

# The AIDS Pandemic in the 21<sup>st</sup> Century

Issued March 2004

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## International Population Reports

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U.S. Agency for International Development  
Bureau for Global Health  
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# HIGHLIGHTS







## HIGHLIGHTS

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At the beginning of the 21<sup>st</sup> century, Human Immunodeficiency Virus (HIV), which causes the Acquired Immune Deficiency Syndrome (AIDS) continues to have its greatest impact in the developing world. Although the full demographic impact is not expected to be felt for several more years, and perhaps will not be completely measured at the pandemic's epicenter in Sub-Saharan Africa, the emerging downward trends in life expectancy and population growth, the distortions in age structures, and the breakdowns in support systems are already being seen in some countries. At the extreme in Southern Africa, Botswana, South Africa, and Zimbabwe are thought to be experiencing negative population growth due to AIDS mortality. At the beginning of the 21<sup>st</sup> century, AIDS is the number four cause of death globally but the number one cause of death in Africa.

- If current trends in HIV seroprevalence (the proportion of population infected with HIV) continue into the near future and existing relationships between HIV infection rates and

subsequent AIDS mortality continue to hold, the AIDS pandemic will dictate the size, growth, and age-sex structures of entire populations around the world.

- The U.S. Census Bureau's modeling and projections work indicates that severe distortions in age-sex structures are likely in severely affected countries. In countries with moderate epidemics, AIDS mortality is expected to have less effect on the population structure.
  - Life expectancies in HIV/AIDS affected countries are projected to decline, negating gains achieved during the past several decades. By 2010, many countries in southern Africa are expected to see life expectancies falling to near 30 years of age, levels not seen since the beginning of the 20<sup>th</sup> century.
  - The most direct impact of AIDS is expected to be an increase in the number of deaths in populations affected. In many Sub-Saharan African countries, crude death rates are projected to be even higher in 2010 than in 2000, even though mortality
- due to non-AIDS causes will continue to decline.
- Infant mortality rates are now higher than they were in 1990 in some Sub-Saharan African countries. In four Sub-Saharan African countries, more infants are likely to die from AIDS in 2010 than from all other causes.
  - In 26 Sub-Saharan African countries, under-5 mortality rates have increased over what they would have been without AIDS. Based on current trends, under-5 mortality rates in 2010 are expected to be much higher with AIDS than they would have been without AIDS. If programs to prevent mother-to-child transmission are dramatically scaled up, then the course of future child mortality rates can be changed.
  - By 2010, populations in the majority of Sub-Saharan African countries are projected to increase, despite the high levels of mortality. The exceptions are Botswana, Lesotho, Mozambique, South Africa, Swaziland, and Zimbabwe.



# INTRODUCTION





## INTRODUCTION

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The AIDS pandemic in the 21<sup>st</sup> century continues to have devastating impacts on populations, particularly in the developing world. Since the beginning of the epidemic two decades ago, more than 20 million people have died of AIDS. Twice that many—40 million—are now living with HIV. Barring some major breakthrough, most of these people are expected to die during the next 10 years or so. In 2001, the Joint United Nations Programme on AIDS (UNAIDS) estimated that 5 million people were newly infected with HIV.

This report provides an update on one of the key international health

and demographic events of our time, the worldwide HIV/AIDS pandemic, a source of some of the uncertainty associated with demographic change in the coming decades. It includes information on the impact of AIDS on mortality and population. In addition, the report reviews the current status of the HIV/AIDS epidemics in Africa, Asia, and Latin America.

This report presents the methodology and results of incorporating AIDS mortality into the U.S. Census Bureau's population estimates and projections for severely affected countries of the world. The available information and the

methodology and assumptions used for incorporating AIDS mortality into the population estimates and projections are described in Appendix A. This report is also published as a chapter in the Census Bureau's ***Global Population Profile: 2002***.

Questions about the demographic impacts of the HIV/AIDS pandemic presented in this report or about the methodology employed in estimating those impacts may be directed to: Chief, Health Studies Branch, International Programs Center, U.S. Census Bureau, Washington, DC 20233-8860.

This report is available on the Census Bureau Web site as a chapter in **Global Population Profile: 2002**. The Web address is: [www.census.gov/ipc/www/wp02.html](http://www.census.gov/ipc/www/wp02.html). The data presented in this report draw upon information stored in two databases maintained and annually updated by the International Programs Center (IPC) of the U.S. Census Bureau. IPC compiles, evaluates, electronically stores, and analyzes selected demographic and health data for all countries. IPC's Health Studies Branch maintains the *HIV/AIDS Surveillance Data Base*, a compilation of information on HIV prevalence from all available studies from Africa, Asia, Latin America, Eastern Europe and the New Independent States. The *International Data Base (IDB)* contains statistical tables providing demographic and socio-economic data for all countries of the world.

- The *HIV/AIDS Surveillance Data Base* includes all available epidemiological information on HIV/AIDS seroprevalence and incidence for countries in Africa, Asia, Latin America, Eastern Europe, and the New Independent States taken from the scientific literature and from unpublished reports prepared for international conferences and various workshops. The current update of the data base contains over 72,000 individual data records drawn from over 6,500 publications and presentations.

The *HIV/AIDS Surveillance Data Base* can be obtained free of charge on CD-ROM from the Health Studies Branch or downloaded from the Internet at:

[www.census.gov/ipc/www/hivaidn.html](http://www.census.gov/ipc/www/hivaidn.html)

Requests for specific data items or a CD-ROM, or questions about the *HIV/AIDS Surveillance Data Base* should be directed to:

Chief, Health Studies Branch  
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Washington Plaza II, Room 313A  
U.S. Census Bureau  
Washington, DC 20233-8860 USA

Telephone: 301/763-1433;  
FAX: 301-457-3034  
e-mail: [ipc-hiv@census.gov](mailto:ipc-hiv@census.gov)

- The *International Data Base* contains information derived from censuses, surveys (for example, population by age and sex, labor force, and contraceptive use), and administrative records (for example, registered births and deaths) for selected years from 1950 to the present. Some variables are available by urban/rural residence. The IDB contains the International Programs Center's current estimates and projections of fertility, mortality, migration, and population on a single-year basis to the year 2020 and for every fifth year from 2025 to 2050. IDB estimates and projections may be more recent than those presented in this report, which are current to October 2002.

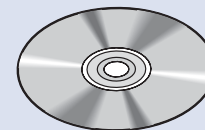
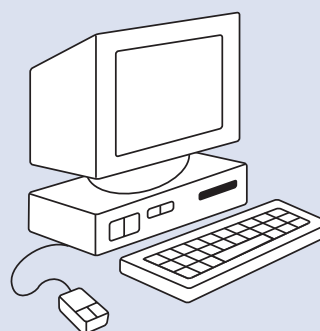
Direct access and further information about the IDB are available through the Internet at:

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# THE AIDS PANDEMIC IN THE 21<sup>ST</sup> CENTURY





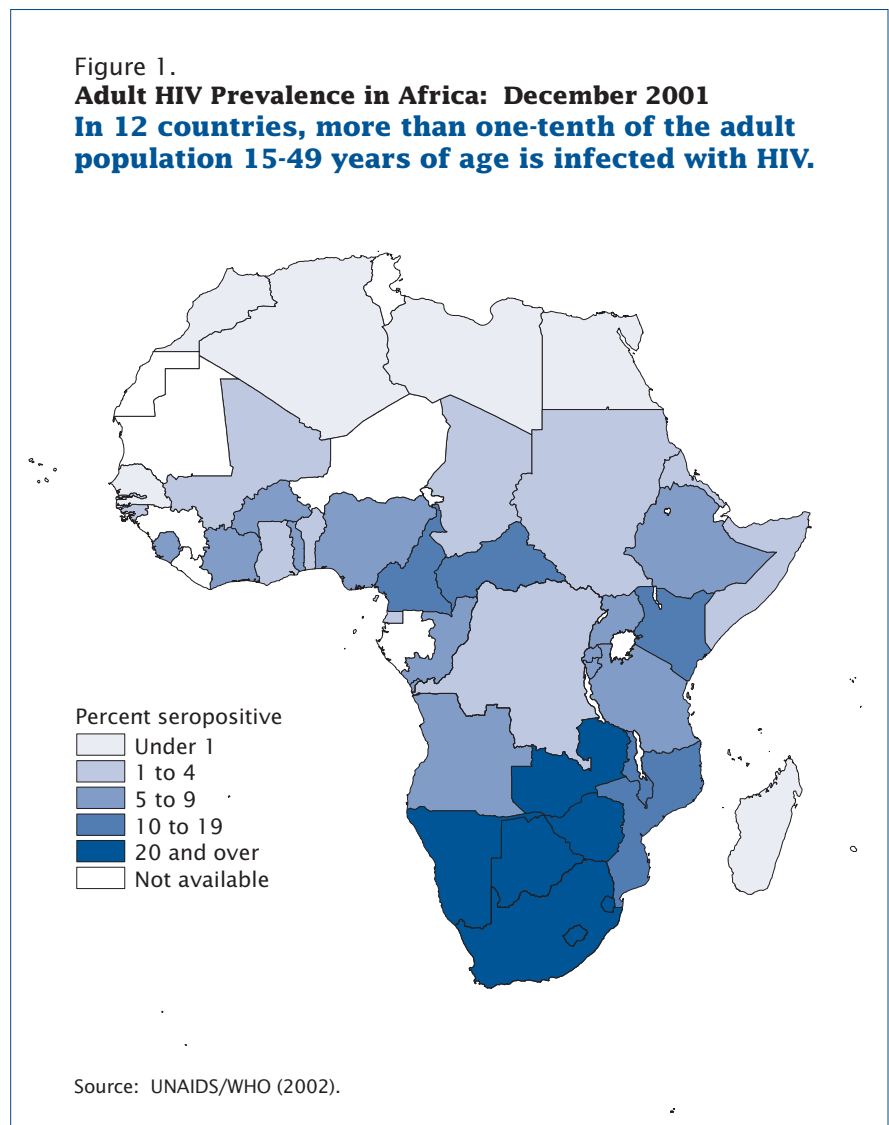


**The AIDS Pandemic in the 21<sup>st</sup> Century Continues to Have Its Greatest Impact in the Developing World**

Over 90 percent of people infected with the Human Immunodeficiency Virus (HIV), which causes AIDS, live in the developing world. The Joint United Nations Programme on HIV/AIDS (UNAIDS) expects that this “proportion will continue to rise in countries where poverty, poor health systems, and limited resources for prevention and care fuel the spread of the virus” (UNAIDS, 1999).

Over 70 percent of the global total of HIV-positive people, 28.5 million out of 40 million, live in Sub-Saharan Africa, even though this region contains only 11 percent of the global population. Nine percent of all adults in Sub-Saharan Africa are HIV positive, compared to 0.6 percent of adults in the United States. Since the beginning of the epidemic, over 15 million Africans have died from AIDS; 2.2 million AIDS deaths occurred there in 2001.

Southern and eastern Africa have been the most severely affected regions. According to the latest UNAIDS/WHO figures, seven countries have an estimated adult (ages 15-49) HIV prevalence of 20 percent or greater: Botswana, Lesotho, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe



(UNAIDS/WHO, 2002). In these countries, all in southern Africa, at least one adult in five is living with HIV. An additional five countries, Cameroon, Central African

Republic, Kenya, Malawi, and Mozambique, have adult HIV prevalence levels higher than 10 percent (Figure 1).

The HIV/AIDS epidemics in southern Africa started later but they have been explosive, such as in Botswana, where HIV prevalence among pregnant women<sup>1</sup> in Francistown increased from 7 percent in 1991 to 44 percent in 2000.

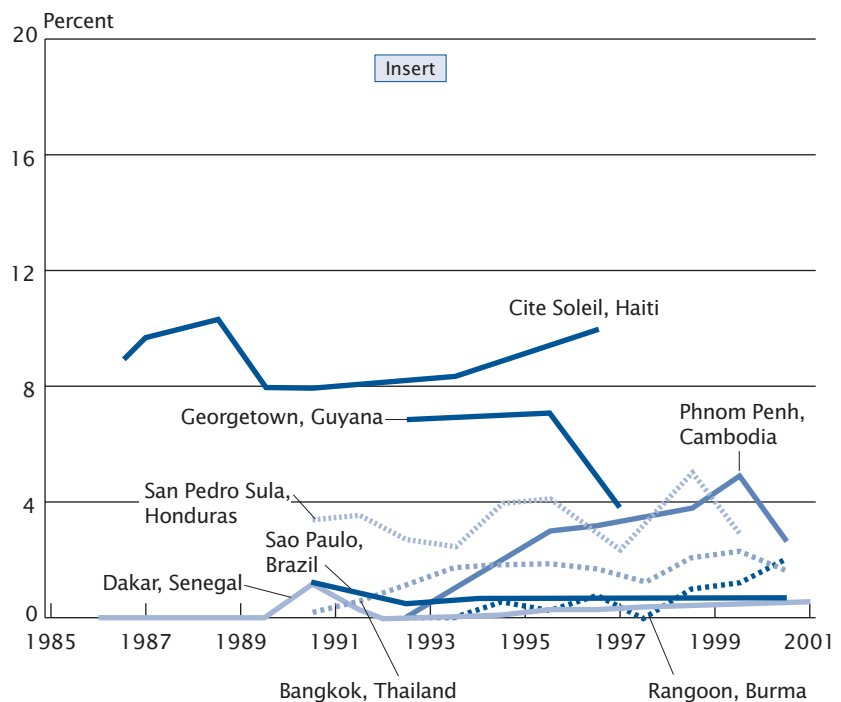
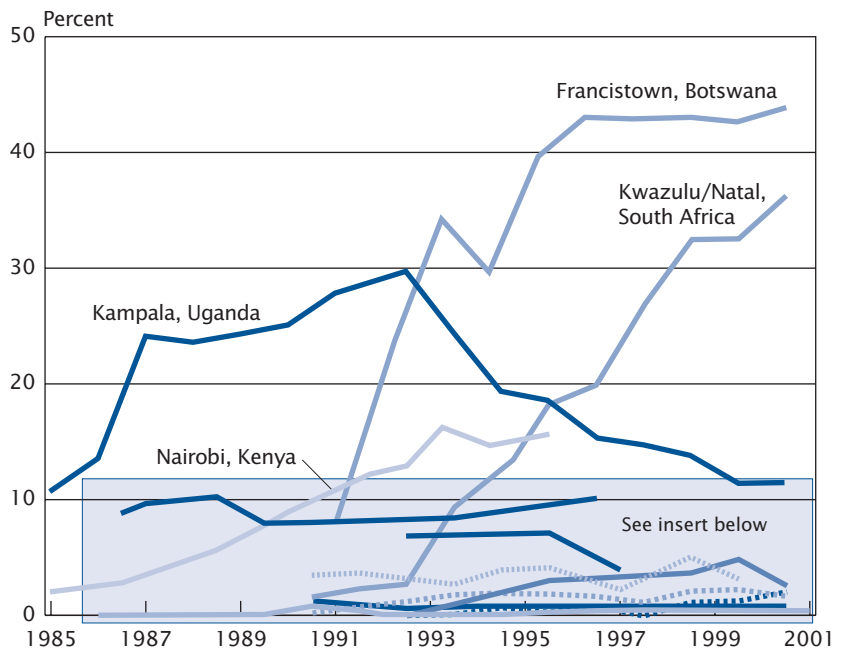
The two success stories in Sub-Saharan Africa continue to be Uganda and Senegal. HIV prevalence among pregnant women in Uganda continues to decline in most sentinel surveillance sites. In Kampala, HIV prevalence declined from its peak of 30 percent in 1993 to 11 percent in 2000. In Dakar, AIDS control programs have managed to keep HIV prevalence at very low levels (Figure 2).

In comparison, HIV prevalence levels among pregnant women in Asia are relatively low. HIV prevalence exceeds 1 percent in only three countries: Burma, Cambodia, and Thailand. However, even these epidemics differ. In Thailand, another success story, and Cambodia, HIV prevalence is declining in some areas and stabilizing at low levels in other areas. In Burma, HIV prevalence rates fluctuated at low levels into the mid-1990s and show a slight increase since then.

In Latin America and the Caribbean, the HIV/AIDS epidemics vary from those that are concentrated among injecting drug users (Argentina and Uruguay) and men who have sex with men (Peru and Mexico) to epidemics that seem to be driven by heterosexual transmission. The last include those in the Bahamas, Haiti, Honduras, and Guyana, the countries with the highest HIV prevalence levels

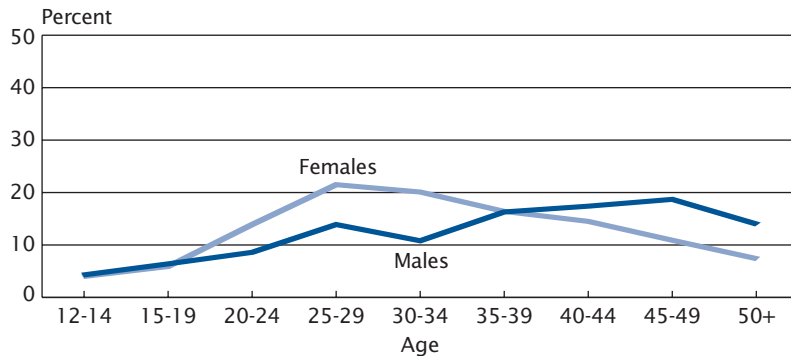
<sup>1</sup> In this report, "pregnant women" refers to those pregnant women attending antenatal clinics.

Figure 2.  
**HIV Seroprevalence for Pregnant Women in Selected Urban Areas of Africa, Asia, and Latin America: 1985-2001**  
**HIV/AIDS epidemics in urban areas vary widely from region to region with African countries typically showing higher urban HIV prevalence than countries in Asia and Latin America.**



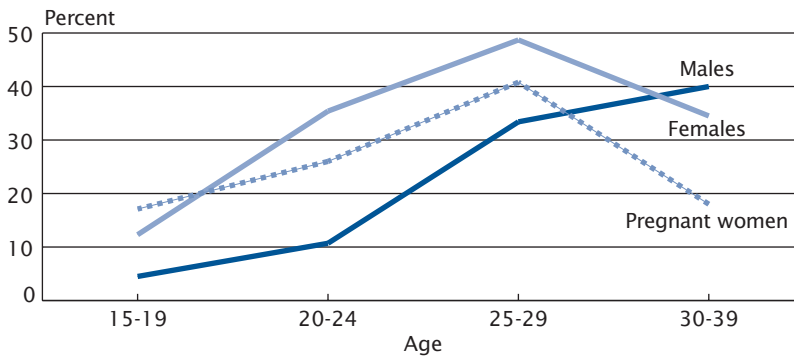
Source: U.S. Census Bureau, International Programs Center, HIV/AIDS Surveillance Data Base (2002 release).

Figure 3.  
**HIV Seroprevalence by Age and Sex in Rwanda: 1997**  
**In Sub-Saharan Africa, HIV prevalence tends to be much higher among young females than among males of their same age.**



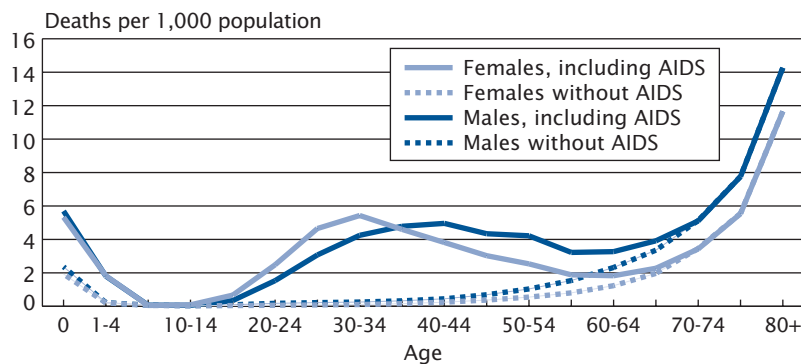
Source: Rwanda, Ministry of Health (1998).

Figure 4.  
**HIV Seroprevalence for Pregnant Women and the General Population in Zambia: 1995-1996**  
**Seroprevalence levels for pregnant women are a useful proxy for the combined adult population of males and females.**



Source: Fylkesnes et al. (1998)

Figure 5.  
**Death Rates With and Without AIDS by Age and Sex in South Africa: 2020**  
**AIDS mortality increases death rates in those ages where mortality due to all other causes is very low.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

among pregnant women in the region. In Brazil, already strong HIV prevention programs were augmented in recent years by advances in provision of antiretrovirals to all those HIV positive, thereby lessening the effects of AIDS mortality on the population.

**In Sub-Saharan Africa, More Women Than Men Are HIV Positive**

At the end of 2001, UNAIDS estimated that 58 percent of all HIV infections in Sub-Saharan Africa were among women. Peak HIV prevalence among women occurs at a younger age than among men: around age 25 compared to age 35-40. As Figures 3 and 4 show for Rwanda and Zambia, younger women tend to have higher levels of HIV infection than men of their same age.

Several studies have shown that HIV prevalence among pregnant women attending antenatal clinics provides a reasonable overall estimate of HIV prevalence in the general adult population, although it underestimates the rate among all women while overestimating it among men. This is shown for Zambia in Figure 4.

**Mortality Patterns Are Driven by HIV Prevalence Patterns**

Median survival time with HIV/AIDS is estimated to be around 10 years. In South Africa, by 2020, death rates for adults at ages 20-45 are likely to be much higher than they would have been without AIDS. Among those under age 60, mortality for women is projected to peak during the ages of 30-34, earlier than the peak projected for men: 40-44 years (Figure 5).

**At the Beginning of the 21<sup>st</sup> Century, the Population Growth Rate in Botswana Is Now Negative Due to AIDS Mortality<sup>2</sup>**

Other countries with sharply reduced growth rates include several additional African countries: Lesotho, Malawi, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe (Figure 6).

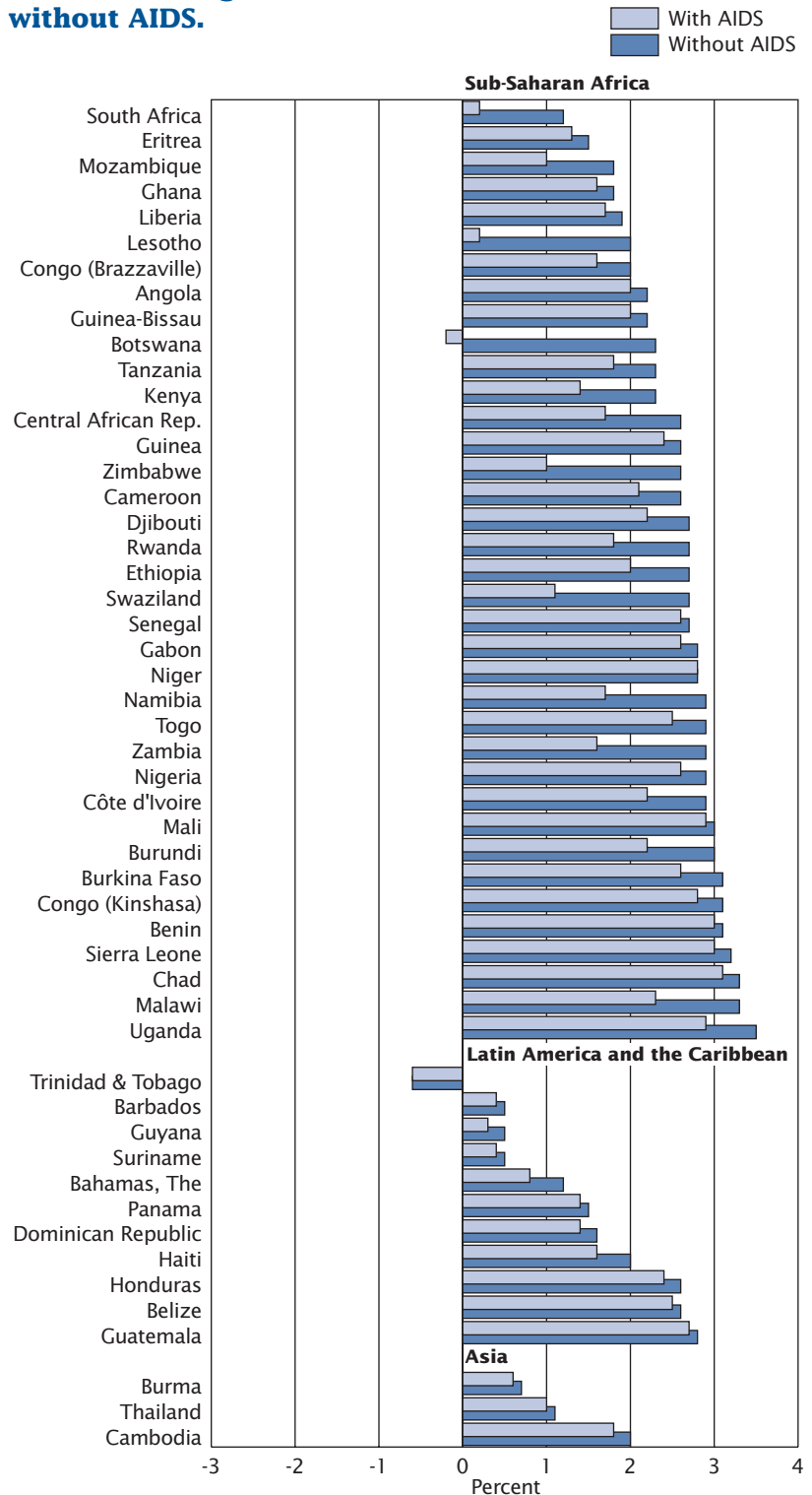
The negative population growth seen in Trinidad and Tobago in 2002 reflects the impact of out-migration and AIDS mortality. The underlying non-AIDS growth rate for Trinidad and Tobago is nearly -0.6 percent.

In Asia, AIDS mortality has slightly lowered population growth rates in Burma, Cambodia, and Thailand.

<sup>2</sup> Refer to Tables 1 and 2 for country-specific indicators.

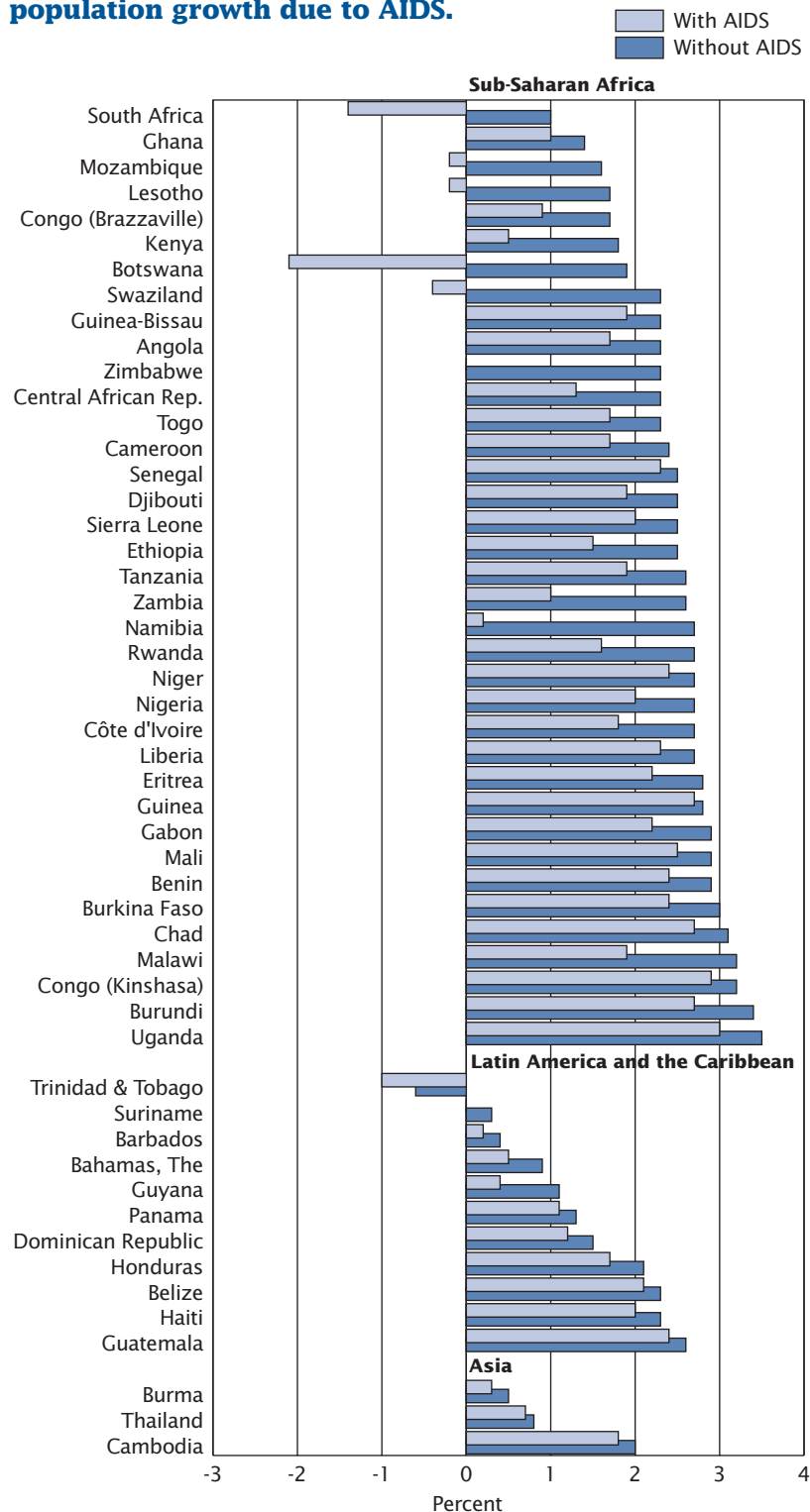
In Figures 6 through 17, two series of data are shown for each of the 51 seriously affected countries where AIDS is having an impact on demographic indicators. The first series, "With AIDS," shows what has happened and what is projected to happen in each country because of AIDS mortality and its demographic consequences. In this work, fertility is assumed to be unaffected by HIV/AIDS, though numbers of births decrease as a result of mortality-induced reductions in women of reproductive age. Second, a hypothetical "Without AIDS" series shows what the Census Bureau's modeling work indicates would have happened if a country had not been affected by the HIV/AIDS epidemic. This modeling takes into account not only lower death rates but also associated changes to a country's age-sex structure and, indirectly, the combined effects of lower mortality and changing population composition on demographic indicators.

Figure 6.  
**Population Growth Rates With and Without AIDS for Selected Countries: 2002**  
**Botswana is now experiencing negative population growth. In South Africa, growth is now less than half what it might have been in 2002 without AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Figure 7.  
**Population Growth Rates With and Without AIDS for Selected Countries: 2010**  
**By 2010, Botswana, Mozambique, Lesotho, Swaziland, and South Africa, are all expected to experience negative population growth due to AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**By the Year 2010, Five Countries Are Projected to Show Negative Population Growth Because of AIDS Mortality**

The growth rate for Botswana is projected to be suppressed and by 2010 it will be -2 percent. In South Africa it is projected to be -1.4 percent and in Swaziland -0.4 percent. This negative population growth is due to the high levels of HIV prevalence in these countries and relatively low fertility. Previously, most HIV/AIDS experts never expected HIV prevalence rates to reach such high levels for any country. By the end of 2001, adult HIV prevalence had reached an estimated 39 percent in Botswana, 20 percent in South Africa, and 33 percent in Swaziland (UNAIDS/WHO, 2002). By 2010, Zimbabwe and Namibia are projected to experience a growth rate of close to zero. Without AIDS, these countries would have had a growth rate of 2 percent or greater (Figure 7).

In Latin America and the Caribbean, the Bahamas and Guyana are projected to see the greatest relative impact, with growth rates reduced from 1 percent to 0.5 percent. Trinidad and Tobago's already negative population growth, due to out-migration, is projected to decline further due to AIDS mortality.

In Asia, growth rates are projected to be slightly lower in Burma, Thailand, and Cambodia due to HIV/AIDS.

Table 1.  
**Demographic Characteristics With and Without AIDS: 2002**

Country	Growth rate			Life expectancy at birth			Crude death rate			Infant mortality rate			Under-5 mortality rate			Total fertility rate
	With AIDS	Without AIDS	Net decrease	With AIDS	Without AIDS	Net decrease	With AIDS	Without AIDS	Net increase	With AIDS	Without AIDS	Net increase	With AIDS	Without AIDS	Net increase	
Angola	2.0	2.2	0.2	37.1	38.9	1.8	25.8	24.3	1.5	195.2	191.6	3.6	287.4	281.8	5.6	6.4
Benin	3.0	3.1	0.1	51.3	53.8	2.5	13.6	12.4	1.2	87.7	84.4	3.3	149.6	143.8	5.9	6.1
Botswana	-0.2	2.3	2.5	33.9	72.4	38.5	28.6	4.8	23.8	64.8	20.0	44.8	107.1	30.6	76.5	3.4
Burkina Faso	2.6	3.1	0.5	44.7	52.3	7.6	18.8	14.7	4.1	100.9	93.5	7.5	199.8	187.9	11.8	6.4
Burundi	2.2	3.0	0.8	43.0	57.6	14.6	18.0	10.4	7.6	72.7	59.1	13.6	133.8	111.5	22.3	6.1
Cameroon	2.1	2.6	0.5	48.1	58.8	10.6	15.3	10.0	5.3	71.1	61.7	9.4	124.1	108.4	15.7	4.7
Central African Republic	1.7	2.6	0.9	42.1	57.5	15.4	19.5	10.8	8.7	94.5	78.6	15.9	144.7	118.2	26.5	4.8
Chad	3.1	3.3	0.1	48.7	51.4	2.7	16.4	15.0	1.4	96.7	93.5	3.3	171.1	165.4	5.8	6.5
Congo (Brazzaville)	1.6	2.0	0.4	50.5	58.1	7.6	14.0	10.1	3.9	96.8	88.8	8.0	148.2	134.1	14.1	3.8
Congo (Kinshasa)	2.8	3.1	0.3	48.7	55.2	6.5	15.1	11.9	3.2	98.5	92.4	6.0	142.5	132.4	10.1	6.8
Côte d'Ivoire	2.2	2.9	0.8	42.8	55.6	12.7	18.4	11.2	7.1	99.6	86.9	12.6	152.6	131.6	20.9	5.6
Djibouti	2.2	2.7	0.5	43.1	51.6	8.5	19.5	14.4	5.1	108.4	99.6	8.8	175.3	161.0	14.3	5.6
Eritrea	1.3	1.5	0.2	53.6	56.6	3.0	13.1	11.7	1.4	77.1	73.5	3.5	130.2	123.7	6.5	5.8
Ethiopia	2.0	2.7	0.7	41.6	53.1	11.5	20.0	13.1	6.9	104.3	92.1	12.2	169.9	150.0	20.0	5.7
Gabon	2.6	2.8	0.3	57.7	63.7	6.0	10.9	8.4	2.5	55.8	50.2	5.6	82.8	72.6	10.2	4.9
Ghana	1.6	1.8	0.3	56.8	62.4	5.7	10.4	7.9	2.5	53.8	49.2	4.7	92.9	84.4	8.5	3.5
Guinea	2.4	2.6	0.1	49.4	51.4	2.0	15.9	14.8	1.1	94.8	92.8	2.0	168.8	165.3	3.5	5.9
Guinea-Bissau	2.0	2.2	0.2	47.0	49.8	2.9	16.7	15.0	1.7	111.9	108.4	3.4	180.3	174.6	5.7	5.1
Kenya	1.4	2.3	1.0	45.5	65.6	20.1	15.7	6.2	9.5	64.1	46.9	17.2	95.0	65.7	29.2	3.6
Lesotho	0.2	2.0	1.7	37.1	64.4	27.3	24.4	8.2	16.3	87.2	59.1	28.2	127.7	80.6	47.1	3.6
Liberia	1.7	1.9	0.2	48.3	51.8	3.5	17.9	16.0	1.8	133.9	130.1	3.8	203.2	196.8	6.4	6.3
Malawi	2.3	3.3	1.0	38.5	56.3	17.8	22.3	12.0	10.3	106.1	87.2	18.9	184.7	155.0	29.7	6.2
Mali	2.9	3.0	0.1	45.6	47.4	1.9	19.3	18.3	1.0	120.4	119.5	0.9	218.1	215.4	2.7	6.7
Mozambique	1.0	1.8	0.8	32.1	40.0	7.9	29.3	21.9	7.4	199.7	186.1	13.6	304.1	280.9	23.1	5.0
Namibia	1.7	2.9	1.1	45.0	65.8	20.9	17.6	7.0	10.6	67.3	42.0	25.3	104.1	59.2	44.9	4.8
Nigeria	2.6	2.9	0.3	51.5	57.8	6.3	13.6	10.5	3.1	72.2	65.8	6.5	136.2	124.9	11.4	5.5
Niger	2.8	2.8	0.1	42.2	43.5	1.3	21.9	21.1	0.8	124.6	122.7	1.9	269.8	267.1	2.7	7.0
Rwanda	1.8	2.7	0.8	39.5	51.5	12.1	21.6	14.0	7.6	103.6	90.4	13.2	185.9	164.9	21.0	5.7
Senegal	2.6	2.7	0.1	56.2	59.0	2.9	11.0	9.8	1.2	58.6	56.2	2.4	110.7	106.4	4.4	5.0
Sierra Leone	3.0	3.2	0.2	43.0	46.0	3.0	20.7	18.8	1.9	148.5	144.3	4.2	225.6	218.9	6.8	5.9
South Africa	0.2	1.2	1.0	48.8	66.3	17.5	16.6	7.3	9.3	59.5	38.9	20.6	97.3	61.4	35.9	2.3
Swaziland	1.1	2.7	1.6	41.4	72.6	31.1	19.3	4.1	15.2	66.5	34.2	32.3	103.5	48.1	55.4	4.0
Tanzania	1.8	2.3	0.6	44.7	54.3	9.6	17.3	12.1	5.3	105.3	96.0	9.3	156.5	140.9	15.6	5.3
Togo	2.5	2.9	0.4	53.8	62.6	8.9	11.4	7.7	3.7	69.8	62.6	7.2	119.1	106.6	12.5	5.1
Uganda	2.9	3.5	0.6	44.5	56.0	11.5	17.3	11.6	5.7	89.7	79.2	10.5	145.2	127.9	17.3	6.8
Zambia	1.6	2.9	1.3	35.3	55.4	20.1	24.3	11.5	12.8	100.2	76.5	23.7	170.8	132.7	38.1	5.4
Zimbabwe	1.0	2.6	1.6	40.2	69.0	28.8	20.8	5.4	15.4	65.9	34.7	31.2	100.7	47.2	53.4	3.7
Bahamas, The	0.8	1.2	0.3	65.8	74.0	8.2	8.6	5.2	3.4	26.7	21.4	5.4	35.8	26.3	9.5	2.3
Barbados	0.4	0.5	0.1	72.0	74.5	2.5	9.0	7.9	1.1	12.8	10.9	1.9	15.6	12.2	3.4	1.6
Belize	2.5	2.6	0.1	67.3	71.3	4.1	6.1	4.7	1.4	27.8	25.0	2.8	36.0	30.8	5.2	4.0
Dominican Republic	1.4	1.6	0.2	68.3	74.2	5.9	6.7	4.5	2.2	35.1	31.3	3.8	45.3	38.2	7.1	2.9
Guatemala	2.7	2.8	0.1	65.3	67.8	2.5	6.8	5.9	0.9	39.0	36.9	2.0	51.2	47.5	3.7	4.7
Guyana	0.3	0.5	0.2	63.7	69.0	5.3	8.9	6.6	2.3	37.9	33.3	4.6	52.3	43.8	8.5	2.1
Haiti	1.6	2.0	0.4	51.4	58.7	7.2	13.5	10.3	3.3	77.7	71.5	6.2	117.1	106.6	10.5	5.0
Honduras	2.4	2.6	0.2	67.1	71.5	4.4	6.3	4.8	1.5	30.3	26.8	3.5	41.4	34.9	6.5	4.2
Panama	1.4	1.5	0.1	72.5	76.1	3.6	6.1	4.9	1.3	21.9	19.6	2.3	27.9	23.7	4.1	2.6
Suriname	0.4	0.5	0.1	69.3	71.9	2.6	6.7	5.7	1.0	25.4	23.4	2.0	32.3	28.8	3.5	2.4
Trinidad and Tobago	-0.6	-0.6	0.1	69.9	71.7	1.8	8.4	7.7	0.7	25.3	23.6	1.7	30.0	27.1	2.9	1.8
Burma	0.6	0.7	0.2	55.6	58.5	3.0	12.2	10.6	1.6	72.0	69.5	2.4	101.0	96.4	4.6	2.2
Cambodia	1.8	2.0	0.2	57.4	61.9	4.5	9.4	7.5	1.9	78.3	74.5	3.8	103.0	96.0	7.0	3.6
Thailand	1.0	1.1	0.1	71.1	72.7	1.6	6.8	6.1	0.7	22.5	22.2	0.3	30.0	28.8	1.2	1.9

Note: Growth rate, life expectancy at birth ( $e_0$ ), crude death rate, infant mortality, and under-5 mortality ( ${}_5q_0$ ) are for both sexes combined.

Source: U.S. Census Bureau, International Data Base and unpublished tables.



Table 2.  
**Demographic Characteristics With and Without AIDS: 2010**

Country	Growth rate			Life expectancy at birth			Crude death rate			Infant mortality rate			Under-5 mortality rate			Total fertility rate
	With AIDS	Without AIDS	Net de-crease	With AIDS	Without AIDS	Net de-crease	With AIDS	Without AIDS	Net in-crease	With AIDS	Without AIDS	Net in-crease	With AIDS	Without AIDS	Net in-crease	
Angola	1.7	2.3	0.6	35.0	41.3	6.2	26.8	21.6	5.2	183.6	174.7	8.9	268.9	255.2	13.7	5.9
Benin	2.4	2.9	0.5	47.9	57.0	9.0	14.8	10.2	4.6	80.1	71.3	8.7	132.2	117.5	14.7	5.4
Botswana	-2.1	1.9	4.0	26.7	74.4	47.7	42.8	4.2	38.6	74.6	15.8	58.8	122.9	22.8	100.1	2.7
Burkina Faso	2.4	3.0	0.7	43.6	55.4	11.9	18.6	12.2	6.4	92.1	80.7	11.4	173.9	156.0	18.0	5.9
Burundi	2.7	3.4	0.7	44.6	60.7	16.2	16.7	8.5	8.1	63.3	49.4	13.9	111.4	88.3	23.1	5.3
Cameroon	1.7	2.4	0.7	47.9	61.9	14.0	15.5	8.5	7.0	62.7	51.4	11.3	105.5	86.5	19.0	4.1
Central African Republic	1.3	2.3	1.0	41.0	60.6	19.6	20.2	9.2	11.0	83.9	65.2	18.7	127.1	95.6	31.5	4.1
Chad	2.7	3.1	0.5	46.2	54.6	8.4	16.8	12.5	4.3	88.6	80.8	7.8	151.6	138.6	13.0	6.0
Congo (Brazzaville)	0.9	1.7	0.8	47.0	61.2	14.3	16.5	8.5	8.0	85.7	72.8	12.9	128.8	107.1	21.7	3.0
Congo (Kinshasa)	2.9	3.2	0.3	50.5	58.4	7.9	13.4	9.8	3.6	83.2	76.7	6.6	118.9	107.8	11.2	6.1
Côte d'Ivoire	1.8	2.7	0.9	41.7	58.7	17.0	19.0	9.4	9.6	88.4	72.5	16.0	133.7	107.1	26.6	4.8
Djibouti	1.9	2.5	0.6	43.4	54.8	11.4	19.1	12.6	6.5	95.9	85.3	10.6	152.0	134.6	17.4	5.0
Eritrea	2.2	2.8	0.6	48.9	59.8	10.8	15.0	9.8	5.2	70.9	61.7	9.1	115.9	100.3	15.6	5.2
Ethiopia	1.5	2.5	1.0	40.1	56.3	16.3	20.7	10.9	9.8	94.9	77.9	16.9	150.8	123.3	27.5	4.8
Gabon	2.2	2.9	0.6	52.9	66.5	13.6	12.9	7.0	5.9	50.5	39.7	10.8	74.4	55.5	18.9	4.6
Ghana	1.0	1.4	0.5	55.6	65.4	9.8	11.5	7.0	4.5	47.6	40.2	7.4	78.6	65.7	12.9	2.5
Guinea	2.7	2.8	0.2	51.3	54.6	3.2	14.3	12.7	1.6	83.1	80.1	2.9	143.6	138.5	5.1	5.6
Guinea-Bissau	1.9	2.3	0.3	47.3	52.9	5.6	16.2	13.0	3.2	99.4	93.8	5.6	157.0	147.6	9.3	4.6
Kenya	0.5	1.8	1.3	43.7	68.3	24.7	18.3	5.4	12.9	58.0	37.2	20.9	86.3	50.6	35.7	2.6
Lesotho	-0.2	1.7	1.9	36.5	67.2	30.6	26.0	7.1	18.8	78.1	46.7	31.5	115.9	62.3	53.7	3.0
Liberia	2.3	2.7	0.5	46.3	55.0	8.7	17.9	13.5	4.4	120.5	112.7	7.8	180.7	167.8	12.9	5.7
Malawi	1.9	3.2	1.3	36.9	59.4	22.6	23.1	9.9	13.2	97.9	73.2	24.7	165.1	125.2	39.9	5.7
Mali	2.5	2.9	0.4	44.3	50.5	6.2	18.8	15.3	3.4	110.1	105.1	5.0	193.6	184.8	8.8	6.1
Mozambique	-0.2	1.6	1.8	27.1	42.5	15.4	36.2	19.4	16.9	194.1	169.2	25.0	292.8	253.5	39.3	4.3
Namibia	0.2	2.7	2.4	33.8	68.5	34.8	28.1	5.7	22.4	73.4	32.8	40.6	113.9	44.8	69.1	4.3
Nigeria	2.0	2.7	0.7	47.3	60.9	13.6	15.7	8.7	7.0	65.8	54.6	11.2	117.3	98.3	19.0	4.8
Niger	2.4	2.7	0.3	41.4	46.3	4.9	21.0	17.9	3.1	117.1	110.9	6.2	244.8	235.0	9.8	6.3
Rwanda	1.6	2.7	1.0	38.7	54.7	16.0	22.3	12.0	10.3	94.5	78.1	16.4	164.4	138.0	26.4	5.2
Senegal	2.3	2.5	0.2	58.2	62.1	3.9	9.8	8.2	1.6	50.4	47.1	3.3	90.3	84.5	5.8	4.3
Sierra Leone	2.0	2.5	0.5	41.9	48.9	7.1	20.5	16.1	4.4	135.2	127.2	8.0	203.3	190.5	12.9	5.3
South Africa	-1.4	1.0	2.4	36.5	68.4	31.9	30.1	7.2	22.9	65.1	31.5	33.7	104.3	47.3	57.0	2.0
Swaziland	-0.4	2.3	2.6	33.0	74.6	41.6	28.8	3.8	25.1	70.8	25.6	45.3	111.7	34.6	77.1	3.2
Tanzania	1.9	2.6	0.7	44.6	57.5	12.9	17.1	10.0	7.1	92.3	80.1	12.2	135.5	115.3	20.3	4.6
Togo	1.7	2.3	0.7	50.7	65.5	14.8	12.9	6.3	6.6	61.8	50.6	11.2	101.2	82.0	19.2	3.8
Uganda	3.0	3.5	0.5	46.8	59.2	12.3	15.2	9.5	5.7	76.6	66.5	10.1	121.1	104.1	17.0	6.1
Zambia	1.0	2.6	1.5	34.4	58.6	24.3	25.4	9.5	15.9	92.3	64.7	27.6	153.4	108.3	45.2	4.5
Zimbabwe	0.0	2.3	2.3	34.6	71.4	36.9	27.4	4.8	22.6	69.0	27.0	42.0	107.6	35.8	71.9	3.3
Bahamas, The	0.5	0.9	0.4	65.8	75.8	10.0	9.4	5.4	4.0	22.7	16.3	6.4	30.8	19.7	11.1	2.1
Barbados	0.2	0.4	0.2	71.2	76.3	5.1	9.5	7.4	2.1	11.9	8.7	3.2	15.6	9.7	5.9	1.7
Belize	2.1	2.3	0.2	68.3	73.5	5.2	5.9	4.1	1.8	22.7	19.0	3.7	29.4	23.0	6.4	3.3
Dominican Republic	1.2	1.5	0.3	66.7	76.0	9.3	8.1	4.6	3.5	28.6	22.9	5.8	37.7	27.5	10.2	2.7
Guatemala	2.4	2.6	0.2	65.9	70.3	4.5	6.6	5.0	1.6	31.4	28.2	3.2	41.4	35.6	5.8	4.2
Guyana	0.4	1.1	0.7	57.1	71.4	14.3	13.6	6.4	7.1	35.8	25.7	10.1	50.7	32.9	17.7	2.0
Haiti	2.0	2.3	0.4	53.3	61.7	8.5	12.3	8.6	3.8	64.8	58.2	6.6	95.7	84.4	11.3	4.1
Honduras	1.7	2.1	0.4	62.2	73.6	11.4	8.4	4.3	4.1	28.0	20.7	7.4	39.3	26.2	13.1	3.4
Panama	1.1	1.3	0.2	72.1	77.6	5.5	6.9	5.0	2.0	18.5	15.2	3.4	24.2	18.1	6.1	2.3
Suriname	0.0	0.3	0.2	69.1	74.0	4.9	7.8	5.8	2.0	20.9	17.8	3.2	27.3	21.5	5.8	2.2
Trinidad and Tobago	-1.0	-0.6	0.4	64.5	73.8	9.3	12.5	8.5	4.0	25.2	17.9	7.3	34.6	20.5	14.1	1.7
Burma	0.3	0.5	0.2	57.7	61.6	3.9	12.0	9.8	2.2	59.7	56.4	3.3	82.5	76.6	5.8	1.9
Cambodia	1.8	2.0	0.2	60.6	64.9	4.2	8.5	6.7	1.8	61.9	58.5	3.4	80.2	74.3	6.0	3.1
Thailand	0.7	0.8	0.1	73.0	74.7	1.6	7.3	6.5	0.7	17.4	17.2	0.2	22.5	21.7	0.8	1.8

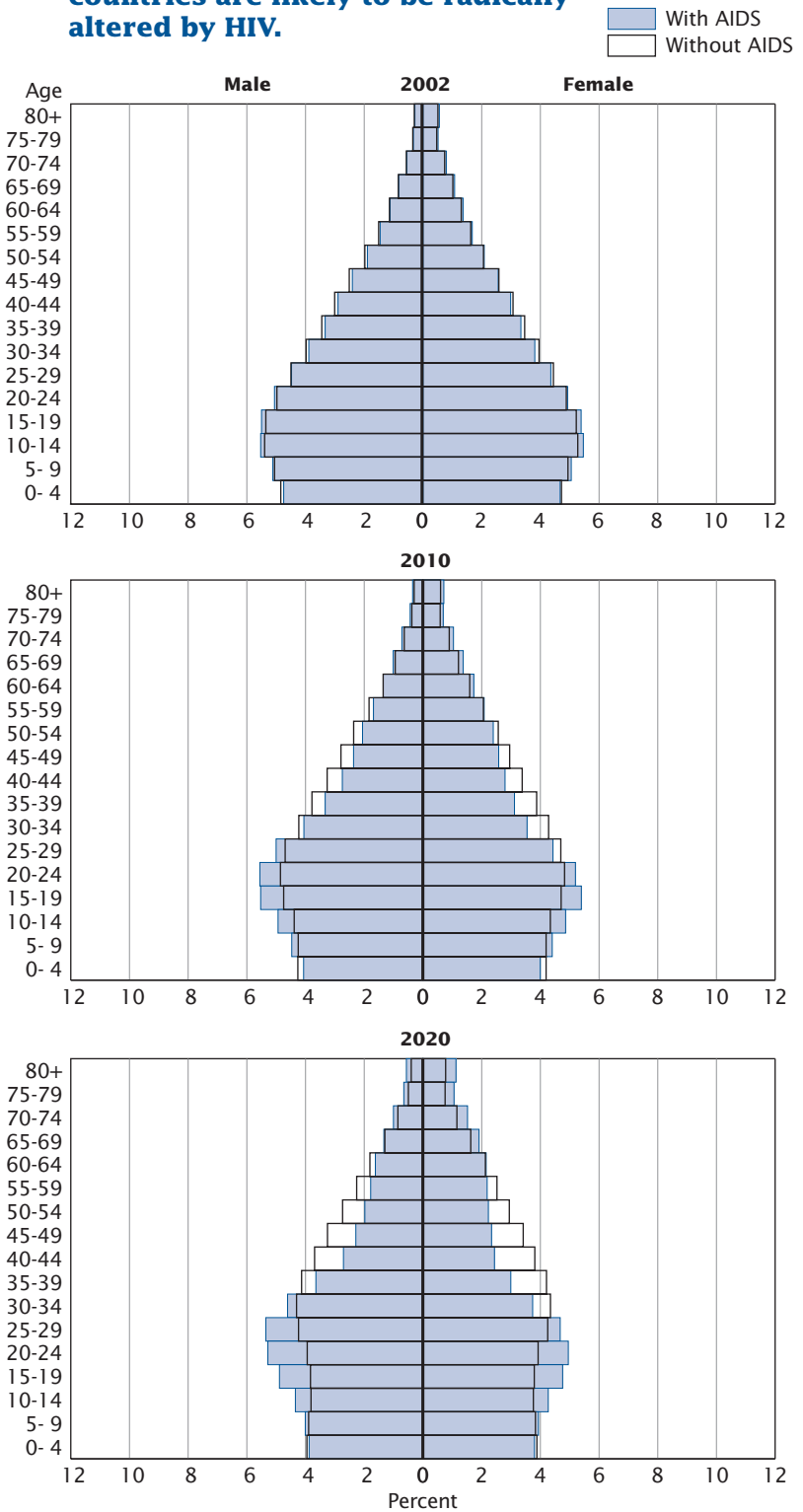
Note: Growth rate, life expectancy at birth ( $e_0$ ), crude death rate, infant mortality, and under-5 mortality ( ${}_5q_0$ ) are for both sexes combined.

Source: U.S. Census Bureau, International Data Base and unpublished tables.

**AIDS Mortality Is Likely to Produce Population Pyramids That Have Never Been Seen Before**

In countries with projected negative population growth—Botswana, Lesotho, Mozambique, South Africa, and Swaziland—population pyramids will have a new shape, “the population chimney.” The implications of this new population structure are not clear. By 2020, men between the ages of 15 and 44 are likely to outnumber women in each of the 5-year age cohorts. This may influence men to seek sexual relationships with younger and younger women. This factor in turn may increase HIV infection rates among younger women. Current evidence (Glynn et al., 2001) indicates that, indeed, older men are infecting younger women. As these women marry, their partners are then at increased risk of HIV infection. This vicious cycle could result in even higher HIV infection levels (Figure 8).

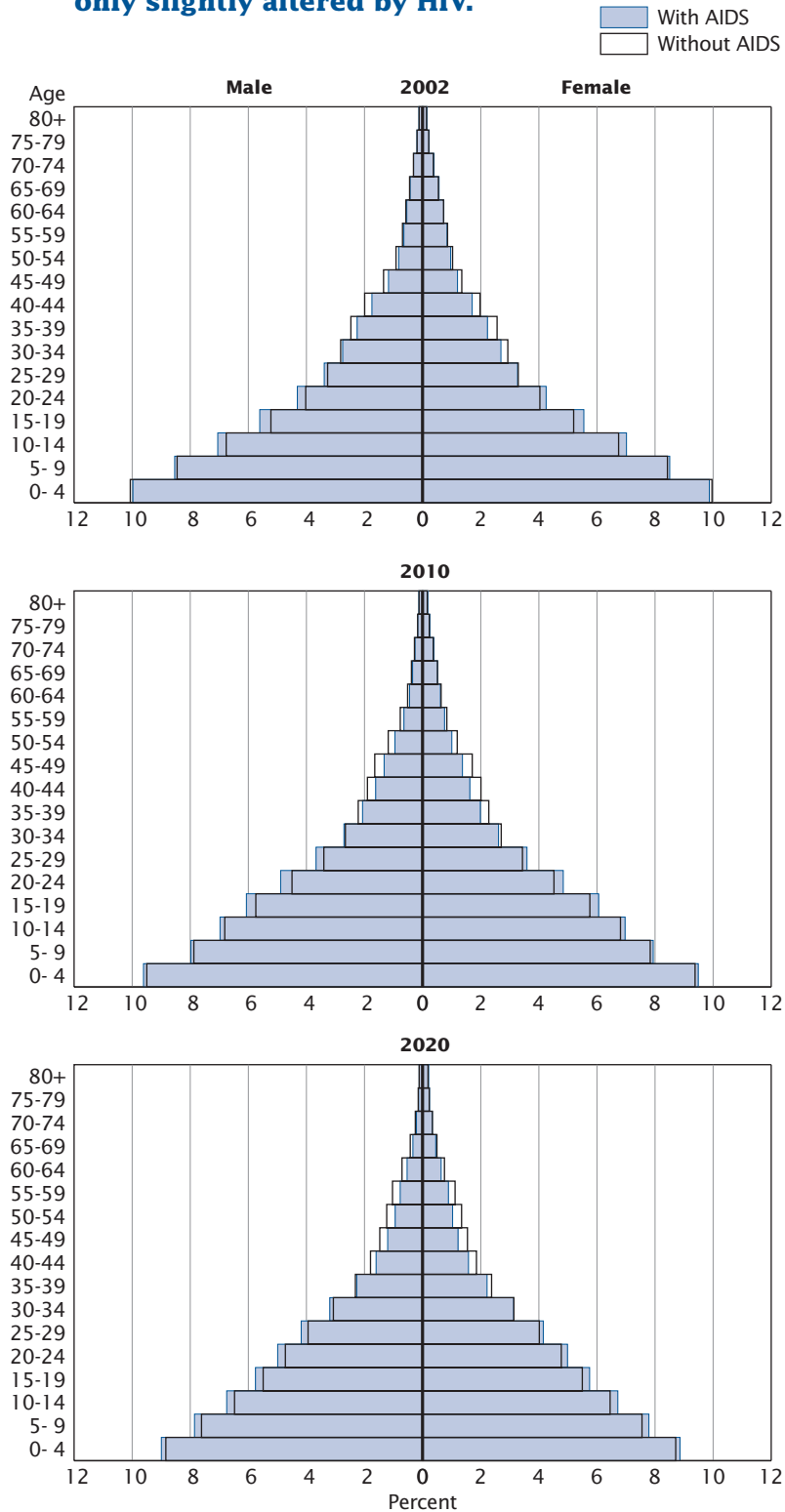
Figure 8. **Population by Age and Sex With and Without AIDS for South Africa: 2002, 2010, and 2020**  
**Population structures of badly affected countries are likely to be radically altered by HIV.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.



Figure 9.  
**Population by Age and Sex With and Without AIDS  
 for Uganda: 2002, 2010, and 2020**  
**The population structure of Uganda is probably  
 only slightly altered by HIV.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**In Countries With Moderate Epidemics, AIDS Mortality Is Likely to Have Less Effect on the Population Structure**

For example, in Uganda, the greatest relative differences in future population size by cohort are evident in the youngest age groups and among people 30-50 years of age in 2002 and 2010. However, the population pyramid maintains its traditional shape in 2020 (Figure 9).

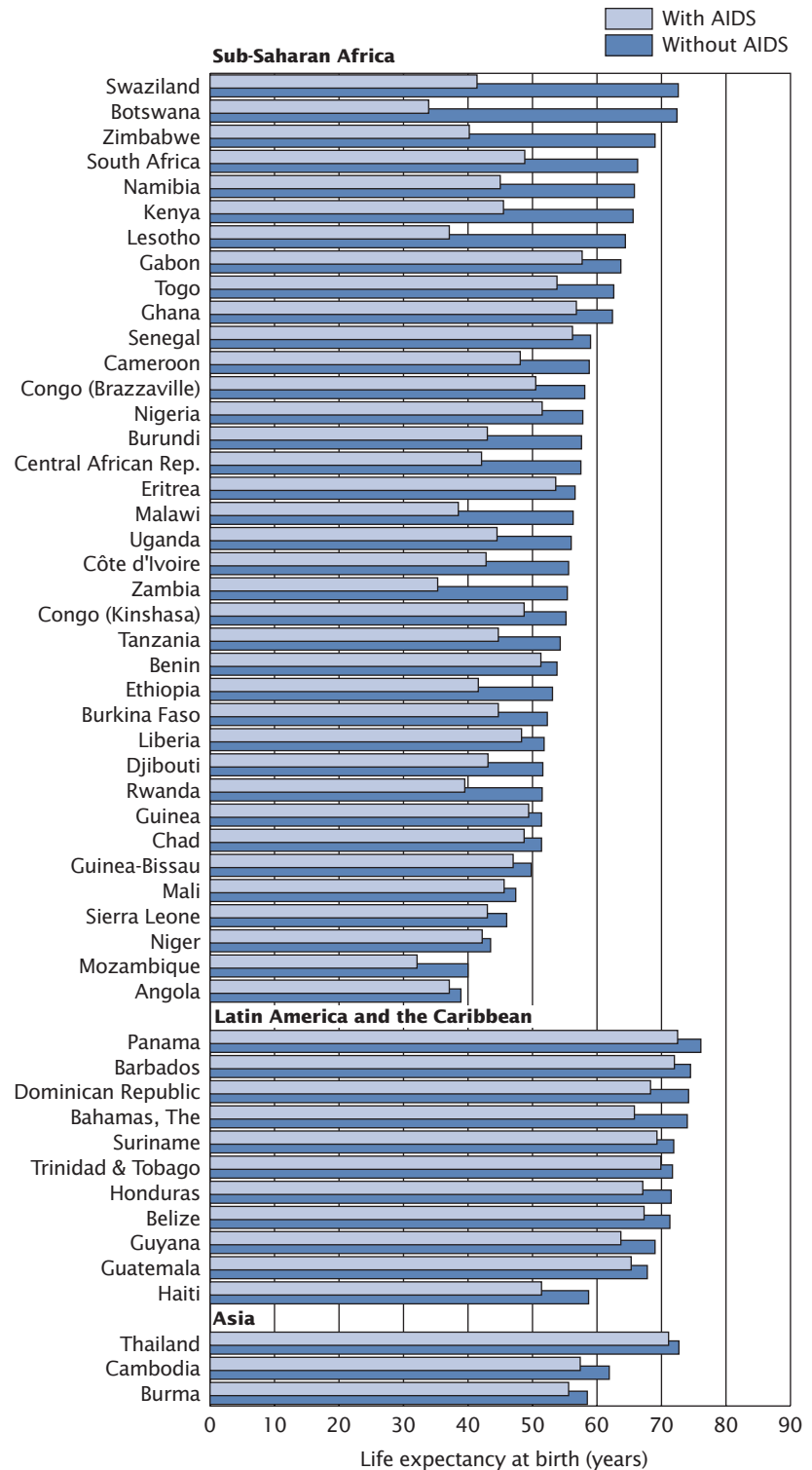
## AIDS Mortality Is Causing Falling Life Expectancies at Birth

Already, life expectancies in Sub-Saharan Africa have fallen dramatically from levels they likely would have reached without AIDS. In Botswana, life expectancy is now 34 years instead of 72. In Zimbabwe, life expectancy is 40 years instead of 69. In fact, seven countries in Sub-Saharan Africa (Angola, Botswana, Lesotho, Malawi, Mozambique, Rwanda, and Zambia) have life expectancies below 40 years. Each of the countries, except for Angola and Mozambique, would have had an estimated life expectancy of 50 years or more without AIDS (Figure 10).

In Latin America and the Caribbean, the impact on life expectancy is not as great as in Sub-Saharan Africa because of lower HIV prevalence levels. However, life expectancy is still lower than it would have been without AIDS. In the Bahamas, life expectancy is now 66 years instead of 74; in Haiti, it is 51 instead of 59.

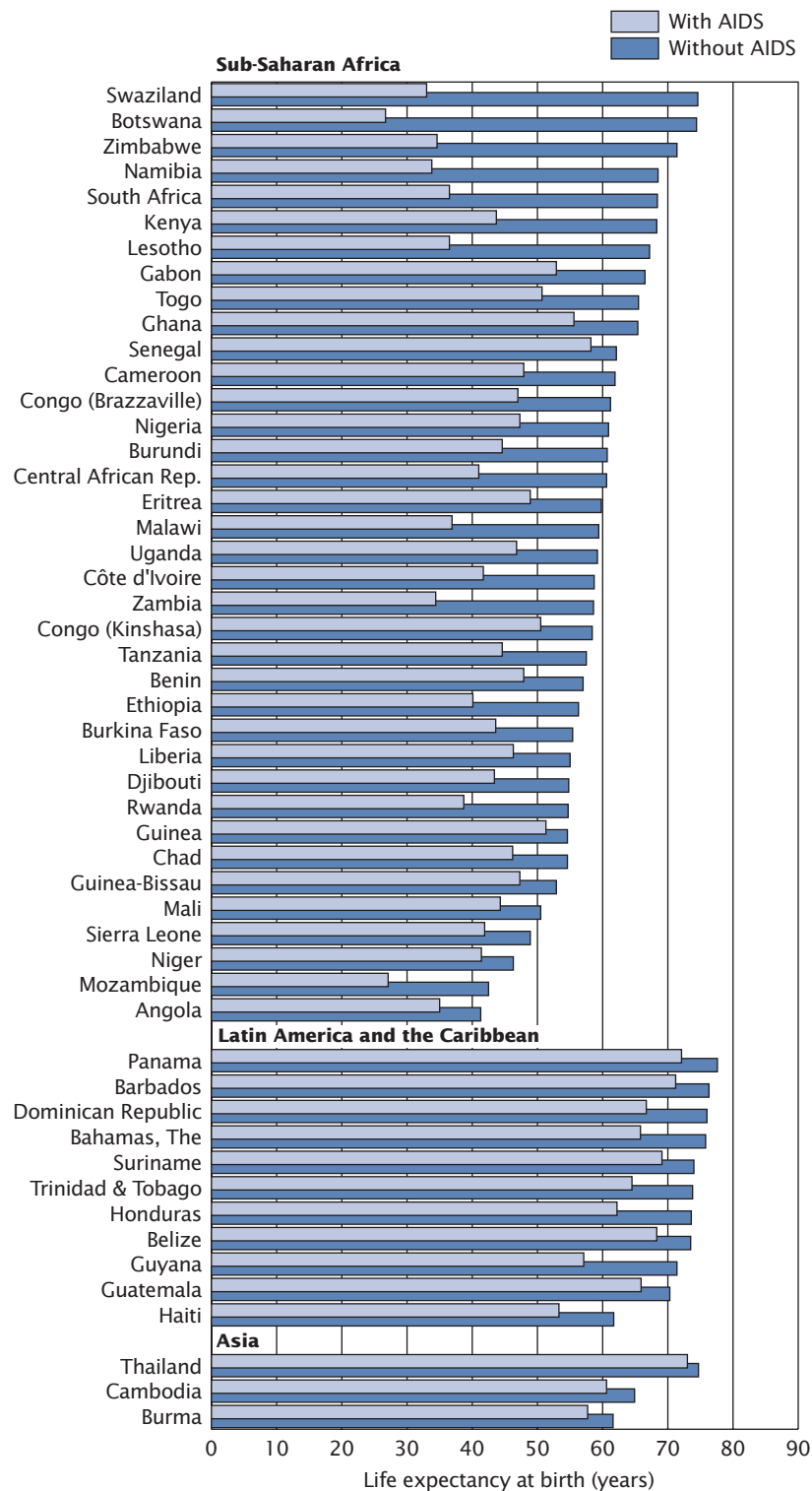
Thailand, Cambodia, and Burma have lost 2 to 5 years of life expectancy.

Figure 10.  
**Life Expectancy at Birth With and Without AIDS for Selected Countries: 2002**  
**In Botswana, nearly 40 years of life expectancy have been lost due to AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Figure 11.  
**Life Expectancy at Birth With and Without AIDS for Selected Countries: 2010**  
**By 2010, Botswana and Swaziland are likely to see life expectancy reduced by over 40 years.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**In Less Than 10 Years, Some Countries Are Projected to See Life Expectancies Fall to Near 30 Years of Age, Levels Not Seen Since the Beginning of the 20<sup>th</sup> Century**

Among countries in Southern Africa that would have approached or exceeded life expectancies of 70 years of age by 2010 in the absence of AIDS, several are likely to see life expectancies fall to around 30:

- Botswana—27 years
- Namibia—34 years
- Swaziland—33 years

Other countries are likely to see life expectancies fall to 30-40 years instead of 50-60 years (Figure 11).

By 2010, AIDS mortality is projected to continue to result in lower life expectancies in Latin America, the Caribbean, and Asia. Life expectancies are projected to be 10-14 years lower in Honduras, the Bahamas, and Guyana than they would have been without AIDS. They are likely to be 2 years lower in Thailand and 4 years lower in Cambodia and Burma.

**The Most Direct Impact of AIDS Is the Increase in the Number of Deaths in Affected Populations**

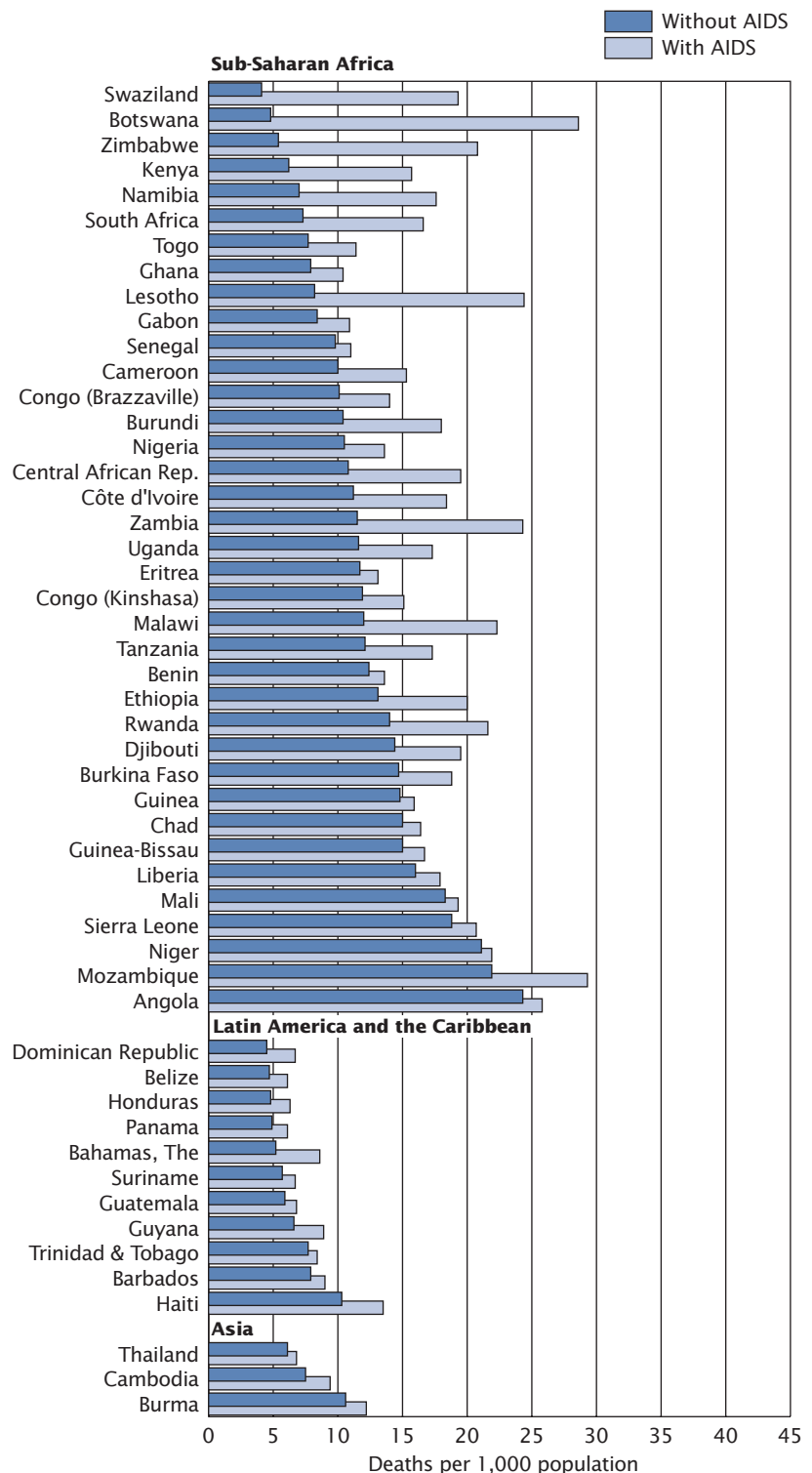
Crude death rates, the number of people dying per 1,000 population, have already been affected by AIDS.

In Africa, HIV epidemics have had their greatest impact in the eastern and the southern regions. Adult HIV prevalence is 20 percent or higher in seven countries and 10 percent to 20 percent in an additional five countries. In many of these countries, reports indicate the presence of the HIV virus since the early 1980s.

As a result of these high levels of HIV infection over several years, estimated crude death rates including AIDS mortality are greater by 50 percent to 500 percent in eastern and southern Africa over what they would have been without AIDS. For example, in Kenya, with an adult HIV prevalence of 15 percent at the end of 2001, the crude death rate in 2002 was estimated to be more than two and a half times as high (16 deaths per 1,000 population) as it would have been without AIDS (6 deaths per 1,000 population). In South Africa, with an estimated 20 percent adult HIV prevalence at the end of 2001, the crude death rate in 2002 was also over twice as high as it would have been without AIDS (17 deaths per 1,000 population compared with 7, as shown in Figure 12).

In Asia and Latin America, estimated crude death rates in 2002 were also higher than they would have been without AIDS, especially in Haiti and the Bahamas.

Figure 12.  
**Crude Death Rates With and Without AIDS for Selected Countries: 2002**  
**Crude death rates are four times as high in Zimbabwe as they would have been without AIDS.**

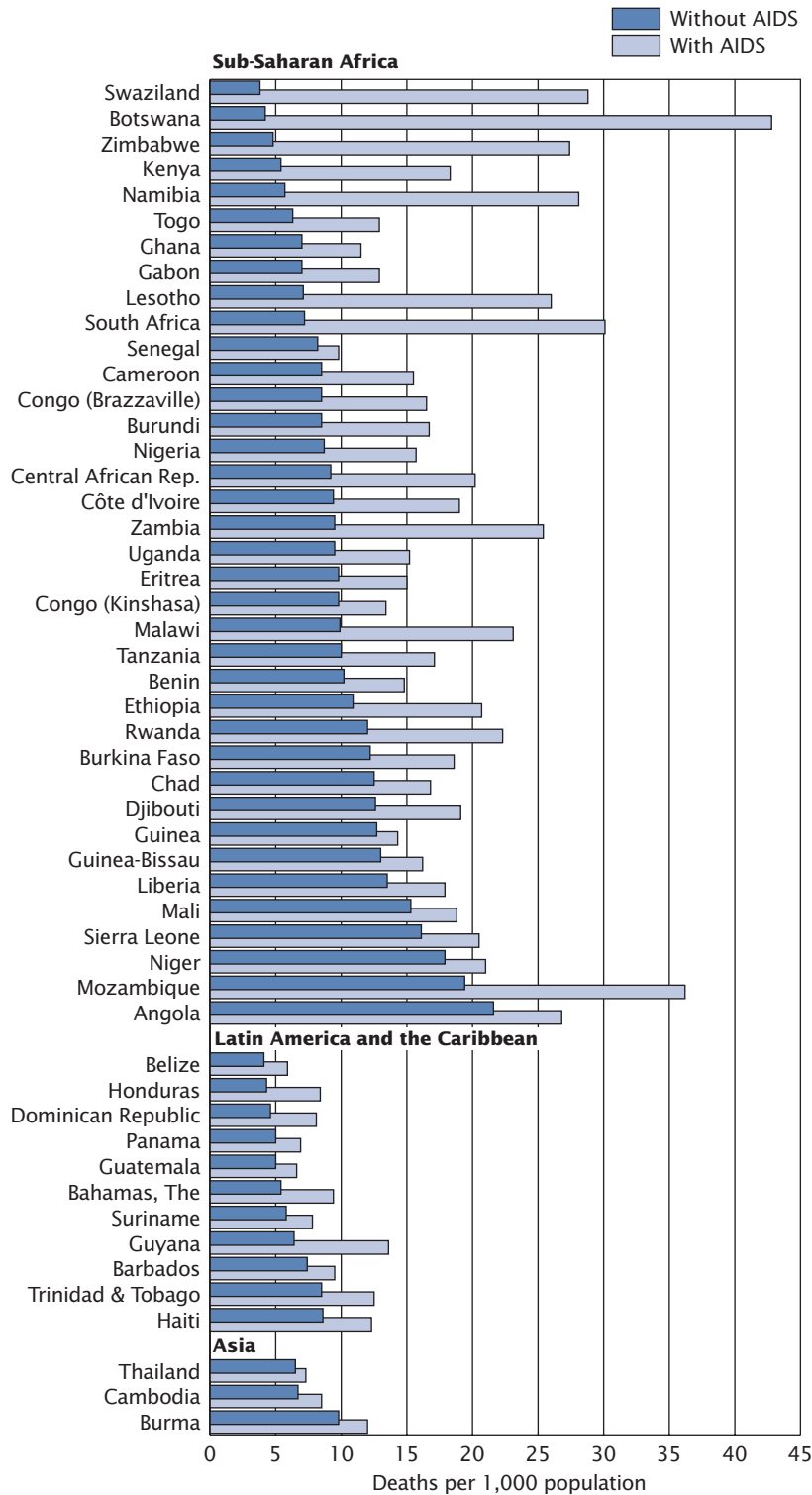


Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Figure 13.

**Crude Death Rates With and Without AIDS for Selected Countries: 2010**

**By 2010, crude death rates are projected to be ten times as high in Botswana and seven times as high in Swaziland as they would have been without AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**In Many Sub-Saharan African Countries, Crude Death Rates Are Projected To Be Higher in 2010 Than in 2002, Even Though Mortality Due to Non-AIDS Causes Is Likely to Decline**

In Botswana, the crude death rate is likely to increase from 29 deaths per 1,000 population in 2002 to 43 in 2010 (Tables 1 and 2). In South Africa, the crude death rate is likely to increase from 17 deaths per 1,000 population to 30; in Zimbabwe, from just under 21 to over 27. In the absence of the AIDS pandemic, crude death rates in 2010 for these three countries that are now projected to range from 27 deaths per 1,000 population to 43 would have ranged, instead, from 4 to 7 (Figure 13).

In Latin America and the Caribbean, Honduras and Guyana are likely to see crude death rates in 2010 twice as high as they would have been without AIDS.

In Asia, crude death rates in 2010 are projected to be somewhat higher with AIDS than they would have been without AIDS. In Thailand, the crude death rate with AIDS is likely to be just over 7 deaths per 1,000 population, or about 12 percent higher than the level without AIDS. In Cambodia, the crude death rate is expected to be between 8 and 9 deaths per 1,000 population, a level 26 percent higher than the projected level without AIDS.

**In Some Sub-Saharan African Countries, Infant Mortality Rates Are Now Higher Than They Were in 1990<sup>3</sup>**

AIDS mortality has reversed the declines in infant mortality rates that occurred during the 1980s and early 1990s. Over 30 percent of all children born to HIV-infected mothers in Sub-Saharan Africa are likely to be HIV positive, either through the birth process or due to breastfeeding. The relative impact of AIDS on infant mortality is likely to depend on both the levels of HIV prevalence in the population and the infant mortality rate from other causes. In 1990,<sup>4</sup> the infant mortality rate in Zimbabwe was 52 infant deaths per 1,000 live births; in 2002 it is 66. In South Africa, the infant mortality rate in 1990 was 51 infant deaths per 1,000; in 2002 it is 60. Without AIDS, infant mortality in Zimbabwe and South Africa would likely have been 35 infant deaths per 1,000 and 39, respectively (Figure 14).

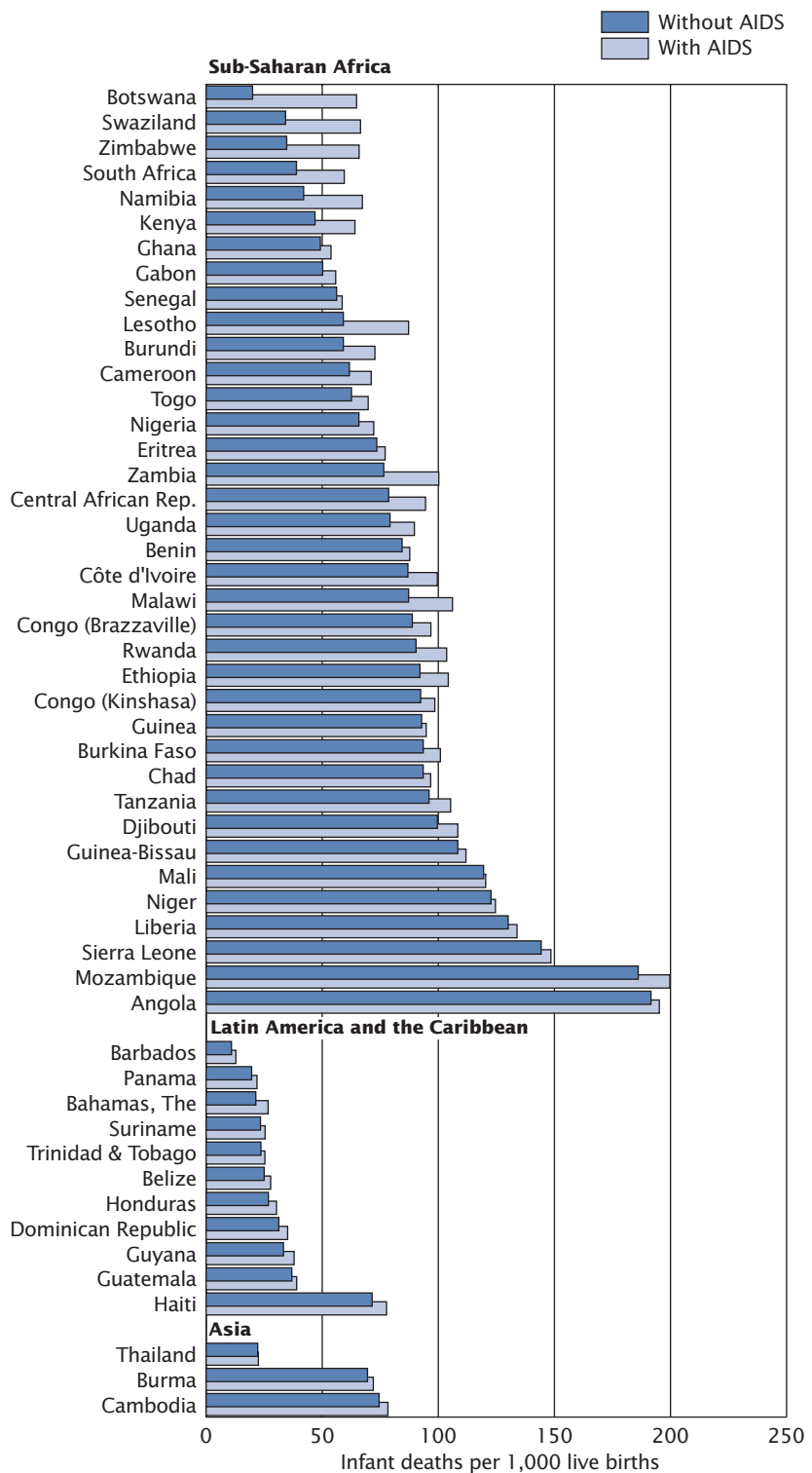
In western and central Africa, where epidemics are generally less severe, infant mortality rates are still higher than they would have been without AIDS. The increase ranges from less than 1 percent in Mali to about 13 percent in Côte d'Ivoire and Rwanda.

In countries most affected by AIDS in Latin America, the Caribbean, and Asia, infant mortality rates are also higher than they would have been without AIDS. In Latin America and the Caribbean, infant mortality rates are 2 percent to 6 percent higher. In Asia, infant mortality is less than 1 percent higher in Thailand and 4 percent higher in Cambodia.

<sup>3</sup> U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

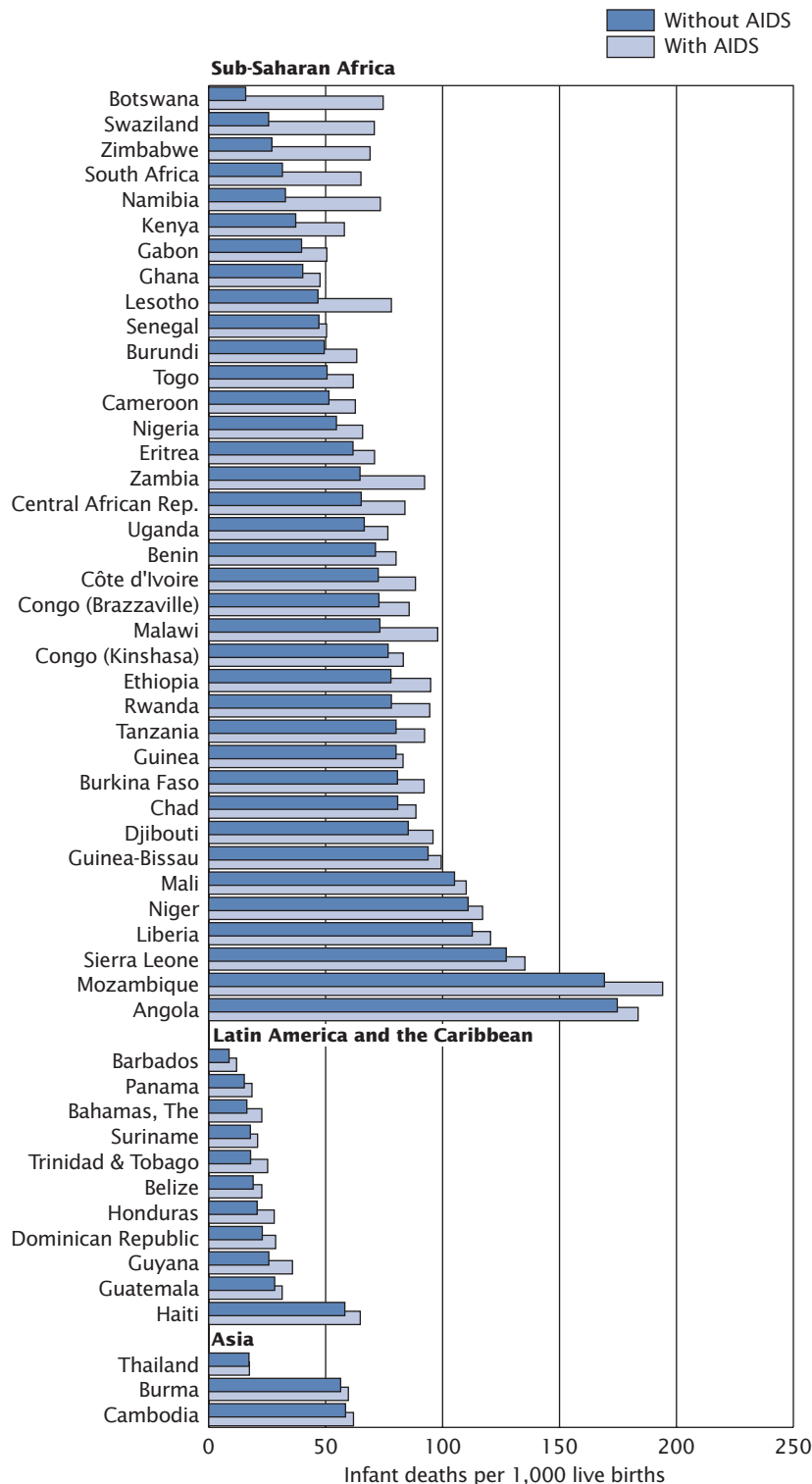
<sup>4</sup> Figures for 1990 also include AIDS mortality.

Figure 14.  
**Infant Mortality With and Without AIDS for Selected Countries: 2002**  
**AIDS doubles infant mortality in some Sub-Saharan African Countries.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Figure 15.  
**Infant Mortality With and Without AIDS for Selected Countries: 2010**  
**By 2010, nearly 60 infants out of every 1,000 live births are expected to die in Botswana from AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**In Five Countries of Sub-Saharan Africa, More Infants Are Likely to Die From AIDS in 2010 Than From All Other Causes**

In Botswana, Swaziland, and Zimbabwe, twice as many infants are likely to die from AIDS in 2010 as from all other causes; in South Africa and Namibia, more infants are likely to die from AIDS than from all other causes. In 46 of the 51 countries examined, overall infant mortality rates are projected to decline between 2002 and 2010. However, in 43 of these 46 countries, infant mortality due to AIDS is projected to increase over the same period, offsetting the greater drop that would otherwise have been achieved. Moreover, in the five countries with projected overall increases, the entire change can be attributed to increases in AIDS mortality among infants. Without the effect of AIDS, infant mortality would have been projected to decline in these countries (Figures 14 and 15).

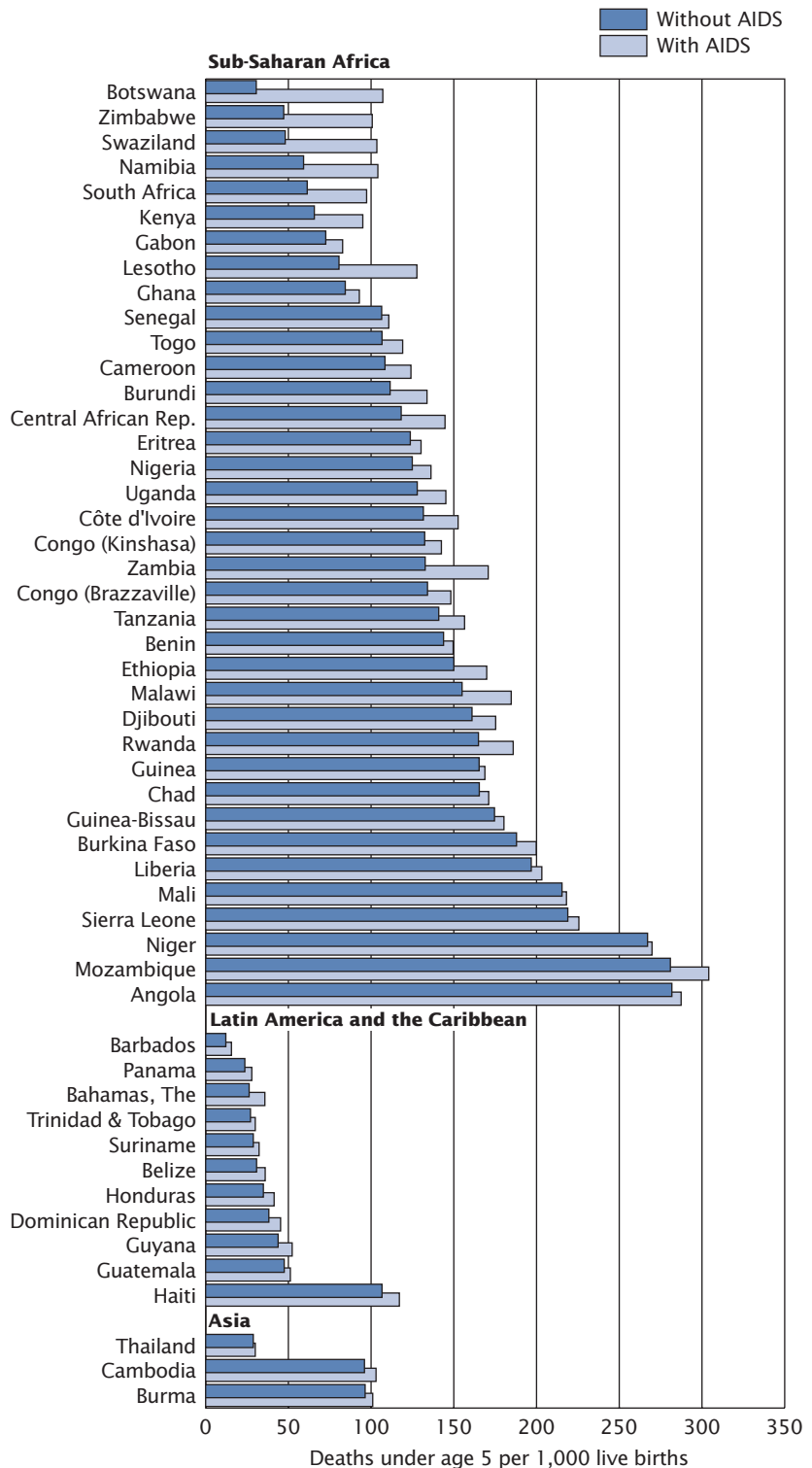
**In 37 Sub-Saharan African Countries, Under-5 Mortality Rates in 2002 Were Higher Than They Would Have Been Without AIDS**

The impact of HIV/AIDS on under-5 mortality is highest among countries that had substantially reduced under-5 mortality due to other causes and where HIV prevalence is high. Many HIV-infected children survive their first birthdays, only to die before the age of 5. In Botswana, more than 70 percent of under-5 mortality is due to AIDS. In Zimbabwe and Swaziland, over half of all deaths among children under 5 are due to AIDS (Table 1 and Figure 16).

The impact of HIV/AIDS in Latin America and the Caribbean has been generally less severe than in Sub-Saharan Africa. For the 11 seriously-affected countries in this region (shown in Table 1), AIDS contributed between 3 child deaths per 1,000 births and 11 per 1,000 in 2002. AIDS accounted for 7 percent to 27 percent of under 5-deaths occurring in these countries.

For Burma, Cambodia, and Thailand, AIDS accounted for 4 percent to 7 percent of under-5 deaths in 2002.

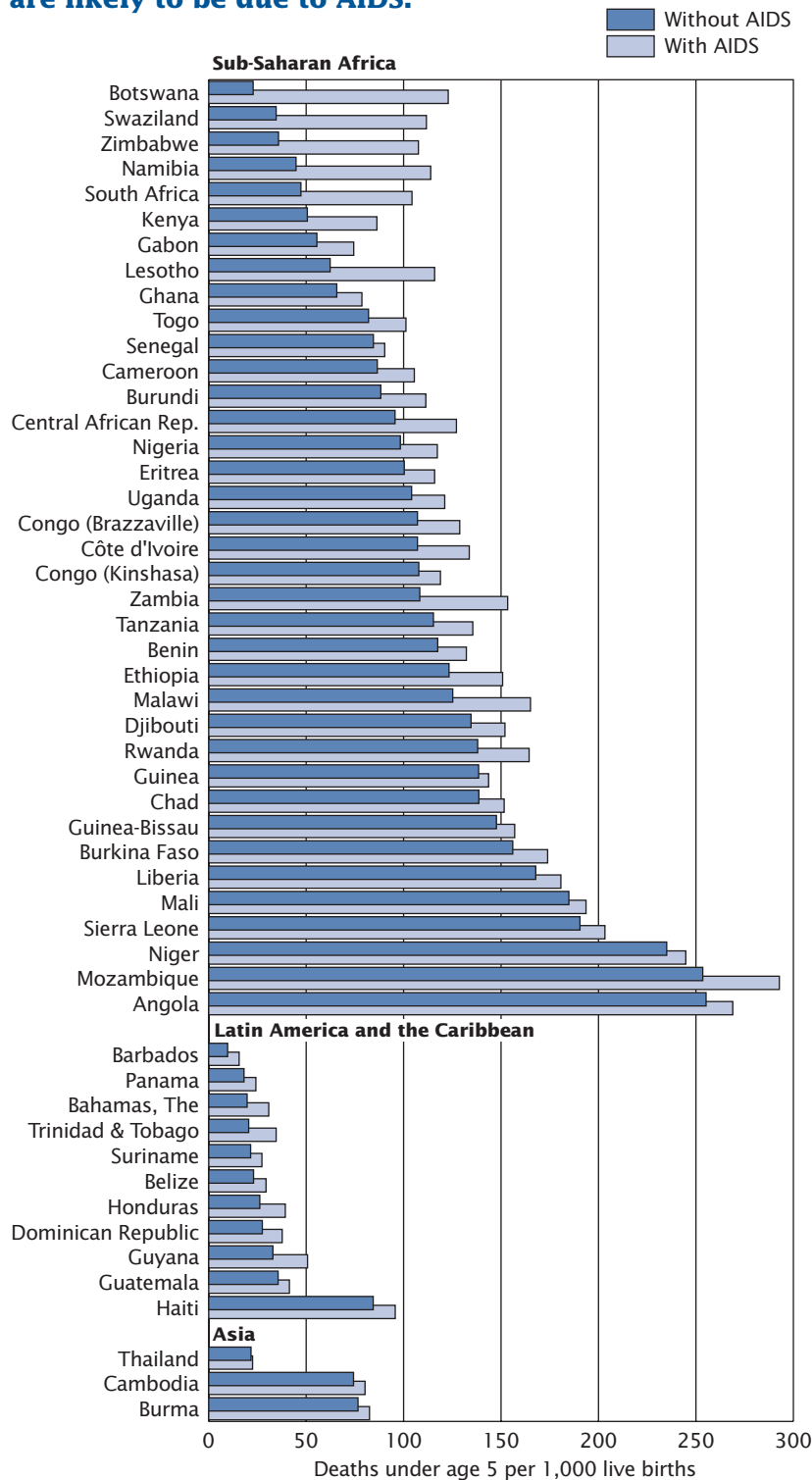
Figure 16.  
**The Under-5 Mortality Rate With and Without AIDS for Selected Countries: 2002**  
**AIDS deaths among children under 5 years of age are resulting in higher mortality rates.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.



Figure 17.  
**The Under-5 Mortality Rate With and Without AIDS  
 for Selected Countries: 2010**  
**Over 80 percent of deaths among children  
 under 5 years of age in Botswana in 2010  
 are likely to be due to AIDS.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

**In the Absence of  
 Prevention of Mother-to-Child  
 Transmission, Under-5  
 Mortality Rates in 2010 Are  
 Projected to Be Much Higher  
 With AIDS Than They Would  
 Have Been Without AIDS**

In Botswana, where under-5 mortality rates in 2010 may have been below 30 deaths per 1,000 live births without AIDS, over 120 children per 1,000 live births born are likely to die before their fifth birthday in 2010. Of that total, over 80 percent are likely to be due to AIDS. In many of the countries in southern Africa, over 50 percent of under-5 deaths are likely to be due to AIDS. In Malawi and Zambia, where under-5 mortality rates due to other causes are already high, AIDS mortality is likely to increase those rates by 30 percent or more (Figure 17).

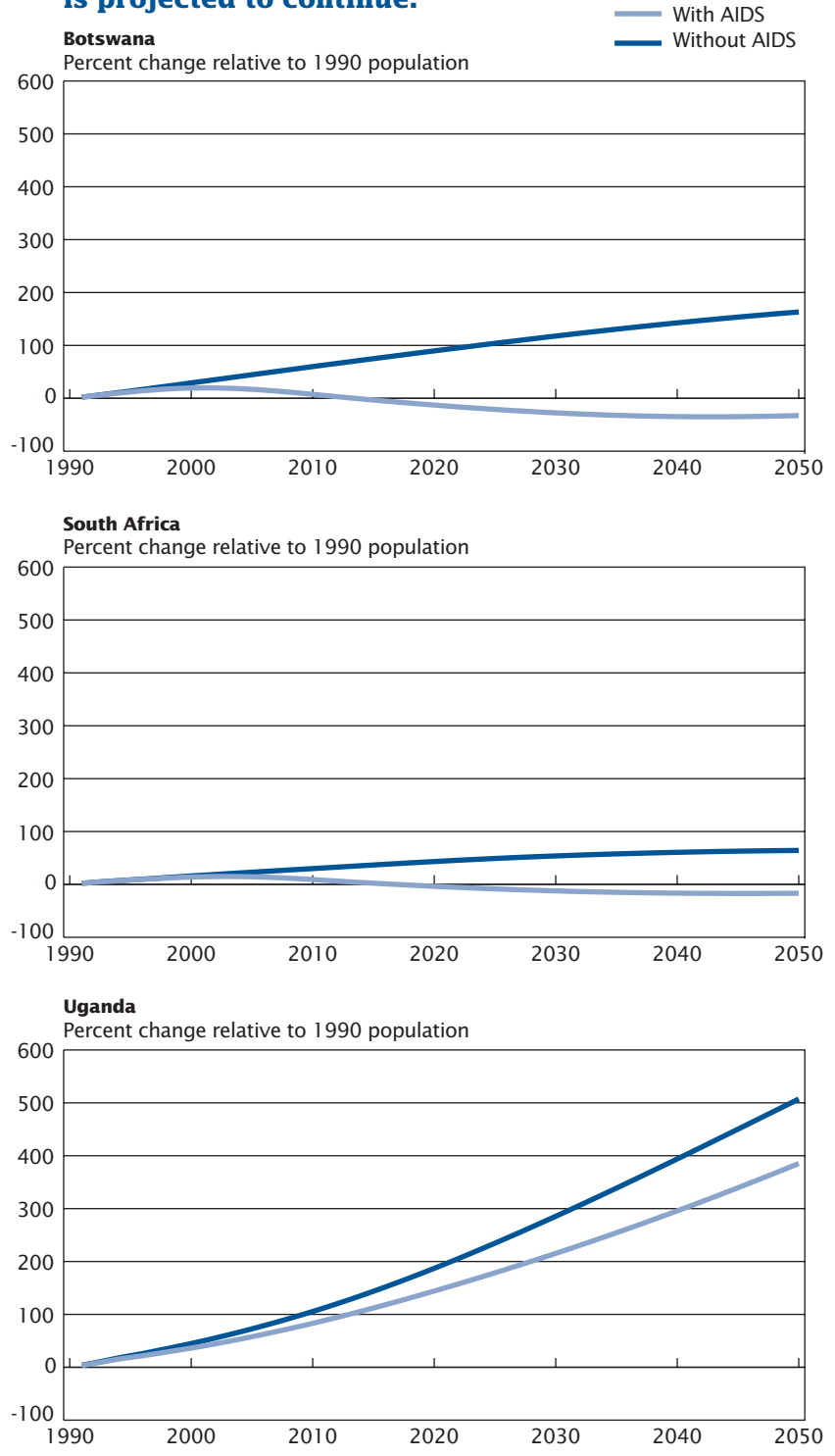
In Trinidad and Tobago, 40 percent of under-5 deaths are likely to be due to AIDS. In a number of other countries in Latin America and the Caribbean, one-third of under-5 deaths are likely to be due to AIDS.

In Burma, Cambodia, and Thailand, under-5 mortality rates are likely to be 1 percent to 6 percent higher with AIDS mortality than they would have been without AIDS.

**Populations in Most Sub-Saharan African Countries Are Projected to Increase, in Spite of the High Levels of Mortality. The Exceptions Are Botswana, Lesotho, Mozambique, South Africa, and Swaziland**

Although AIDS mortality has resulted in lower growth rates, fertility is still high and population growth is still positive in most countries affected by AIDS. Such is the case for Uganda. However, the population in the most severely affected countries, such as Botswana and South Africa, is projected to decline over time, in that the population, by 2050, is likely to be lower than it was in 1990, even if current AIDS control programs result in lowering future HIV incidence and prevalence (Figure 18).

Figure 18.  
**Change in Population of Selected African Countries With and Without AIDS: 1990-2050**  
**The populations of Botswana and South Africa are projected to decline over the next few decades whereas in Uganda, population growth is projected to continue.**



Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

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**At the Beginning of the 21<sup>st</sup> Century, AIDS Is the Number One Cause of Death in Africa and Is Number Four Globally<sup>5</sup>**

Just 20 years ago when AIDS first appeared, few would have predicted the current state of the pandemic, particularly in Sub-Saharan Africa. That over 30 percent of adults would be living with HIV/AIDS in any country was unthinkable. Yet, this is the current situation in four countries. In seven Sub-Saharan African countries, at least one out of five adults is living with HIV/AIDS and in an

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<sup>5</sup> See WHO (1999).

additional five Sub-Saharan African countries, one out of ten adults is HIV positive (UNAIDS/WHO, 2002).

Many individuals and governments have difficulty grasping the reality of these high prevalence levels, and the resulting AIDS mortality is difficult to comprehend. The magnitude of the current epidemic in HIV infection and the low likelihood of an effective vaccine or even widespread availability of therapeutic medication strongly suggest that many more millions of individuals are likely to die of AIDS over the next decade than have over the past two decades. Many of the southern African countries are only beginning to see the

impact of these high levels of HIV prevalence.

Thailand, Senegal, and Uganda are notable success stories. In Thailand and Uganda, concerted efforts at all levels of civil society have turned around increasing HIV prevalence rates. In Senegal, programs put into place early in the epidemic have kept HIV prevalence rates low. These successes can be repeated but doing so would take time. Hence, the current burden of disease, death, and orphanhood is likely to be a problem in many countries of Sub-Saharan Africa for the foreseeable future.



APPENDIX A.  
POPULATION PROJECTIONS  
INCORPORATING AIDS





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## Background

Although it has been clear for a number of years that mortality estimates and projections for many countries would have to be revised due to AIDS mortality, the lack of accurate empirical data on AIDS deaths, the paucity of data on HIV infection among the general population, and the absence of tools to project the impact of AIDS epidemics into the future have all hampered these efforts. Currently, although the accuracy of data on AIDS deaths has not substantially improved, knowledge of HIV infection has expanded and modeling tools have become available to project current epidemics into the future.

The methodology used to project AIDS mortality into the future for this report follows generally the method adopted for *World Population Profile: 1994*, *World Population Profile: 1996*, and *World Population Profile: 1998* with continuing modifications. The method consists of the following steps:

1. Establishing criteria for selecting countries for which AIDS mortality will be incorporated into the projections.
2. For each selected country, determining the empirical epidemic trend and a point estimate of national HIV prevalence.
3. Modeling the spread of HIV infection and the development of AIDS in the population, generating alternative scenarios ranging from super high to low AIDS epidemics, and producing the seroprevalence rates and AIDS-related, age-specific mortality rates which correspond to each epidemic.
4. Using the empirical levels and trends (from step 2) to establish a factor representing each country's position on a continuum between

super high and low epidemics (from step 3), and the derived factor to generate a unique interpolated epidemic curve.

5. Using weighted country total adult seroprevalence to determine the appropriate location on the interpolated total country epidemic curve from step 4. This curve establishes the likely beginning date of the epidemic in the country in question, the progression of the epidemic up to the date of the last empirical data point, and the projection of HIV seroprevalence into the future.
6. Interpolate AIDS-related mortality rates, by age and sex, associated with the estimated speed and level of HIV from epidemic results for the period 1990 to 2010.

In the sections that follow, each of these steps is described, and the method is illustrated.

### Country Selection Criteria

The International Programs Center, U.S. Census Bureau, maintains the *HIV/AIDS Surveillance Data Base*. This data base is a compilation of aggregate data from HIV seroprevalence and incidence studies in developing countries. Currently, it contains over 72,000 data items drawn from over 6,500 publications and presentations. As a part of the biannual updating of the data base, new data are reviewed for inclusion into a summary table which, for each country, lists the most recent and best study of seroprevalence levels for high- and low-risk populations in urban and rural areas.<sup>6</sup>

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<sup>6</sup> High risk includes samples of prostitutes and their clients, sexually-transmitted disease patients, or other persons with known risk factors. Low risk includes samples of pregnant women, volunteer blood donors, or others with no known risk factors. For a more complete description of the selection criteria, see U.S. Census Bureau (2002).

A review of the data in the summary table suggested that a reasonable cut-off point for selection would be countries which had reached 5 percent HIV prevalence among their low-risk urban populations, or, based on recent trends, appeared to be likely to reach this level in the near future. In addition, countries were selected that had national HIV prevalence above 1 percent, as estimated by UNAIDS for year-end 1999.

A total of 51 countries met these criteria for the incorporation of AIDS mortality in the projections. Thirty-seven of these countries were in Africa. The African countries are as follows (newly added countries in italics):

*Angola*  
Benin  
Botswana  
Burkina Faso  
Burundi  
Cameroon  
*Chad*  
Central African Republic  
Côte d'Ivoire  
Congo (Brazzaville)  
Congo (Kinshasa)  
*Djibouti*  
*Eritrea*  
Ethiopia  
Gabon  
Ghana  
*Guinea*  
*Guinea-Bissau*  
Kenya  
Lesotho  
*Liberia*  
Malawi  
*Mali*  
Mozambique  
Namibia  
*Niger*  
Nigeria  
Rwanda  
*Senegal*  
*Sierra Leone*  
South Africa  
Swaziland

Tanzania  
Togo  
Uganda  
Zambia  
Zimbabwe

Outside of Africa, the following countries met the criteria:

The Bahamas  
*Barbados*  
*Belize*  
Burma  
Cambodia  
*Dominican Republic*  
*Guatemala*  
Guyana  
Haiti  
Honduras  
*Panama*  
*Trinidad and Tobago*  
*Suriname*  
Thailand

### Empirical Epidemic Trends

For 50 of the countries meeting the selection criteria, staff members reviewed the HIV seroprevalence information available in the HIV/AIDS Surveillance Data Base to establish urban seroprevalence trends over time (Table A-1, col. 1-4) and to establish the estimated prevalence for the whole country (Table A-1, col. 5). The two data points judged to be most representative for the urban low-risk population were identified and used to calculate the annual change between the dates of the two studies. National prevalence figures were based on year-end 1999 estimates prepared by the World Health Organization and the United Nations Joint Programme on HIV/AIDS. Table A-1, column 6 contains the corresponding estimate for year-end 2001.

### Alternative Scenarios

To project the impact in the selected countries, five alternative epidemic scenarios were developed,

corresponding to low, medium, high, higher, and super high AIDS epidemics. The highest scenarios were added this round to incorporate the very explosive HIV epidemics in southern Africa, and those epidemics where there is little difference between the urban and rural HIV prevalence levels. These scenarios were developed using iwgAIDS, which is a complex deterministic model of the spread of HIV infection and the development of AIDS in a population. This model was developed under the sponsorship of the Interagency Working Group (iwg) on AIDS Models and Methods of the U.S. Department of State (Stanley et al., 1991).

All five of these epidemic scenarios incorporate increasing levels of behavior change in the form of increased condom use. This assumption corresponds to actual changes in behavior that are now beginning to occur in some countries. In addition, all five epidemics exhibit plateauing and subsequent declines in prevalence in the later stages of the epidemic, particularly in urban areas.

### Interpolation of a Unique Epidemic

The empirical urban trend from each country was used to interpolate among the five epidemic scenarios to derive an epidemic trend line matching the observed HIV seroprevalence increase between the two points. Thus, both the level and the rate of increase of the urban epidemic were matched through this procedure and resulted in an interpolation factor used in subsequent steps (Figure A-1).

### Projected Total Seroprevalence

At this point in the estimation procedure, no direct linkage has been made to the total country prevalence or to a particular calendar

year in this country's epidemic. The next step accomplishes these tasks. The total-country adult prevalence estimate (Table A-1, col. 5) was matched with the one implied using the interpolation factor. From this comparison, an "offset" figure was calculated, corresponding to the number of years of difference between the start of the epidemics in the five scenarios, and the empirical epidemic at the reference date (Figure A-2). The resulting projected epidemics for the 1990 to 2010 period for selected countries in Africa are shown in Figure A-3.

### AIDS-Related Mortality Rates

Based on the "interpolation factor" and the "offset" described above, AIDS-related age-sex-specific mortality rates ( $n^m_x$  values) at 5-year intervals from 1990 to 2010 were interpolated and added to non-AIDS  $n^m_x$  values for the same period.<sup>7</sup> Population projections were prepared with the combined  $n^m_x$  values as input, using the Rural-Urban Projection (RUP) program of the U.S. Census Bureau.

The future course of the AIDS pandemic is uncertain, but the projections require that some assumptions be made. It was assumed that the epidemics would peak in 2010, with no further growth in HIV infection after that year. AIDS mortality was assumed to decline from the level reached in 2010 to nil by 2070, thus implying a return to "normal" mortality levels in the latter year. To implement the projection process, life tables for 2070, assuming no AIDS mortality, were used.

<sup>7</sup> Non-AIDS  $n^m_x$  values were derived by making standard assumptions concerning the improvement in mortality conditions.



Table A-1.  
**Empirical Seroprevalence Data for Urban and Rural Areas for Selected Countries**

Country	Urban trend, pregnant women				Estimated percent seropositive, total country	
	Date <sup>4</sup>	Percent seropositive	Date	Percent seropositive	December 31, 1999	December 31, 2001
Angola	1995.00	1.2	1999.00	3.4	2.8	5.5
Benin	1994.50	1.1	1998.50	2.5	2.5	3.6
Botswana	1994.50	27.8	1997.30	34.0	35.8	38.8
Burkina Faso	1991.00	7.8	1996.75	10.0	6.4	6.5
Burundi	1986.00	14.7	1998.90	19.1	11.3	8.3
Cameroon	1992.60	4.0	1994.60	5.7	7.7	11.8
Chad	1995.00	2.4	1999.00	6.2	2.7	3.6
Central African Republic	1986.50	4.7	1996.50	11.7	13.8	12.9
Congo (Brazzaville)	1987.50	3.1	1993.50	7.2	6.4	7.2
Congo (Kinshasa)	1985.50	6.9	1991.50	9.2	5.1	4.9
Côte d'Ivoire	1989.50	6.0	1997.00	15.9	10.8	9.7
Djibouti <sup>3</sup>	1993.00	4.0	1995.50	6.1	6.1	(NA)
Eritrea	(NA)	(NA)	1994.00	3.0	2.9	2.8
Ethiopia	1991.00	10.7	1996.50	17.9	10.6	6.4
Gabon	1998.50	0.5	1994.50	1.7	4.2	(NA)
Ghana	1992.50	1.2	1996.50	2.2	3.6	3.0
Guinea	1990.00	1.1	1996.00	2.1	1.5	(NA)
Guinea-Bissau	1990.00	0.9	1997.00	2.5	2.5	2.8
Kenya	1992.50	14.4	1995.50	18.5	14.0	15.0
Lesotho	1991.50	5.5	1996.50	20.6	23.6	31.0
Liberia	1992.00	3.7	1993.00	4.0	2.8	(NA)
Malawi	1991.50	22.0	1995.50	27.6	16.0	15.0
Mali	1988.00	1.3	1994.00	4.4	2.0	1.7
Mozambique	1994.90	10.7	1998.90	17.0	13.2	13.0
Namibia	1991.50	4.2	1996.60	16.0	19.5	22.5
Niger	1988.00	0.5	1993.00	1.3	1.4	(NA)
Nigeria	1992.00	2.9	1994.00	5.4	5.1	5.8
Rwanda	1989.00	26.8	1992.00	28.9	11.2	8.9
Senegal	(NA)	(NA)	1991.00	0.3	1.8	0.5
Sierra Leone	1990.00	0.8	1992.00	2.0	3.0	7.0
South Africa	1994.90	6.4	1997.90	16.1	19.9	20.1
Swaziland	1993.50	21.9	1998.50	31.6	25.5	33.4
Tanzania	1986.50	3.7	1996.50	13.7	8.1	7.8
Togo	1995.50	6.0	1997.50	6.8	6.0	6.0
Uganda—High <sup>1</sup>	1987.50	24.0	1992.00	29.5	12.0	(NA)
Uganda—Low Stable <sup>1</sup>	1996.50	15.3	1997.50	14.7	8.3	5.0
Zambia	1990.00	24.5	1994.75	27.5	20.0	21.5
Zimbabwe	1990.00	23.8	1995.00	30.0	25.1	33.7
Bahamas, The	1990.50	3.0	1993.50	3.6	4.1	3.5
Barbados	1991.00	1.3	1996.00	1.1	1.2	1.2
Belize	1993.50	0.2	1995.50	2.3	2.0	2.0
Dominican Republic	1995.50	1.2	1999.50	1.7	2.8	2.5
Guatemala	1991.50	0.0	1998.50	0.9	1.4	1.0
Guyana	1990.50	1.5	1991.50	1.9	3.0	2.7
Haiti	1989.80	7.1	1993.50	8.4	5.2	6.1
Honduras	1992.35	2.0	1995.50	4.1	1.9	1.6
Panama	1993.50	0.8	1995.50	0.9	1.5	1.5
Suriname	1991.50	0.8	(NA)	(NA)	1.3	1.2
Trinidad and Tobago	1991.50	0.2	1999.50	3.4	1.1	2.5
Burma	1992.50	0.5	1997.50	<sup>2</sup> 1.4	2.0	(NA)
Cambodia	1995.75	3.0	1998.75	4.9	4.0	2.7
Thailand <sup>1</sup>	(NA)	(NA)	(NA)	(NA)	2.2	1.8

NA Data not available.

<sup>1</sup>Country-specific "modeling" was undertaken for Thailand and Uganda.

<sup>2</sup>Burma military recruit data.

<sup>3</sup>Estimated percentage shown in column 5 for Djibouti is for 1995.

<sup>4</sup>The decimal part of dates shown refers to the timing of seroprevalence estimates within calendar years. For example, 1995.00 is January 1, 1995; 1994.50 is June 30, 1994 (midyear 1994).

Source: Urban and rural data are from U.S. Census Bureau, International Programs Center, HIV/AIDS Surveillance Data Base, January 2000. Estimated seropositive percentages at the national level are from UNAIDS (2000), UNAIDS/WHO (2000), and Burton and Mertens (1998).

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### **The Special Case of Uganda**

Prevalence levels for pregnant women in major urban areas in Uganda appear to have peaked in the early 1990s, with rather dramatic declines subsequently. Infection levels of nearly 30 percent were detected in 1992; by 1996, HIV prevalence rates had declined by nearly 50 percent (Table A-1). Although discussion of the causes of these declines is still underway, it appears clear that a substantial change has occurred. Consequently, the approach described above needed to be modified to conform to the empirical evidence of declining HIV prevalence rates.

To handle this epidemiological pattern in Uganda, the 1990-2010 period was divided into a rising epidemic period (1990-1995), a transition period (1995-2005), and a period of a relatively low and stable epidemic (2005-2010). This classification is represented in Figure A-4. Mortality rates corresponding to the rising epidemic and the stable epidemic were separately derived, and the transition between the two was accomplished

by linear interpolation between the two epidemics.

### **The Special Case of Thailand**

Modeling activities have also been undertaken for Thailand with the support of the Interagency Working Group. The AIDS epidemic in Thailand has substantial injecting drug use components, while those in Africa do not (WHO/GPA, 1993). For Thailand, AIDS-related mortality rates from recent epidemiological and demographic projections (TNES-DB, 1994) were added to the non-AIDS  $n^m_x$  values for the 1990 to 2010 period.

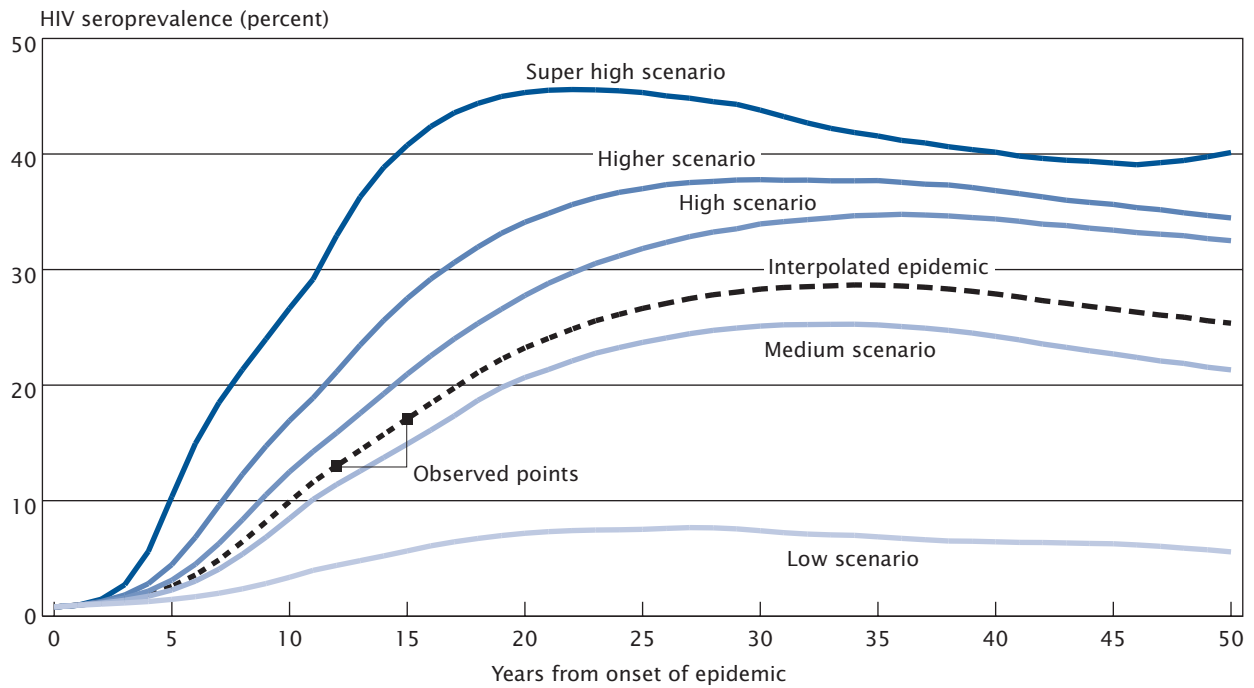
### **Caveats and Limitations**

In developing the methodology for these projections, the International Programs Center has attempted to maximize the use of both the empirical data and the modeling tools available. However, much is unknown about the dynamics of AIDS epidemics in countries around the world, and the methodology is necessarily imprecise. The actual path of AIDS epidemics in the countries that were selected will undoubtedly differ from the course projected. As epidemics

grow, future behavior changes and interventions being implemented in countries around the world may alter that course.

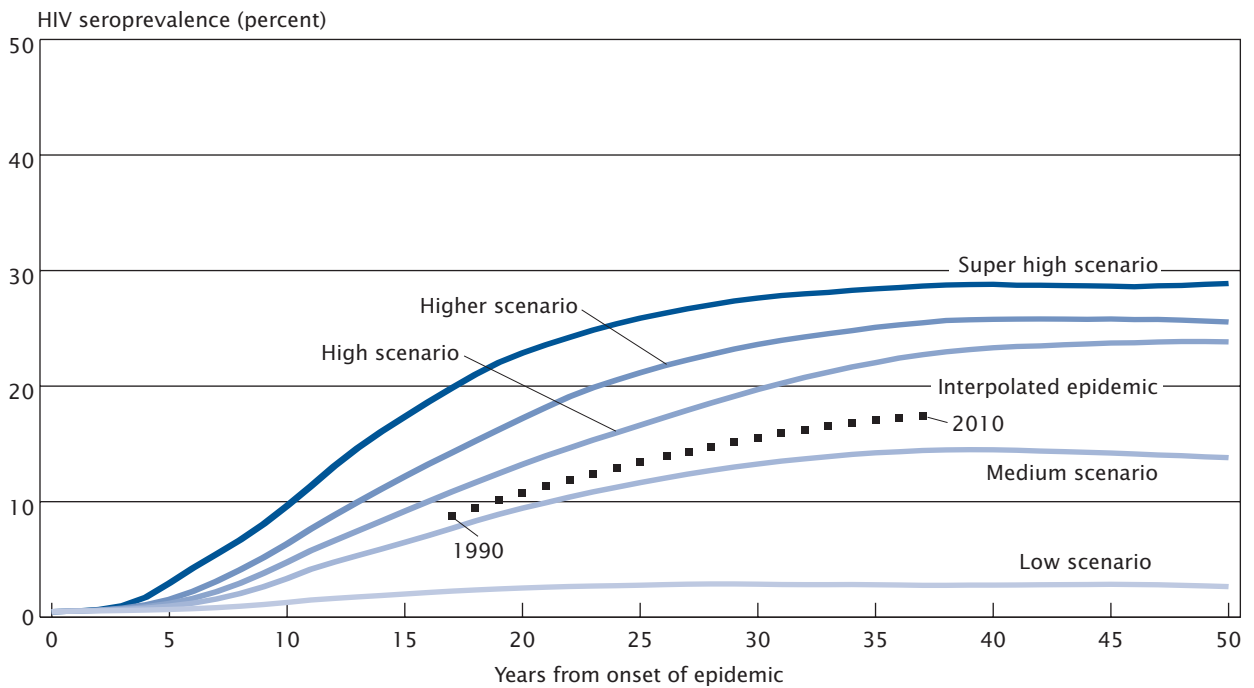
What if AIDS epidemics do not peak in 2010 as assumed? Will entire populations become infected with HIV and eventually die from AIDS? The simulations used for this report and available epidemiological and behavioral evidence suggest that this will not happen in any population. Variations in sexual behavior help to ensure that the majority of the population in countries around the world is not at high risk of HIV infection. And when substantial proportions of the population are at lower risk of infection, a plateau in HIV seroprevalence after an initial rise is likely. Indeed, some of the countries with high HIV seroprevalence levels are beginning to show evidence of this plateau effect. However, as evidenced in our projections, population declines are possible in countries with a sustained widespread epidemic, particularly in the presence of low fertility levels.

Figure A-1.  
**Scenarios and Empirical Trend: Urban Female HIV Seroprevalence**



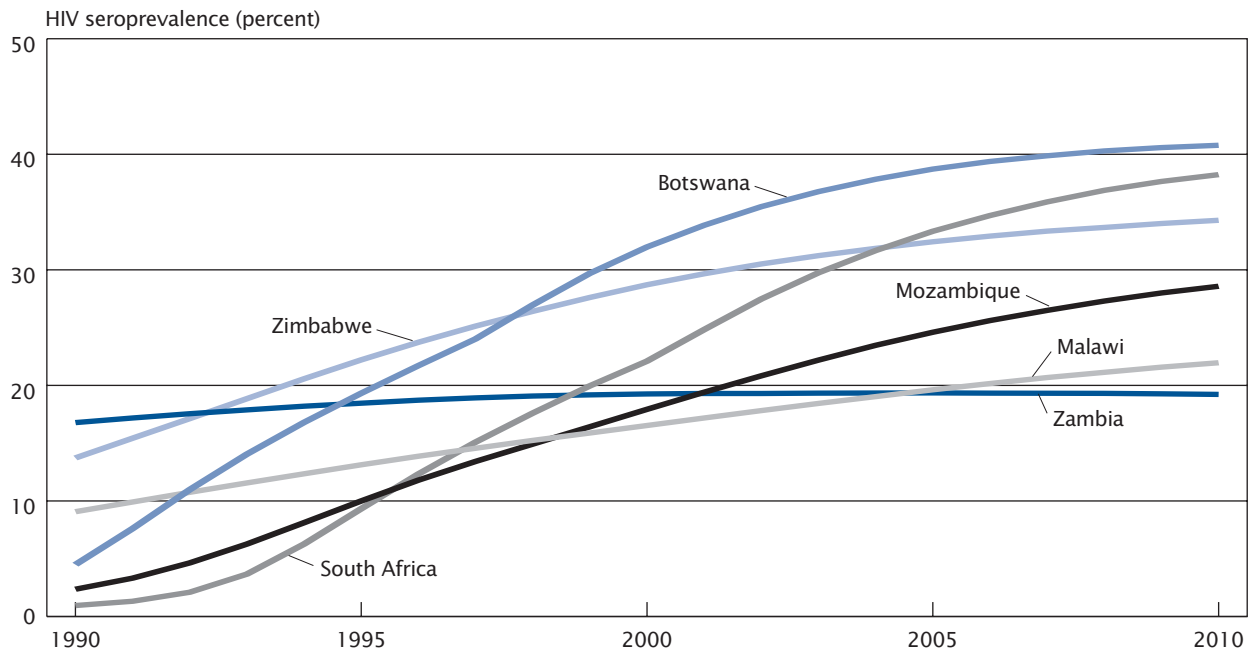
Note: For assumptions, see text of Appendix A.  
 Source: U.S. Census Bureau, International Programs Center, unpublished tables.

Figure A-2.  
**Five Scenarios and Empirical Trend: Total Female HIV Seroprevalence**



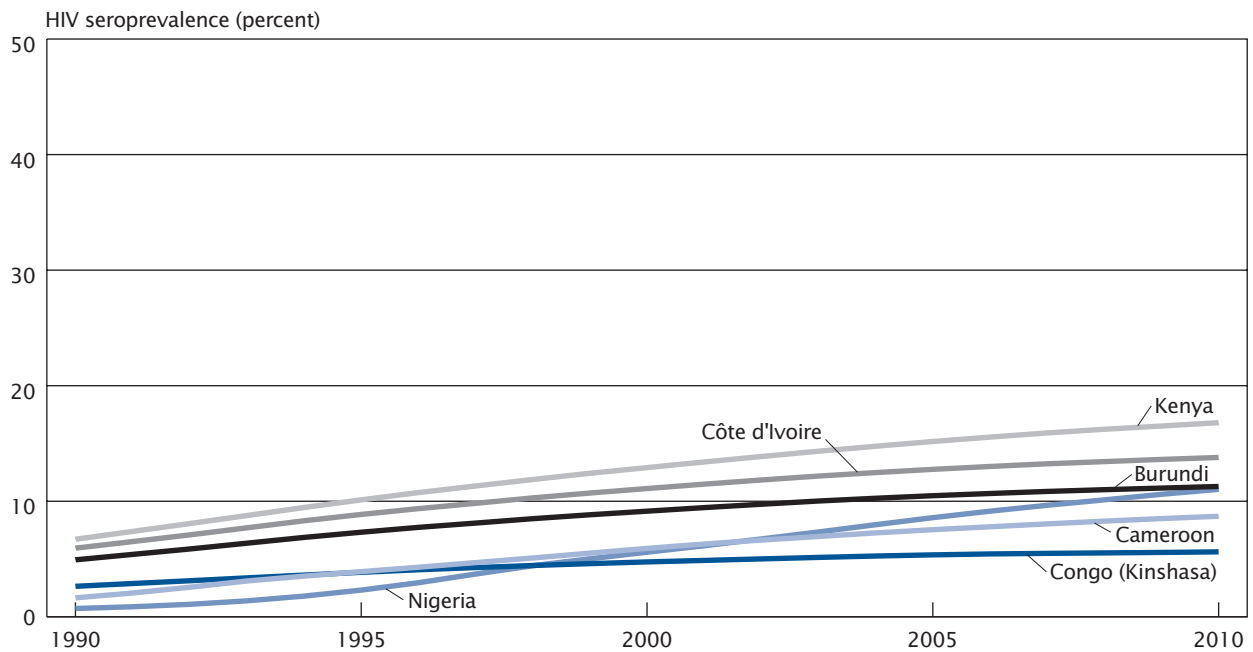
Note: For assumptions, see text of Appendix A.  
 Source: U.S. Census Bureau, International Programs Center, unpublished tables.

Figure A-3a.  
**Projected HIV Seroprevalence for Selected Countries of Africa: 1990-2010**



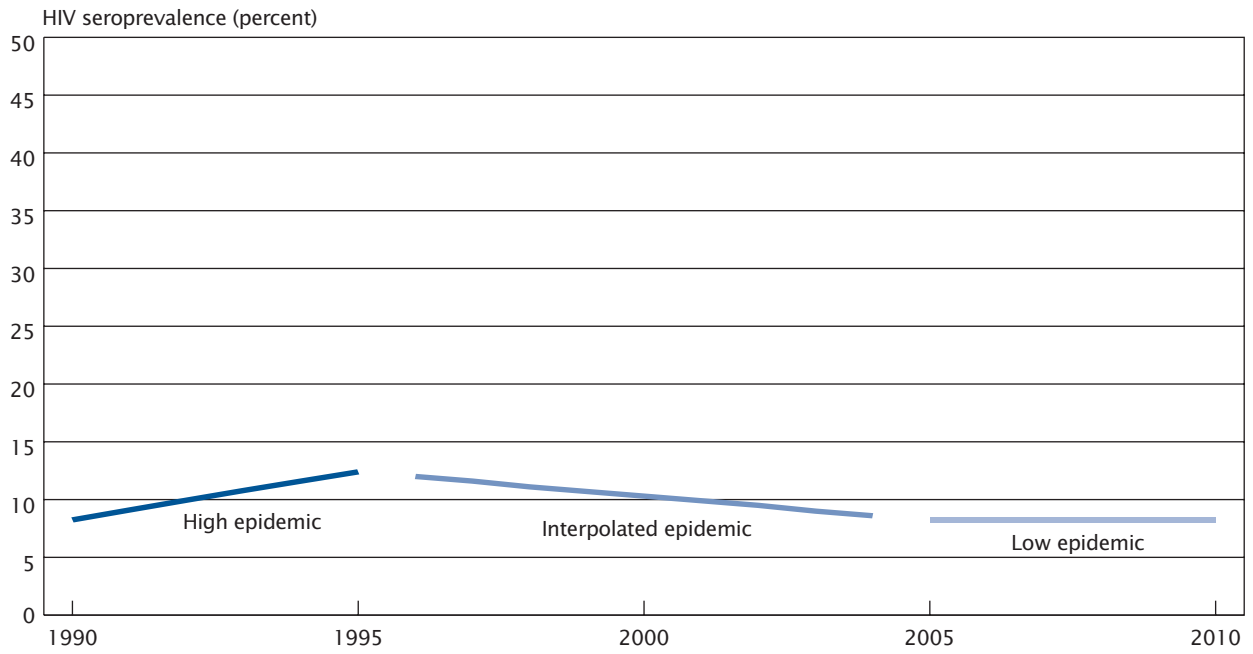
Note: For assumptions, see text of Appendix A.  
 Source: U.S. Census Bureau, International Programs Center, unpublished tables.

Figure A-3b.  
**Projected HIV Seroprevalence for Selected Countries of Africa: 1990-2010**



Note: For assumptions, see text of Appendix A.  
 Source: U.S. Census Bureau, International Programs Center, unpublished tables.

Figure A-4.  
**Projected HIV Seroprevalence for Uganda: 1990-2010**



Note: For assumptions, see text of Appendix A.  
Source: U.S. Census Bureau, International Programs Center, unpublished tables.



## APPENDIX B. REFERENCES







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## APPENDIX C. GLOSSARY





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**Age structure.** The distribution of a population according to age, usually by 5-year age groups.

**Age-specific fertility rate.** The number of births during a year to women in a particular age group, usually per 1,000 women in a 5-year age group at midyear.

**AIDS.** Acquired immune deficiency syndrome.

**Birth rate.** The average annual number of births during a year per 1,000 population at midyear. Also known as the crude birth rate.

**Crude birth rate.** See birth rate.

**Crude death rate.** See death rate.

**Death rate.** The average annual number of deaths during a year per 1,000 population at midyear. Also known as the crude death rate.

**Growth rate.** The average annual percent change in the population, resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country. The rate may be positive or negative. Also known as population growth rate or average annual rate of growth.

**HIV.** Human immunodeficiency virus. The virus that causes AIDS.

**Infant mortality rate.** The number of deaths of infants under 1 year of age from a cohort of 1,000 live births. Denoted  ${}_1q_0$  or IMR, it is the probability of dying between birth and exact age 1.

**iwgAIDS.** Interagency Working Group on AIDS.

**Life expectancy at birth.** The average number of years a group of people born in the same year can be expected to live if mortality at each age remains constant in the future.

**Natural increase.** The difference between the number of births and the number of deaths.

**Pandemic.** A global epidemic.

**Projections.** Data on population and vital rates derived for future years based on statistics from population censuses, vital registration systems, or sample surveys pertaining to the recent past, and on assumptions about future trends.

**Rate of natural increase.** The difference between the crude birth rate and the crude death rate.

**Sentinel surveillance.** Surveillance conducted through “watchpost” sites that provide access to populations that are of particular interest or represent a larger population.

**Seroprevalence.** The percentage of a population testing positive for infection in a blood test. In the context of this report, the percentage testing positive for antibodies to HIV.

**Total fertility rate.** The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates.

**Under-5 mortality.** Number of deaths of children under 5 years of age from a cohort of 1,000 live births. Denoted  ${}_5q_0$ , it is the probability of dying between birth and exact age 5.

**UNAIDS.** United National Joint Programme on HIV/AIDS.

**Vital events.** Births and deaths.

**Vital rates.** Birth rates and death rates.

**WHO.** World Health Organization.

**WHO/GPA.** World Health Organization/Global Programme on AIDS.



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Population Division, U.S. Census Bureau

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