Supplementary material to manuscript:

The impact of antiretroviral treatment on the age composition of the HIV epidemic in sub-Saharan Africa

General model structure

We used STDSIM, a stochastic microsimulation model of the transmission and control of HIV and other sexually transmitted infections (STIs) [1-4]. The model simulates the life course of individuals in a dynamic network of sexual contacts. Events like partnership formation or the acquisition of infections are the result of random processes, determined by probability distributions. Therefore, the results of the model are subject to stochastic variation. It is necessary to perform multiple runs and average the results to diminish the stochasticity in predictions.

The model consists of four modules: *demography*, *sexual behaviour*, *transmission and natural history*, and *interventions*. The demography module implements the processes of birth, death, and migration. Processes for initiation and dissolution of sexual relationships, for mixing according to age preference, for sexual contacts within relationships and for sexual contacts between clients and sex workers are defined in the sexual behaviour module. In the transmission and natural history module, transmission probabilities per sexual contact are specified for HIV and other simulated STIs. Finally, the interventions module specifies the timing and effectiveness of control measures in curbing transmission or enhancing survival. Model runs start in the year 1910 with a fixed population size. The country-specific background age-specific fertility and mortality rates create a population of about 20,000 to 50,000 in 2010. This modelled population size needs to be extrapolated to observed

population sizes. In order to do this, we divide the population size in 2010 as reported by the United

Nations World Population Prospects (2010 revision) [5] by the modelled population size in 2010, and

apply the obtained ratio to all years. Figure S4 shows that the resulting population projections of the

model compared to the UN world population prospects are highly similar.

Further details about the general model structure can be found in van der Ploeg *et al* [4], Korenromp *et

al* [2], and Orroth *et al* [3]. The modeling of antiretroviral therapy (ART) is described by Hontelez *et

al* [1,6]. This document contains tables S1 and S2, and figures S1 to S3.

REFERENCES

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3. Orroth KK, Freeman EE, Bakker R, Buve A, Glynn JR, Boily MC*, et al.* Understanding the differences between contrasting HIV epidemics in east and west Africa: results from a simulation model of the Four Cities Study. Sex Transm Infect 2007; **83 Suppl 1**: i5-16.

4. van der Ploeg CPB, Van Vliet C, De Vlas SJ, Ndinya-Achola JO, Fransen L, van Oortmarssen GJ*, et al.* STDSIM: A Microsimulation Model for Decision Support in STD Control. Interfaces 1998; **28**: 84-100.

5. UNDP (2010) International Human Development Indicators. United Nations Development Programme.

6. Hontelez JA, Lurie MN, Newell ML, Bakker R, Tanser F, Barnighausen T*, et al.* Ageing with HIV in South Africa. AIDS 2011; **25**: 1665-1667.

7. Williams BG, Lloyd-Smith JO, Gouws E, Hankins C, Getz WM, Hargrove J*, et al.* The potential impact of male circumcision on HIV in Sub-Saharan Africa. PLoS Med 2006; **3**: e262.

8. UNAIDS (2010) Report on the Global AIDS epidemic 2010. Geneva: UNAIDS.

9. Mutevedzi PC, Lessells RJ, Rodger AJ, Newell ML. Association of age with mortality and virological and immunological response to antiretroviral therapy in rural South African adults. PLoS One 2011; **6**: e21795.

10. UN (2010) World Population Prospects, the 2010 revision. Geneva: United Nations Population Division.

Figure S1. Life-expectancy remaining at ART initiation by CD4 cell count, model prediction versus data. Source for data: Mutevedzi*et al*[9]
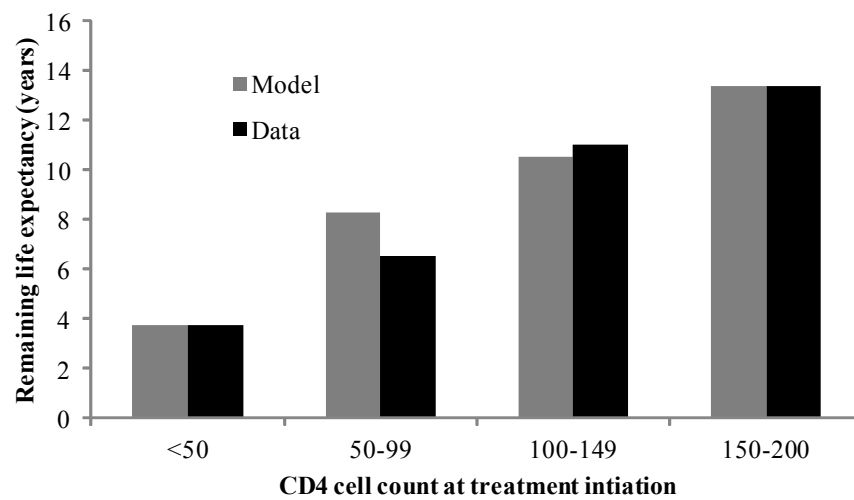
Figure S2. Country specific survival corrected for HIV mortality. A. Women; B. Men. Each line represents a country.
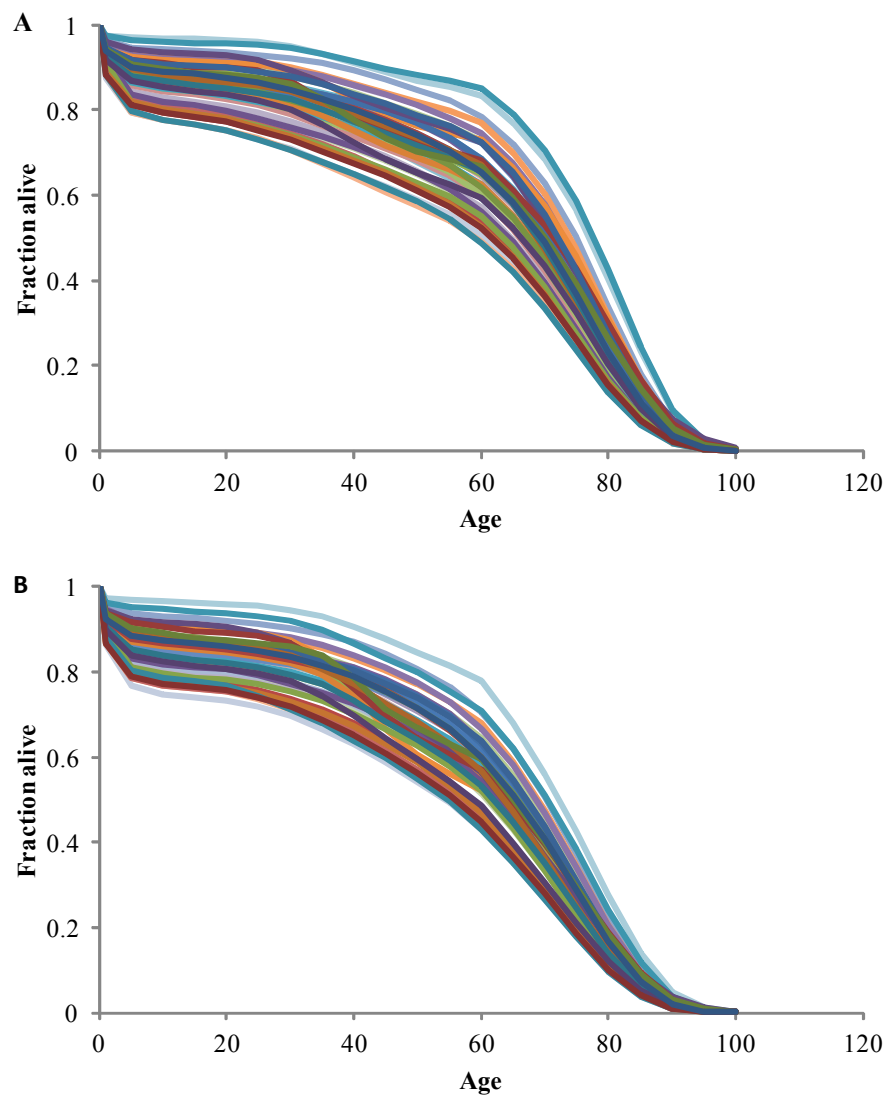
Figure S3. Trends in population size for the population aged 15-49 and 50+ in sub-Saharan Africa, model predictions versus UN projections. UN projections represent the UN population prospects 2010 update. We used the 'medium' variant population projections for comparison [10].
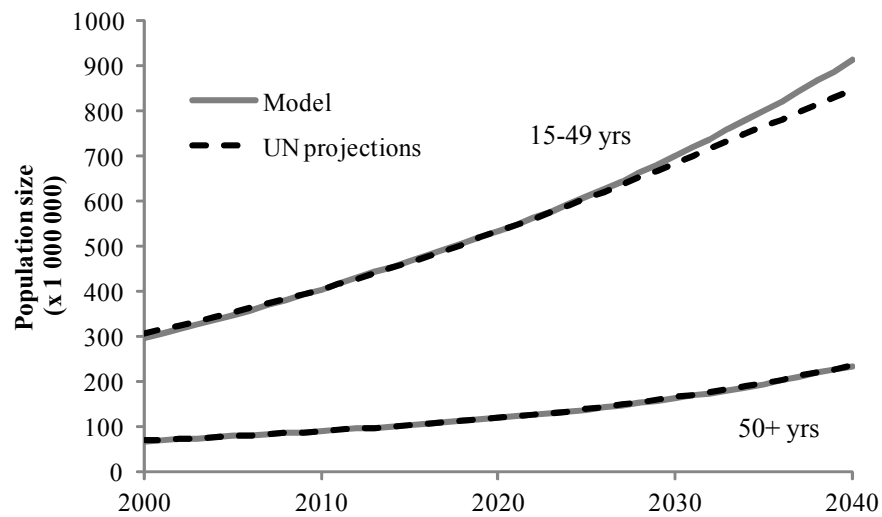
Table S1. Sexual behaviour profiles. Profiles based onOrroth*et al.*[3], with modifications explained in the main text.

	Sexual behaviour Profile				
	Concentrated	*Concentrated (low condom use)*	*Mixed*	*Mixed (low condom use)*	*Generalized*
Age at sexual debut (range)					
Men	18 yrs (±3 yrs)	18 yrs (±3 yrs)	17 yrs (±3 yrs)	17 yrs (±3 yrs)	17 yrs (±3 yrs)
Women	18 yrs (±4 yrs)	18 yrs (±4 yrs)	17 yrs (±4 yrs)	17 yrs (±4 yrs)	15 yrs (±4 yrs)
Proportion in a stable relationship					
Men (aged 15-49)	40%	40%	44%	44%	53%
Women (aged 15-49)	43%	43%	34%	34%	66%
Portion of men with 2+ partners in last 12 months					
Baseline	36%	36%	50%	50%	55%
+25% partner change rates	39%	39%	53%	53%	58%
-25% partner change rates	33%	33%	46%	46%	51%
Commercial sex					
Number of clients per week	4	4	2	2	1.6
Proportion of men visiting sex workers (no. visits/year)					
Married	24% 2/year; 0.5% 24/year	24% 2/year; 0.5% 24/year	29% 4/year; 5% 24/year	29% 4/year; 5% 24/year	28% 4/year; 6% 24/year
Unmarried	48% 2/year; 10% 24/year	48% 2/year; 10% 24/year	60% 4 /year; 11% 24/year	60% 4 /year; 11% 24/year	55% 4 /year; 11% 24/year
Proportion of women being sex worker	0.3%	0.3%	0.7%	0.7%	2 %

Condom use
Commercial sex

1990	10%	0%	10%	0%	10%
1993	25%	10%	25%	10%	20%
1995	50%	25%	50%	25%	30%

Casual partnerships

1990	10%	10%	10%	10%	10%
1995	20%	20%	20%	20%	25%

Table S2. Country specific HIV prevalence and ART roll-out fits. All countries included in the analyses are listed with their corresponding sexual behaviour profile, circumcision prevalence, ART scale-up function, HIV introduction year, change in overall partner-change rates, and change in overall CSW visit rates.

	Profile[1]	Circumcision prevalence[2]	ART roll-out		Year of HIV introduction[3]	Fine-tune[4]	
			Start year	Function (MF)		Partner change rates	CSW visit rates
Angola	Concentrated (LC)	66%	2002	Q (0.004)	1990	-20%	-20%
Benin	Concentrated	84%	2004	L (0.167)	1989	0%	0%
Botswana	Generalized	25%	2001	Linear (0.5)	1989	+10%	n/a
Burkina Faso	Concentrated (LC)	89%	2004	Linear (0.1)	1985	0%	0%
Burundi	Concentrated	2%	2004	Sqrt (0.003)	1985	+20%	0%
Cameroon	Mixed (LC)	93%	2001	Q (0.004)	1989	-10%	n/a
CAR	Mixed	67%	2003	Q (0.004)	1989	-5%	n/a
The Congo	Concentrated (LC)	70%	2004	L (0.05)	1983	-20%	-5%
Côte D'Ivoire	Mixed	93%	2003	L (0.033)	1988	-25%	n/a
Chad	Concentrated (LC)	64%	2004	Q (0.014)	1984	+25%	0%
Djibouti	Concentrated (LC)	94%	2003	Sqrt (0.0017)	1990	0%	0%
DR Congo	Concentrated (LC)	70%	2004	Sqrt (0.0013)	1989	-20%	-20%
Equatorial-G	Mixed (LC)	86%	2005	Sqrt (0.001)	1995	+40%	n/a
Eritrea	Concentrated	95%	2005	Q (0.03)	1990	-10%	0%
Ethiopia	Concentrated (LC)	76%	2004	L (0.083)	1991	-20%	-10%
Gabon	Mixed (LC)	93%	2001	Q (0.01)	1990	0%	n/a
Gambia	Concentrated (LC)	90%	2003	Sqrt (0.0033)	1996	+13%	0%
Ghana	Concentrated (LC)	95%	2003	Q (0.006)	1990	-20%	-15%
Guinea	Concentrated (LC)	83%	2003	Q (0.01)	1990	-20%	-20%
Guinea-B	Concentrated (LC)	91%	2005	Q (0.02)	1990	+25%	0%
Kenya	Mixed	84%	2003	Q (0.015)	1985	+10%	n/a
Lesotho	Generalized	0%	2004	Q (0.025)	1989	-5%	n/a
Liberia	Concentrated	70%	2003	Q (0.003)	1986	+20%	0%
Madagascar	Concentrated	100%	2005	Q (0.003)	1996	-25%	-25%

Malawi	Mixed (LC)	27%	2003	Q (0.015)	1990	-35%	n/a
Mali	Concentrated	95%	2004	L (0.125)	1989	0%	0%
Mauritania	Concentrated	100%	2005	L (0.071)	1994	0%	0%
Mozambique	Generalized	56%	2005	L (0.0833)	1991	+5%	n/a
Namibia	Mixed	15%	2004	L (0.5)	1990	+5%	n/a
Niger	Concentrated	92%	2005	Q (0.011)	1991	-20%	-5%
Nigeria	Concentrated (LC)	81%	2004	L (0.033)	1983	+20%	0%
Rwanda	Concentrated	10%	2004	L (0.333)	1981	+20%	0%
Senegal	Concentrated	89%	2003	L (0.125)	1995	-20%	-20%
Sierra Leone	Concentrated (LC)	90%	2001	L (0.0167)	1995	-7%	0%
Somalia	Concentrated	93%	2005	L (0.0125)	1995	-20%	-20%
South Africa	Generalized	35%	2003	Q (0.014)	1990	0%	n/a
Sudan	Concentrated	47%	2004	Q (0.003)	1999	-35%	-35%
Swaziland	Generalized	8%	2002	Q (0.02)	1990	+5%	n/a
Togo	Concentrated (LC)	93%	2001	Q (0.004)	1994	-20%	-20%
Tanzania	Mixed	70%	2004	L (0.0833)	1986	+25%	n/a
Uganda	Concentrated (LC)	25%	2001	Q (0.006)	1981	+13%	0%
Zambia	Mixed (LC)	12%	2004	Q (0.056)	1990	-30%	n/a
Zimbabwe	Generalized	10%	2004	Q (0.014)	1987	+15%	n/a

1. Figure S1 gives geographical representation of the chosen profiles; 2. Source: Williams BG*et al*[7] except for Madagascar, Mauritania, and Swaziland, where data comes from UNAIDS database [8]. Year of circumcision prevalence is 2006, except for CAR (1995); Eritrea (2003); Gabon (2001); Madagascar (2010); Mauritania (2001); Sudan (1991); Swaziland (2008); and Togo (1999). 3. Year of HIV introduction does not necessarily represent the year first HIV case(s) were identified in a country. The year is chosen to fit the country specific development of the HIV epidemic in our model. 4. Change in overall partner change rates and CSW visit rates compared to original profile. Effects of change on number of partners in the last 12 months is shown in table S1
CSW=Commercial Sex Worker; CAR = Central Africa Republic; Guinea-B = Guinea-Bissau; Equatorial-G = Equatorial Guinea; DR Congo = Democratic Republic of Congo n/a = Not applicable; MF = Multiplication Factor; Q = Quadratic; L = Linear; Sqrt = Square-Root; LC = low condom use.