

# Projecting the Demographic Impact of HIV/AIDS in the 21<sup>st</sup> Century: Alternative Scenarios

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## Extended abstract

Without question, the impact of AIDS on mortality and population in highly affected countries is severe. However, reliable and detailed data are scarce, both on the prevalence of HIV at the national level and on survival of HIV-infected individuals. The United Nations Population Division faces the challenge of projecting national populations to the year 2050 in the face of great uncertainty about both the present situation and future prospects of the HIV epidemic. This paper examines the projected impact of HIV/AIDS on mortality, population growth, and population structure. In addition to the published results of the medium variant of the *2002 Revision of World Population Prospects*, we present several scenarios with alternative assumptions about various aspects of the course of the epidemic.

### *Data and Methods*

Data are taken from the *2002 Revision of World Population Prospects*, the biennial population projections produced by the United Nations Population Division. The impact of HIV/AIDS was explicitly modelled for 53 countries. In most of these countries, HIV prevalence in 2001 was estimated to be 2 per cent or more among the population aged 15-49. In addition, a few populous countries with lower prevalence levels were included because they had a large number of persons living with HIV (more than one million persons). Of the 53 countries, 38 are in Saharan Africa (Angola, Benin, Botswana, Burundi, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Malawi, Mali, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe), five in Asia (Cambodia, China, India, Myanmar and Thailand), eight in Latin America and the Caribbean (Bahamas, Belize, Brazil, Dominican Republic, Guyana, Haiti, Honduras, Trinidad and Tobago), and one each in Europe (Russian Federation) and Northern America (United States of America). Of the 37.1 million adults in the world infected by HIV by 2001, 34.6 million or 93 per cent resided in these 53 countries (UNAIDS, 2002).

The estimates of national HIV prevalence among the population aged 15-49 in 2001 are from UNAIDS (2002). The past trajectory and future course of the epidemic are estimated and projected using a four-parameter epidemiological model developed by the UNAIDS Reference Group on Estimates, Modelling and Projections (2002), with the addition of a dynamic demographic component. The four parameters defining the epidemic curve are  $t(0)$ , the starting point of the epidemic;  $f(0)$  the initial fraction of the adult population that is considered to be at risk of HIV infection;  $r$ , the reproductive factor; and  $\phi$ , which describes recruitment into the high-risk group. A survival curve based on evidence from cohort studies determines the length of

time between infection with HIV and death. A separate curve describes the mortality of children who are infected through mother to child transmission.

To obtain mortality estimates at the population level, a hypothetical No-AIDS scenario is developed for each country to estimate background mortality risks for uninfected individuals. Beginning at  $t(0)$ , estimates of annual infections by age and sex are produced and cohorts of infected individuals are followed subject to competing risks of non-AIDS and AIDS mortality.

In the *2002 Revision*, the Population Division assumes that  $r$  and  $\phi$ , as fitted to the prevalence estimates up to 2001, will remain constant until 2010. Beginning in that year, behavioural interventions are assumed have an impact that produces a gradual, sustained decline in these parameters, and thus in the incidence and prevalence of HIV, until the end of the projection period in 2050.

In addition, several “illustrative scenarios” were produced to explore the potential effect of different interventions on the mortality impact of AIDS. These scenarios, which have not yet been published, were obtained by assuming the effect that interventions would have on either the behavioural parameters of the model or the survival curve. The alternatives include a high scenario, in which no behavioural changes are assumed and the epidemic remains at a relatively constant endemic level; a treatment scenario, in which survival from infection to death is extended by 50 per cent; and a scenario in which an “instant vaccine” puts an immediate stop to the spread of infection.

## *Results*

Summary results of the demographic impact of AIDS have been published in the *2002 Revision Highlights* (United Nations, 2003a), and detailed results are available on CD-ROM (United Nations, 2003b) and in an upcoming analytical volume (United Nations, forthcoming). In this paper, I plan to highlight key results from the medium variant showing the devastating impact of AIDS on mortality. For example, in 2000-2005, life expectancy in the 7 most-affected countries (those with HIV prevalence greater than 20 per cent in 2001) is projected to be 22 years lower than it would have been in the absence of AIDS. By 2010-2015, this difference will rise to 29 years. In four countries – Botswana, Lesotho, South Africa, and Swaziland – total population in 2050 is projected to be lower than the population in 2000 as a result of AIDS.

However, the focus of the paper will be on the alternative scenarios and their implications for mortality and population structure. While a full analysis has not yet been completed, initial examination of the scenarios shows, for example, that the treatment scenario brings only marginal gains in life expectancy at the national level. In the “instant vaccination” scenario, life expectancy eventually returns to the level projected in the absence of AIDS; however, the population effects of current infections carry through for many decades. The “instant vaccination” scenario is intended as an extreme scenario. Additional scenarios may be formulated to look at different, more likely combinations of prevention and treatment options.

## *References*

UNAIDS (2002). *Report on the Global HIV/AIDS Epidemic, June 2002*. Geneva: Joint United Nations Programme on HIV/AIDS.

UNAIDS Reference Group on Estimates, Modelling and Projections (2002). Improved methods and assumptions for estimation of the HIV/AIDS epidemic and its impact: Recommendations of the UNAIDS Reference Group on Estimates, Modelling and Projections. *AIDS* (June 14) 2002, **16**:W1-W14.

United Nations (2003a). *World Population Prospects: The 2002 Revision, Highlights*. ESA/P/WP.180

United Nations (2003b). *World Population Prospects: The 2002 Revision, CD-ROM*.

United Nations (forthcoming). *World Population Prospects: The 2002 Revision, vol. III: Analytical Report*.