1}^{3} \sum_{v=1}^{4} P_{s,r,h,v,t} \ast R_{I_h} \right) / 2.05 \]

{Weighted average of population by disease stage and relative infectiousness by stage, where $R_{I_4}$, relative infectiousness in the symptomatic stage, is a weighted average of the infectiousness for those on ART and those not on ART.}

{to calibrate to 1 with steady state distribution of infected population by stage}

* $(1 - VEI) \ast V\%$

{Reduction in infectiousness due to vaccination}

The population newly sexually active is allocated to the risk groups on the basis of an assumed distribution. However, if a constant proportion of new recruits is allocated to each risk group, the proportion of the population the highest risk groups will decline due to the effects of AIDS mortality. If high risk deaths are replaced, fully or partially, then the proportion of new recruits to each risk group needs to change. A larger percentage of the newly sexually active population is allocated to groups that have fallen below the initial proportion if the replacement factor is something other than zero.

Progression to the next stage of infection is determined by the amount of time in each stage.

\[ S_{s,r,stage,v,t} = P_{s,r,stage,1,t} / \text{Average time in stage} \]
Table 3. Descriptions, default values and sources of model parameters

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Default Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic processes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( a_{t} )</td>
<td>Proportion reaching age 50 in year ( t )</td>
<td></td>
<td>DemProj</td>
</tr>
<tr>
<td>( P_{15,s,t} )</td>
<td>Number of 15 year old in year ( t )</td>
<td></td>
<td>DemProj</td>
</tr>
<tr>
<td>( u_{s,t} )</td>
<td>Non-AIDS mortality rate</td>
<td></td>
<td>DemProj</td>
</tr>
<tr>
<td>Behavioral parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Act_{s,r,s,t} )</td>
<td>Sexual contacts per partner</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( AFS_{s,t} )</td>
<td>Age at first sex</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( C_{r,s,t} )</td>
<td>Proportion of acts protected with condoms</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( F_{s,t} )</td>
<td>Force of infection for IDU</td>
<td></td>
<td>Fit</td>
</tr>
<tr>
<td>( M_{s,r,t} )</td>
<td>Proportion married</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( MC )</td>
<td>Proportion of males circumcised in base year</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( NP_{r,t,s,t} )</td>
<td>Number of partners</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( R_{r,s,t} )</td>
<td>Percent of population in risk group ( r ) in first year</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>( RP_{r,s} )</td>
<td>Replacement of high risk population</td>
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<tr>
<td>STI_{r,s,t}</td>
<td>Prevalence of other sexually transmitted infections</td>
<td></td>
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<tr>
<td>Epidemiological parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( ART_{surv} )</td>
<td>Proportion of patients on ART that survive to following year</td>
<td>90%</td>
<td>6</td>
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<tr>
<td>( Ceff )</td>
<td>Efficacy of condom use in preventing HIV transmission</td>
<td>80%</td>
<td>4</td>
</tr>
<tr>
<td>( MCSus )</td>
<td>Reduction in probability of acquiring HIV due to male circumcision</td>
<td>60%</td>
<td>5</td>
</tr>
<tr>
<td>( MCinf )</td>
<td>Reduction in probability of transmitting HIV due to male circumcision</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>( MF )</td>
<td>Multiplier on probability of transmission per act for male to female transmission</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>( MSM )</td>
<td>Multiplier on probability of transmission per act for male to male transmission</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>( r )</td>
<td>Probability of transmission of HIV in a single sex act between an infected woman and an uninfected man</td>
<td>0.0011</td>
<td>1</td>
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<tr>
<td>( RI_{h} )</td>
<td>Infectiousness in disease stage ( h ) compared to asymptomatic stage</td>
<td>8</td>
<td>2</td>
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<tr>
<td>- Primary</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- Asymptomatic</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>- Symptomatic (no ART)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- Symptomatic (with ART)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( STIm )</td>
<td>Multiplier on probability of transmission per act when either partner has an STI</td>
<td>4 – 8</td>
<td>7</td>
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<tr>
<td>Vaccine parameters</td>
<td></td>
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<tr>
<td>( d )</td>
<td>Duration of vaccine protection (years)</td>
<td>10</td>
<td></td>
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<tr>
<td>( VES )</td>
<td>Reduction in susceptibility due to vaccine</td>
<td>0.3-0.7</td>
<td>Scenario</td>
</tr>
<tr>
<td>( VEI )</td>
<td>Reduction in infectiousness due to vaccine</td>
<td>0.3-0.7</td>
<td>Scenario</td>
</tr>
<tr>
<td>( VEA )</td>
<td>Increase in time in asymptomatic stage due to vaccination</td>
<td></td>
<td>Scenario</td>
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</table>
VII. References


VIII. 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).

**Dialogue box.** A box permitting users to choose among a limited number of options. The box is accompanied by text elaborating upon those options.

**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 28th 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.

**Pop-up menu.** A menu from which users can select items or actions. Pop-up menus can appear anywhere on the screen.

**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.

**Pull-down menu.** A menu opened by clicking on key words at the top edge of the screen. Pull-down menus allow users to select operations.
Radio button. These buttons emulate raised buttons on early radios, which were punched to select radio stations. The graphically portrayed raised “radio buttons” on interfaces permit users to select among at least three alternatives.

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.
### IX. Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>AIDS</td>
<td>acquired immune deficiency syndrome</td>
</tr>
<tr>
<td>GDP</td>
<td>gross domestic product</td>
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<tr>
<td>GNP</td>
<td>gross national product</td>
</tr>
<tr>
<td>HIV</td>
<td>human immunodeficiency virus</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labor Organization</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>NACP</td>
<td>national AIDS control program</td>
</tr>
<tr>
<td>PLHIV</td>
<td>person living with HIV</td>
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<tr>
<td>STI</td>
<td>sexually transmitted infection</td>
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<tr>
<td>TFR</td>
<td>total fertility rate</td>
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<tr>
<td>TB</td>
<td>tuberculosis</td>
</tr>
<tr>
<td>UNAIDS</td>
<td>Joint United Nations Programme on HIV/AIDS</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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