HIV INVESTMENT IN TOGO

OPTIMIZING INVESTMENTS FOR A SUSTAINABLE AND EFFICIENT HIV RESPONSE IN TOGO

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FINDINGS FROM AN HIV ALLOCATIVE EFFICIENCY STUDY

Conseil National de Lutte contre le Sida et les Infections Sexuellement Transmissibles
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ABBREVIATIONS

AE	Allocative Efficiency
AIDS	Acquired immune deficiency syndrome
ART	Antiretroviral therapy
ARV	Antiretroviral
BOD	Burden of disease
CCOCs	Cost-Coverage Outcome Curves
Clients	Clients of female sex workers
DALY	Disability-adjusted life year
DU	Drug users
ENV	Enabling environment
Female youth	Females 15–25 years old excluding key population groups in this age group
Females 25–45	Female 25–49 years old excluding key population groups in this age group
FSW	Female Sex Workers
GDP	Gross domestic product
Global Fund	The Global Fund to Fight AIDs, Tuberculosis and Malaria
HIV	Human Immunodeficiency Virus
HR	Human resources
HTS general	HIV testing services for the general population
IBBSS	Integrated bio-behavioral surveillance survey
IDU	Injecting drug use
IEC	Information, education and communication
INFR	Health Infrastructure
Male youth	Male 15–25 years old excluding key population groups in this age group
Males 25–45	Male 25–49 years old excluding key population groups in this age group
MGMT	Management
Military	Military personnel
M&E	Monitoring and evaluation
MSM	Men who have sex with men
NCD	Non-communicable diseases
NHA	National health accounts
NSP	Needle and syringe exchange program
Optima	Optimization & Analysis Tool
PLHIV	People living with HIV
PMTCT	Prevention of mother-to-child transmission
Condoms and SBCC	Condom promotion and distribution and Social and behavior change communication
STI	Sexually Transmitted Infection
THE	Total Health Expenditure
WCA	West and Central Africa
WHO	World health Organization
YLL	Years of life lost

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EXECUTIVE SUMMARY

BACKGROUND

This report summarizes the findings of an allocative efficiency analysis to support Togo's national HIV response. Togo has recently drafted a National HIV Strategic Plan (2016–20) and is preparing a new Global Fund concept note (2018–20). The Government of Togo would like to mobilize additional resources, including domestic and private resources, for comprehensive HIV services to respond to the goals of the national HIV Strategic Plan. To assure that the resources that have been, or will be, mobilized are used in the most efficient way, and to determine the allocation of resources that brings the greatest health benefit, the Government requested the World Bank to conduct this allocative efficiency analysis (Section 1), using the Optima mathematical model (Section 2–9 and Annexes).

Togo's spending on health is one of the highest in West and Central Africa, but it remains insufficient to cover a very large treatment gap.

Togo is a low-income country with an estimated population of 7.12 million in 2014. Togo's Human Development Index ranks 166 out of 188 countries, with an index of 0.473, similar to Sudan, Benin and Uganda. GDP per capita was USD 625 in 2014, an increase of 11% from 2011. The three leading causes of DALYs for all age groups in 2013 were malaria (14%), lower respiratory tract infections (9%) and HIV/AIDS (9%)[1]. Of these, HIV/AIDS had the highest increase since 1990 (885%). Togo has a mature, mixed HIV epidemic with an estimated prevalence of 2.5% among males and females (15–49 years) in 2014, but with significant disparities between gender, regions and key populations. Considering the high burden of disease attributable to HIV, the HIV response remains a critical component of health service delivery.

Togo has a very large ARV treatment gap, in 2014 it was estimated that only 33% of the 110,400 PLHIV were on ART. Togo's ART coverage is the 23rd lowest in Sub Saharan Africa[2]. A low ART coverage and a low proportional spent on ART is characteristic of the HIV responses in West and Central Africa. According to UNAIDS, People living with HIV in Eastern and Southern Africa are more likely to obtain treatment services than people in Western and Central Africa[3]. In the West Africa Region, 79% of people who were estimated to be eligible for treatment under the 2013 WHO guidelines were not receiving antiretroviral therapy as of December 2012, compared to 59% in East and Southern Africa. Similarly, only 34% of HIV spending in the region went for spending for care and treatment, compared to 54% in East and Southern Africa and 55% globally.

Togo's spending on health is one of the highest in West and Central Africa. According to WHO estimates for 2013, total health spending as a percentage of GDP in Togo was 9%,

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1 http://www.healthdata.org/Togo.

2 Estimated ART coverage among PLHIV in low and middle income country, Africa region WHO 2013 http://gamapserver.who.int/gho/interactive_charts/hiv/art/atlas.html.

3 UNAIDS, Access To Antiretroviral Therapy In Africa, Status Report On Progress Towards The 2015 Targets; UNAIDS Geneva.

an increase of more than 60% since 2000. In the same year, per capita health expenditure was USD 54, a four-fold increase since 2000, and 52% of health expenditure was funded from public sources. Government health expenditure has increased by more than 80% since 2000, while out-of-pocket spending has decreased from 63% to 41% of total health expenditure.

The HIV response has remained heavily dependent on donors' contribution. Total HIV spending in Togo increased by nearly 50% between 2006–14. During the same period, public funding nearly tripled and international funding has increased by approximately 30%. The Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) has been the country's major international donor, contributing around 60% of all donor funds in 2014. In 2014, the total funding for Togo's HIV response was approximately USD 21 million, of which 75% was financed from international donors and the remainder was funded by domestic sources. In 2014, 12% of domestic funding was financed from private sources, with household contributions through out-of-pocket user-fees representing approximately 80% of private spending.

After consultation with key stakeholders and in collaboration with the steering committee of this study, the following specific questions were set for the optimization analysis:

- What are the expected trends in the epidemic if current spending volume and patterns are maintained?
- What is the impact of past and current spending?
- What can be improved by optimizing the allocation of current funding?
- What is the expected future impact of different policy or program implementation scenarios, including the impact of reaching UNAIDS' 90/90/90 goals, and Attaining 90% PMTCT coverage?
- How much will it cost to achieve proposed National HIV Strategic Plan targets?
- What are the long-term financial commitments to HIV services for PLHIV?

METHODS

The analysis was conducted using Optima, which is an epidemiological and economic model of HIV transmission with a resource optimization feature (Section 2 and Annex). For the analysis, the inputs into the Optima model were gathered through a comprehensive literature review and key parameters were defined using a participatory consultation of key stakeholders. Local demographic, epidemiological and programmatic data were used to populate the model. Population data for key populations (FSW, MSM, PWUD, Prisoners) were extrapolated based on the available local size estimation. Cost and expenditure estimates were derived from the National AIDS Spending Assessment (NASA).

KEY FINDINGS

- Under current conditions, assuming stable behavior and program coverage in absolute numbers, **the number of PLHIV is predicted to increase** by 24% from 110,400 in 2014 to 136,300 by 2030. **New infections are predicted to increase** 57% from 6,300 per year in 2014 to 9,900 per year in 2030. **Deaths are predicted to increase** 31% from 4,400 per year in 2014 to 5,700 per year by 2030.

- If current conditions and funding levels are maintained, HIV prevalence is expected to stabilize in all key populations between 2014 and 2030. Among children, male youth and female youth in the general population, prevalence is estimated to stabilize at low levels between 2014 and 2030. Prevalence is also expected to stabilize among men and women aged 25-49 years in the general population, but at higher levels.

- At the end of 2014, there was a large treatment gap in Togo with only 33% of PLHIV receiving treatment. This treatment gap is typical of the HIV response in West and Central Africa where, on average, only 21% of PLHIV eligible for treatment under the WHO 2013 guidelines were receiving antiretroviral therapy as of December 2012.

- The HIV allocative efficiency analysis using Optima confirmed that the current annual budget of USD 20.8 million was close to being optimally allocated, with limited gains to be made from reallocation between the different interventions and population groups. However, it should be noted that the optimization doesn't take into account indirect costs which are considered fixed. If all indirect costs were reduced by 25%, then 16,900 more PLHIV might be placed onto treatment. This could avert approximately 19,900 new infections and 15,400 deaths by 2030. As management costs make up a large proportion of indirect costs, reducing management costs by 25% might enable an extra 10,600 people to be put onto treatment, thus averting 9,900 deaths and 11,000 new infections by 2030.

- **The current (2014) annual budget of USD 20.8 million will not be enough to reduce incidence and deaths by 50%.** In order for Togo to reduce incidence and deaths by 50% by 2020, an annual budget envelope of approximately USD 39.2 million is required (88% increase on current budget).

- **Being even more ambitious, meeting UNAIDS goals of 90-90-90 will require additional HIV funding during the 2016 to 2020** HIV strategy period. Achieving 90-90-90 targets would cost an estimated USD 93.7 million between 2016 and 2020 for treatment, and USD 3.2 million for testing, at 2014 unit costs, in real terms. **Meeting 90-90-90 targets could avert an estimated 63,400 (56%) new infections by 2030 and 47,900 (68%) deaths** compared to current coverage.

- **This implies that HIV financing needs to be increased (either through domestic or international sources)** to cover treatment gaps and sustain other

comprehensive, harm reduction oriented prevention services for key populations.

- Alternatively, one way to expand the total budget available for the programmatic epidemic response may be through the reduction of indirect costs (e.g. management costs). **Future technical and production efficiency analyses should explore ways to reduce costs without compromising the quality of care.**

- **PMTCT programs also remain critical,** both for preventing new infections among children, and increasing testing and treatment coverage for females aged 15-49 years. If 90% coverage of PMTCT was obtained by 2020, this could avert 3,000 (35%) of new infections among children.

CONCLUSIONS

1 **The Togolese government has responded effectively to a complex, mixed HIV epidemic.** The government's opportunities for optimization and better allocation of current HIV spending to further minimize HIV incidence, prevalence and HIV-related deaths are minimal.

2 The findings highlight however a significant treatment gap, and in this context, argue strongly for additional funding, optimally allocated, to achieve 90-90-90 targets and respond most effectively to this epidemic. **Effective ART scale-up is needed** and **c**overage must be increased if global targets are to be met.

3 **In order to reduce the treatment gap, whilst ensuring additional funding for non-ART HIV programs for key populations, in particular FSW which are a key driver of the epidemic, a series of concomitant actions are required:** reduced spending on general prevention programs targeting low-risk population, a larger budget envelope, prioritization of spending on core programs, reduced spending on indirect programs where feasible, technical efficiency gains, investment from budgets not earmarked for HIV that benefit from the broader public health impacts of key population programs.

4 In order to reduce incidence and deaths by 50%, resources should be shifted from prevention programs targeting the general low risk population to non-ART key population programs, ART and PMTCT.

5 **Key population HIV programs would benefit from fully integrating ART initiation and adherence**. The model recommends a proportionately higher increase of spending of key populations within PLHIV to be put onto treatment.

6 **Additional domestic resources will be needed to sustain the HIV response.** Funding for HIV in Togo has increased since 2007. However, excluding ART, preventive programs and programs targeted at key populations are primarily funded by international donors. As such, the withdrawal of international funding without a concurrent increase in domestic resources would have a significant negative impact on the HIV epidemic in Togo.

7 **Greater technical efficiency in spending might be achieved through strategies to reduce the average spend per person reached**. This is particularly true for indirect spending. Care should be taken however, that these strategies do not compromise the quality of prevention or treatment and further analyses of technical efficiency are needed before more robust conclusions can be reached.

8 **All the results from this study point towards the conclusion that Togo currently doesn't have the appropriate resources to achieve its targets and that optimization gains alone cannot close this gap.**

Figure E 1 Comparing the allocation of 2014 annual spending against the optimal allocation to reduce deaths and incidence by 50%

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1 BACKGROUND: WHY ALLOCATIVE EFFICIENCY ANALYSIS NOW?

1.1 POPULATION, WEALTH AND HUMAN DEVELOPMENT IN TOGO

Togo is a low-income country with an estimated population of 7.12 million in 2014. The population has increased rapidly from 4.87 million in 2000, at an average of 2.7% per year4, giving Togo the 17th highest population growth in the world5.

Togo's Human Development Index ranks 166 out of 188 countries, with an index of 0.473, similar to Sudan, Benin and Uganda6 GDP per capita was USD 625 in 20147, an increase of 11% from 2011.

Togo shares a border with Burkina Faso, Ghana, and Benin and is situated along the Abidjan-Lagos Transport Corridor, which plays an important role in the HIV epidemic.

1.2 TOGO'S HEALTH AND HEALTH FINANCING CONTEXT

1.2.1 BURDEN OF DISEASE

Life expectancy in 2013 in Togo was 61.1 years for males and 64.7 years for females, an increase from 57.4 years and 59.7 years in 1990 respectively[8]. Togo's overall burden of disease is characterized by a mix of significant causes of morbidity and mortality (**Figure 1.1**). There is a continued contribution of neonatal and child mortality to the overall number of disability adjusted life years (DALYs). The three leading causes of DALYs for all age groups in 2013 were malaria (14%), lower respiratory tract infections (9%) and HIV/AIDS (9%)[9]. Of these, HIV/AIDS had the highest increase since 1990 (885%). Considering the high burden of disease attributable to HIV, the HIV response remains a critical component of health service delivery.

4 http://data.worldbank.org/country/togo

5 https://www.cia.gov/library/publications/the-world-factbook/rankorder/2002rank.html

6 http://data.un.org/DocumentData.aspx?id=364

7 World Bank Development indicators World Bank

8 http://www.healthdata.org/Togo

9 http://www.healthdata.org/Togo

Figure 1.1 Cause Specific Disability adjusted life years (DALYs) by age, 2010[10]

1.2.2 HEALTH CARE FINANCING AND EXPENDITURE

Togo has a mixed health financing system funded from both public and private sources. The main sources of financing are government contributions, out of pocket payments, compulsory social health insurance (SHI) contributions and voluntary private insurance contributions. Compulsory social health insurance, introduced in 2012, covers only public-sector workers who account for 10% of the population. A number of private health insurance companies similarly cover only a minority of the population, mainly from higher-income groups[11,12]

Togo's spending on health is one of the highest in West and Central Africa (WCA) (see **Figure 1.2**). According to WHO estimates for 2013[13], total health spending as a percentage of GDP in Togo was 9%, an increase of more than 60% since 2000 (see **Table 1.1**). In the same year, per capita health expenditure was USD 54, a four-fold increase since 2000 (see **Table 1.1**), and 52% of health expenditure was funded from public sources (see **Table 1.1**). Government health expenditure has increased by more than 80% since 2000, while out-of-pocket spending has decreased from 63% to 41% of total health expenditure (**see Table 1.1**).

[10] http://vizhub.healthdata.org/gbd-compare/patterns

[11] Togo Country Cooperation Strategy brief,,2014

[12] IOM Country Fact Sheet, 2014.

[13] Source: WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en)

Table 1.1 Trends in health expenditure in Togo, 2000–2013[14]

INDICATOR	2000	2005	2010	2011	2012	2013
GDP (current prices, US$, millions)	1,294	2,110	3,193	3,688	3,882	4,306
Total health expenditure (US$, millions)	69	139	251	295	320	371
Total health expenditure (US$ per capita)	14	25	40	46	48	54
Total health expenditure as a percentage of GDP	5	7	8	8	8	9
Government health expenditure as a percentage of total health expenditure	29	29	48	47	51	52
Private health expenditure as a percentage of total health expenditure	71	71	52	53	49	48
Government health expenditure as a percentage of total government expenditure	8	10	15	15	15	15
External resources for health as a percentage of total health expenditure	6	19	17	16	15	6
Social security expenditure on health as a percentage of total government expenditure	12	10	6	6	6	6
Out-of-pocket health expenditure as a percentage of total health expenditure	63	60	44	45	42	41

Source: Authors

Figure 1.2 Total expenditure on health as a % of GDP in West and Central African countries, 2013, WHO estimates

[14] Source: WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en), accessed 20 April 2016.

1.3 THE HIV EPIDEMIC IN TOGO

1.3.1 OVERVIEW OF HIV EPIDEMIC

Togo has a mature, mixed HIV epidemic with an estimated prevalence of 2.5% among males and females (15-49 years) in 2014[15]. Significant disparities between gender, regions and key populations exist. Estimated prevalence is higher amongst women (3.1%) than men aged 15-49 (1.7%)[16]. Prevalence is also higher in the coastal regions (Lome 3,4%, Maritime 3%) than the northern regions (Kara 1.8%, Savane 0.3%), and in urban areas (3.5%) compared to rural areas (1.5%)[17]. Population size and HIV prevalence for key populations at higher risk of HIV exposure are outlined in **Table 1.2**. Prevalence is higher among certain key populations such as FSW (11.7%)[18], MSM 13.0%[19], prisoners (4.3%)[20], drug users (5.5%)[21] and military (3.8%)[22]. Within the drug user population in Togo, injecting drug users make up 2.8%, making sexual transmission a higher risk factor than injecting drug use among this population[23].

1.3.2 HIV INCIDENCE TRENDS

The Optima model, which will be described in more detail in the next section, estimates that the highest number of new infections transmitted in 2014 were by males aged 25-49 years (39%), while the largest number of new infections acquired in 2014 were among females aged 25-49 years (49%), followed by 25-49 year old males (26%), and female youth (15%) (**Figures 1.3 and 1.4**). These findings are supported by other studies in the region[24], which suggests that the impact of networks between older men and young females plays an important role in the HIV transmission dynamics.

15 National HIV Strategic Plan draft 2016-2020, based on Spectrum/EPP

16 Rapport d'activite sur la riposte au VIH/Sida au Togo Juin 2015

17 Rapport d'activite sur la riposte au VIH/Sida au Togo Juin 2015

18 FSW BBS survey 2015

19 MSM BBS survey 2015

20 Programme National de Lutte contre le Sida et les IST, 2011. Enquête comportementale et de séroprévalence du VIH chez les prisonniers Togo en 2011

21 Programme National de Lutte contre le Sida et les IST, 2011. Enquête comportementale et de séroprévalence du VIH chez les utilisateurs de drogues au Togo en 2011.

22 Enquête de Comportement et de Séroprévalence chez les Militaires 2014

23 Programme National de Lutte contre le Sida et les IST, 2011. Enquête comportementale et de séroprévalence du VIH chez les utilisateurs de drogues au Togo en 2011.

24 Prudden, H. J., Beattie, T. S., Bobrova, N., Panovska-Griffiths, J., Mukandavire, Z., Gorgens, M., Wilson, D. and Watts, C. H. 2015. Factors Associated with Variations in Population HIV Prevalence across West Africa: Findings from an Ecological Analysis. *PLoS ONE,* 10**,** e0142601.

Table 1.2 Population size and prevalence among populations

POPULATION	ESTIMATED POPULATION SIZE (MOST RECENT VALUE)	PREVALENCE (MOST RECENT VALUE)
FSW	17,909[25,26]	11.7% (CI 9.9%-13.5%)[27]
FSW Clients	106,847 (estimate)[28]	1.8% (CI 0.8%-2.6%)[29]
MSM	7,649[30]	13.0 (CI 10.1%-16.0)[31]
Drug users	40,800[32]	5.5% (CI 3.2% – 7.8%)[33]
Prisoners	4,349[34]	4.3% (CI (3.2% – 5.5%)[35]
Military	13,800[36]	3.8% (CI 2.9%-4.7%)[37]

[25] Papworth E, Grosso A, Ketende S, Wirtz A, Cange C, Kennedy C, Lebreton M, Ky-Zerbo O, Anato S, and Baral S. Examining Risk Factors for HIV and Access to Services among Female Sex Workers (FSW) and Men who have Sex with Men (MSM) in Burkina Faso, Togo, and Cameroon. March 2014. Baltimore: USAID | Project Search: Research to Prevention. The proportion of the population who are FSW in Togo is estimated to be 0.82% (95% CI 0.57-1.07%) or 13,771 (95% CI 9,634-17,909).

[26] Conseil National De Lutte Contre Le SIDA, 2015. Etude Sur L'estimation De La Taille Et Cartographie Des Sites HSH et PS au Togo. According to these estimates, 6292 (CI 5234-7352) or 2.4%, of the female population 15-49 living in cities were FSW. In order to reconcile both these studies, it was decided to use the higher estimate from the national study (Papworth et al 2014).

[27] Universite de Lome and Unite de Recherche Demographique. 2015. Enquête comportementale et de séroprévalence du VIH chez les professionnelles du sexe et leurs clients au Togo PS-TOGO_2015

[28] Estimate derived from raw data from DHS report. Source: Ministère de la Planification, du Développement et de l'Aménagement du Territoire (MPDAT), Ministère de laSanté (MS) et ICF International, 2015. Enquête Démographique et de Santé au Togo 2013-2014 . Rockville, Maryland, USA : MPDAT, MS et ICF International.

[29] Universite de Lome and Unite de Recherche Demographique. 2015. Enquête comportementale et de séroprévalence du VIH chez les professionnelles du sexe et leurs clients au Togo PS-TOGO 2015

[30] Conseil National De Lutte Contre Le SIDA, 2015. Etude Sur L'estimation De La Taille Et Cartographie Des Sites HSH et PS au Togo.

[31] Enquête comportementale et de séroprévalence du VIH chez les hommes ayant des rapports avec d'autres hommes (HSH) Togo en 2015

[32] Conseil National De Lutte Contre Le Sida et Les Infections Sexuellement Transmissibles (2014) Rapport De Progres Sur La Riposte Au VilH et Au Sida Au Togo (GARPR 2014)

[33] Programme National de Lutte contre le Sida et les IST, 2011. Enquête comportementale et de séroprévalence du VIH chez les utilisateurs de drogues au Togo en 2011.

[34] Direction General de l'Administration Penitenciaire.

[35] Programme National de Lutte contre le Sida et les IST, 2011. Enquête comportementale et de séroprévalence du VIH chez les prisonniers Togo en 2011

[36] Expert opinion

[37] Enquête de Comportement et de Séroprévalence chez les Militaires 2014

Figure 1.3 Estimated number of new HIV infections transmitted, 2000–14, according to Optima modelling

Figure 1.4 Estimated number of new HIV infections acquired, 2000–14, according to Optima modelling

An important characteristic of sexual relationships in this context is the frequency of transactional sex. Sex workers in Togo are defined as per the UNAIDS definition, 'adults or youth who receive goods and/or money in exchange for sex'[38]. Some sex workers define themselves as official sex workers, based in brothels ('les PS affichees') and non-brothel based ('les PS ambulantes'). However, a large proportion of sex workers do not identify themselves as sex workers ('les PS clandestines'). In 2009, 6% of sex workers

[38] UNAIDS. Guidance note on HIV and sex work. Geneva, UNAIDS, updated 2012.

were brothel-based, 19% were non-brothel based and the majority (75%), did not identify themselves as sex workers[39]. In this report, the highest available size estimate of FSW, 17 909 or 1.07% of the 15-49 female population, was used in order to take as much as possible hidden sex workers into account.

1.3.3 HIV AMONG FEMALES

The disproportionate burden of HIV among females in Togo is characteristic of the West African epidemiological context and most mixed and generalized HIV epidemics. Analysis conducted by Prudden et al (2015) highlights the influences of networks between older men and young females (**Figure 1.3**). In the context of higher prevalence among the FSW population, and their clients, an increase in HIV infections has been noted when clients and other younger women have sexual relationships, or when either of these groups has multiple partners (**Figure 1.3**). In Togo, prevalence among young females was estimated to be almost five times that of young males in 2013 (2.4% compared to 0.5%)[40] indicating that young women and older men have sexual relationships with one another. Female youth are also more likely to have multiple partners (1.3%) than older females aged 25-49 years (0.4%), and older males aged 25-49 years are more likely to have multiple partners (22.7%) than male youth (7.5%)[41].

Figure 1.5 Revised conceptual framework of HIV spread through sexual networks of individuals within the population[42]

[39] Pitché, P., Gbetoglo, K., Saka, B., Akakpo, S., Landoh, D.E., d'Alméida, S., Kere, Banla, A.K., Sodji, D., Deku, K. 2013. *HIV prevalence and behavioral studies in female sex workers in Togo: a decline in the prevalence between 2005 and 2011*. PanAfrican Medical Journal 2013; 15:62.

[40] Evaluation du secteur de l'éducation 2015

[41] Prudden, H. J., Beattie, T. S., Bobrova, N., Panovska-Griffiths, J., Mukandavire, Z., Gorgens, M., Wilson, D. and Watts, C. H. 2015. Factors Associated with Variations in Population HIV Prevalence across West Africa: Findings from an Ecological Analysis. *PLoS ONE,* 10**,** e0142601.

[42] Prudden, H. J., Beattie, T. S., Bobrova, N., Panovska-Griffiths, J., Mukandavire, Z., Gorgens, M., Wilson, D. and Watts, C. H. 2015. Factors Associated with Variations in Population HIV Prevalence across West Africa: Findings from an Ecological Analysis. *PLoS ONE,* 10**,** e0142601.

Figure 1.4 Revised conceptual framework of HIV spread through sexual networks of individuals within the population (continued)

1.3.4 CHARACTERISTICS OF HIV RESPONSE IN TOGO

A decline in HIV prevalence among males and females aged 15-49 years, between 2000 and 2014, was previously noted. This success is attributable in part to the HIV response to date. Self-reported condom use is high for commercial acts with FSW, at 93% in 2014,[43] and 86% with casual partners for MSM in Lomé and Kara in the same year[44].

Of the estimated 110,400 PLHIV in 2014, it is estimated that 52% have been diagnosed[45]. The number of women covered under the Option B/B+[46] approach within the PMTCT program has increased in recent years. In 2014, it was estimated that 87% of diagnosed pregnant women received treatment[47].

ART coverage has steadily increased since 2000 but remains low at an estimated 33% in 2014. This is a major challenge, given the individual clinical benefit and population-level HIV prevention benefit of treatment. Togo's low ART coverage is echoed elsewhere in the WCA region, where the ARV treatment gap among those estimated to be eligible for treatment according to WHO guidelines is 79%[48]. The WCA treatment gap is 13% higher

[43] Universite de Lome and Unite de Recherche Demographique. 2015. Enquête comportementale et de séroprévalence du VIH chez les professionnelles du sexe et leurs clients au Togo PS-TOGO 2015.

[44] Papworth E, Grosso A, Ketende S, Wirtz A, Cange C, Kennedy C, Lebreton M, Ky-Zerbo O, Anato S, and Baral S. Examining Risk Factors for HIV and Access to Services among Female Sex Workers (FSW) and Men who have Sex with Men (MSM) in Burkina Faso, Togo, and Cameroon. March 2014. Baltimore: USAID | Project Search: Research to Prevention. The proportion of the population that is FSW in Togo is estimated to be 0.82% (95% CI CI 0.57-1.07) or 13,771 (95% CI CI 9,634-17,909).

[45] Rapport Annuel D'activite de la Reponse Nationale Contre le VIH/SIDA en 2014. In-country experts acknowledge that while this value is the best estimate regarding this indicator, it is still an estimate

[46] Option B, refers to an approach in which "all pregnant and lactating women with HIV initially are offered ART – beginning in the antenatal period and continuing throughout the duration of breastfeeding. At the end of breastfeeding those women who do not yet require ART for their own health would discontinue the prophylaxis and continue to monitor their CD4 count, eventually re-starting ART when the CD4 falls below 350 cells/mm3.". Option B+ refers to "all pregnant women living with HIV are offered life-long ART, regardless of their CD4 count". Source: http://www.unicef.org/aids/files/hiv_Key_considerations_options_B.pdf

[47] Togo National HIV Strategic Plan draft 2016-2020.

[48] Based on numbers receiving treatment as of December 2012 and estimated numbers of people eligible as of December 2013 under the 2013 WHO HIV treatment guidelines

than the global average, and significantly higher than East and Southern Africa where it is estimated at 59%[49].

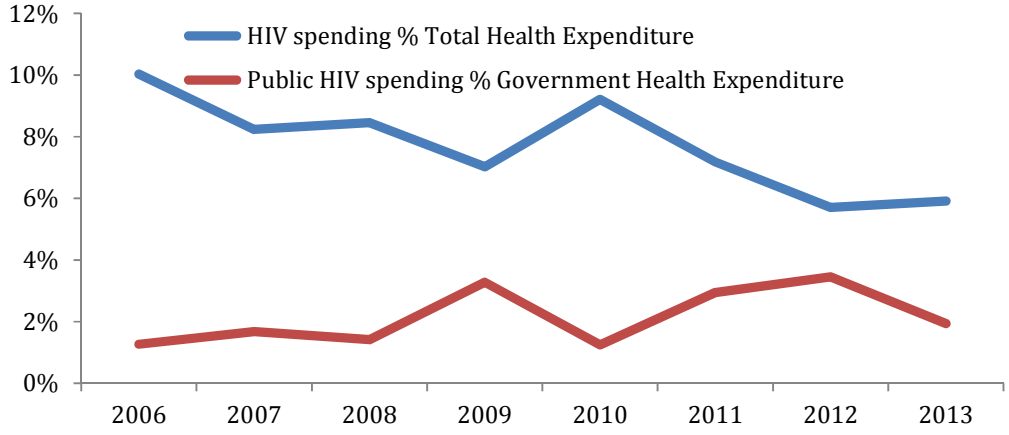
1.4 FINANCING THE HIV RESPONSE IN TOGO

The HIV response has been heavily dependent on donors' contribution. HIV spending in Togo as percentage of total health expenditure has been decreasing since 2006 (**Figure 1.6).** Public spending on HIV as percentage of general government spending on health has increased around 50% since 2006, although it has fluctuated substantially during this period (**Figure 1.6)**.

Total HIV spending in Togo increased by nearly 50% between 2006–14 (**Figure 1.7**). During the same period, public funding nearly tripled and international funding has increased by approximately 30% **(Figure 1.8)**. The Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) has been the country's major international donor, contributing around 60% of all donor funds in 2014.

In 2014, the total funding for Togo's HIV response was approximately USD 21 million, of which 75% was financed from international donors and the remainder was funded by domestic sources. In 2014, 12% of domestic funding was financed from private sources. Household contributions through out-of-pocket user-fees constituted approximately 80% of private spending in 2014 **(Figure 1.9)**.

Figure 1.6 HIV/AIDS spending as a % of total health expenditure and Government expenditure on Health Togo[50]



[49] UNAIDS 2014, Access to Antiretroviral Therapy in Africa. Status report on progress towards the 2015 targets. Geneva, UNAIDS. Source: UNAIDS 2012 estimates. http://www.unaids.org/sites/default/files/media_asset/20131219_AccessARTAfricaStatusReportProgresstowards2015Targets_en_0.pdf

[50] Source: WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en), accessed 20 April 2016.

Figure 1.7 Overall spending on HIV/AIDS in Togo[51]

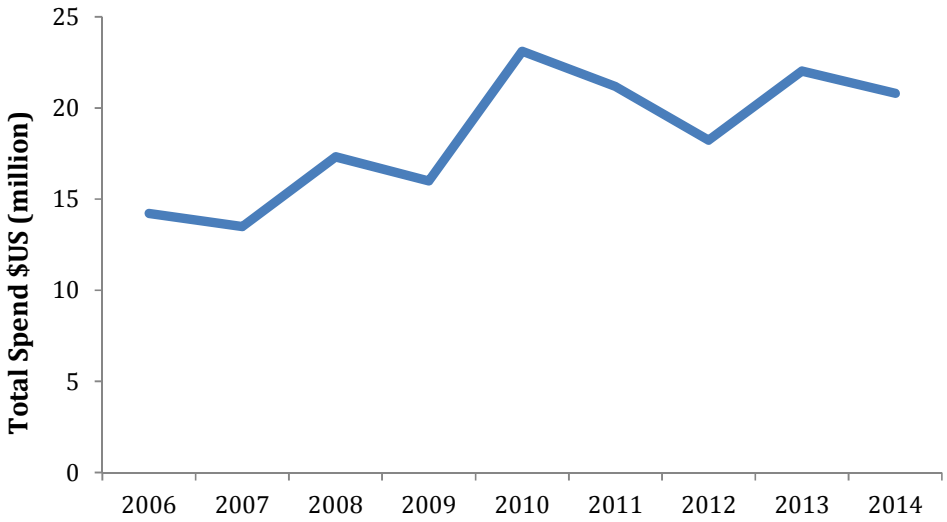


Figure 1.8 Funding for HIV in Togo, by funding source[52]

[51] Source: National HIV/AIDS Spending report 2006-2014.

[52] Source: National HIV/AIDS Spending report 2006-2014

Figure 1.9 Private spending on HIV/AIDS in Togo, based on source of funding [53]

1.5 A NEED FOR IMPROVING ALLOCATIVE EFFICIENCY IN HIV

In the current climate of increasingly limited resources for HIV epidemic responses, focused design and efficiency in service delivery are essential to ensure that programs can do more with less.

A shift towards investment thinking in the design of HIV responses is being promoted by the UNAIDS Secretariat and co-sponsors globally, to maximize the impact of program investment and best realize the long-term health and economic benefits of HIV programs. Investment cases are currently being developed by a number of countries to understand HIV epidemics and design, deliver and sustain effective HIV responses. In support of HIV investment cases, and at the time of drafting Togo's National HIV Strategic Plan 2016–20, this report summarizes the results of an allocative efficiency analysis for Togo.

This report also summarizes the progress made towards reaching key international HIV commitments. In the 2011 UN Political Declaration, countries agreed to reduce sexual and injection-related transmission by 50%, virtually eliminate HIV mother-to-child-transmission, initiate 80% of eligible PLHIV on treatment and end HIV-related discrimination by 2015[54]. The 2014 Gap Report[55] illustrated that substantial additional effort will be required in most countries to achieve these targets. Against this background, UNAIDS globally defined a **Fast-Track**[56] strategy in order to achieve the

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53 Source: National HIV/AIDS Spending report 2006-2014.

54 United Nations General Assembly (2011) Resolution adopted by the General Assembly 65/277. Political Declaration on HIV and AIDS: Intensifying Our Efforts to Eliminate HIV and AIDS. New York.

55 UNAIDS (2014). The Gap Report. Geneva.

56 UNAIDS (2014). Fast-track. Ending the AIDS epidemic by 2030. Geneva.

goal of *Ending AIDS by 2030.* This includes new initiatives such as the 90-90-90 targets[57]. These set out to ensure that 90% of all PLHIV are diagnosed, 90% of diagnosed PLHIV are on ART and 90% of PLHIV on ART are virally suppressed. The **Fast-Track** approach also emphasizes the need to focus on the geographical areas and communities most affected by HIV and recommends that resources be concentrated on programs with the greatest impact.

In the context of this report, the investment case is complemented by a human rights-based approach to health care. As confirmed in the National HIV Strategic Plan draft 2016–20[58], a universal approach based on upholding human rights and non-discrimination is to be adopted.

The concept of allocative efficiency refers to the maximization of health outcomes, with the least costly mix of health interventions, within a defined budget envelope. HIV allocative efficiency studies generally try to answer the question "*How can* a given *HIV funding amount be optimally allocated to the combination of HIV response interventions that will yield the highest impact?*"

There is wide consensus that better outcomes could be achieved in many settings with a given amount of HIV funding, or that given outcomes could be achieved with less funding, if resources were distributed optimally or if resources were used in the most efficient ways. Mathematical modeling is one way to determine optimized HIV resource allocation within defined budget envelopes. The HIV allocative efficiency (AE) analysis in this study was carried out using the Optimization and Analysis Tool (Optima). The results can be utilized to serve the needs of decision-makers and health planners seeking to improve the allocative efficiency of their HIV financing.

[57] UNAIDS (2014). 90-90-90 An ambitious treatment target to help end the AIDS epidemic. Geneva.

[58] Togo National HIV Strategic Plan draft 2016-2020.

2 How will this report answer key policy questions?

This report explores whether a different allocation of Togo's HIV spending could better maximize health outcomes and minimize new HIV infections and HIV-related deaths. The findings of this report can assist the government of Togo in further strengthening its HIV investment case, through which it attempts to increase the effectiveness of HIV investments and define corresponding priorities, strategies and impacts of the HIV response.

2.1 THE OPTIMA MODEL

To assess HIV epidemic trends we use Optima's epidemic module, which consists of a mathematical model of HIV transmission and disease progression. Optima uses best-practice HIV epidemic modelling techniques and incorporates evidence on biological transmission probabilities, detailed infection progression, sexual mixing patterns and drug injection behaviours. Data relating to programs and costs associated with programs are used in an integrated analysis to determine an optimized distribution of investment under defined scenarios. Further details of the Optima model are available elsewhere (see www.optimamodel.com and Kerr et al[59]).

Data from annual reports, bio-behavioral surveys, and clinic registries were supplemented with published data and information from national registers to populate the Optima Model. The Optima model was then used to project the likely trajectory of the HIV epidemic in Togo and to suggest how that epidemic may best be contained and treated with available financial resources.

Optima is calibrated to HIV prevalence data points available from different sub-populations (e.g. FSW, MSM, drug users, females 25–49 and males 25–49), at specific time points, as well as to data points on the number of people on ART, and data surrounding registered HIV/AIDS cases. The calibration process accounted for epidemic dynamics, changes in behavioral risk factors and programmatic responses over time, and interactions between sub-populations. Data input and calibration was performed in consultation with experts on the Togo epidemic. **Section 2** and **Annex 2** provide further details regarding the calibration process.

To assess how incremental changes in spending affect HIV epidemics and thus determine the optimized funding allocation, the model parameterizes relationships between the cost of HIV intervention programs, the coverage level attained by these programs and the resulting outcomes. These relationships are specific to the country, population and program being considered.

Using the relationships between cost, coverage and outcome—in combination with Optima's epidemic module—it is possible to calculate how incremental changes in

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[59] Kerr et al, 2015. Optima: *A Model for HIV Epidemic Analysis, Program Prioritization, and Resource Optimization*. JAIDS 2015;69:365-376. http://optimamodel.com/pubs/optima_methods_paper_JAIDS.pdf

funding allocated to each program, will impact overall epidemic outcomes. Furthermore, by using a mathematical optimization algorithm, Optima is able to determine the "optimal" allocation of funding across different HIV programs.

2.2 ANALYTICAL FRAMEWORK

To tailor the model to a given context, a number of parameters were selected that describe the country population, levels of expenditure, programs to be included or excluded, time frames and the baseline scenario. The parameters appropriate to the Togo context are listed in **Table 2.1** below.

Table 2.1 Modeling Parameters

CATEGORY	PARAMETERIZATION IN THE OPTIMA MODEL	DESCRIPTION/ ASSUMPTIONS
Populations defined in the model	1. Female sex workers 2. Clients of female sex workers 3. Men who have sex with men 4. Drug users 5. Prisoners 6. Military personnel 7. Children 8. Male youth 9. Female youth 10. Males 25-49 years 11. Females 25-49 years 12. Males 50+ 13. Females 50+	1. Females, aged 15-49 2. Males, aged 15+ 3. Males, aged 15+ 4. Males, aged 15-49. Refers to all drug users, including but not limited to, injecting drug users 5. Males, aged 15-49 6. Males, aged 15+ 7. Males and females, aged 0-15 8. Males, aged 15-24, excluding key populations in this age group 9. Females, aged 15-24, excluding FSW 10. Males aged 25-49 years excluding key populations in this age group 11. Females aged 25 -49 years excluding FSW in this age group 12. Males aged 50+, excluding key populations in this age group 13. Females aged 50+, excluding key populations in this age group
Program expenditure areas defined in the model and included in optimization analysis	1. Condoms and Social Behavior and Communication Change 2. Programs for female sex workers and clients 3. Programs for men who have sex with men 4. Programs for drug users 5. Programs for military personnel 6. HIV testing services (general population) 7. Antiretroviral therapy 8. HIV prevention programs for prisoners 9. PMTCT	1. Condom promotion and distribution. Mass media programs, behavior change, HIV education 2. Service package including interpersonal communication and counselling, condom provision, peer education, HIV testing and counselling 3. Service package including interpersonal communication and counselling, condom provision, peer education, HIV testing and counselling 4. Service package including interpersonal communication and counselling, condom provision, peer education, HIV testing and counselling 5. Service package including interpersonal communication and counselling, condom provision, peer

CATEGORY	PARAMETERIZATION IN THE OPTIMA MODEL	DESCRIPTION/ ASSUMPTIONS
		education, HIV testing and counselling 6. Provider-initiated and voluntary testing and counselling (delivered outside programs for specific key populations) 7. Antiretroviral therapy for all population groups 8. HIV testing and counselling, interpersonal communication and counselling 9. Prevention of mother-to-child transmission
Expenditure areas not included in mathematical optimization – indirect programs (because the effect on HIV incidence, morbidity/mortality were not clear, or because the expenditure is central systems expenditure that is essential for several program areas)	1. Costs for indirect programs, also called enablers and synergies, have not been optimized (as they do not have measurable epidemic impact) but instead were fixed at agreed amounts. The components of HIV spending that were not included in the optimization analysis include: *a.* STI *b.* Health infrastructure *c.* HIV care *d.* Management *e.* Human resources and training *f.* Enabling environment g. Monitoring, evaluation, surveillance and research *h.* Other	1. Diagnosis and treatment of sexually transmitted infections 2. Upgrading and construction of health infrastructure 3. Opportunistic infection treatment and other care for PLHIV including psycho-social support 4. Co-ordination and response management 5. Cross-cutting human resource costs – not specific to individual programs 6. Advocacy, stigma reduction 7. Research studies, surveys, monitoring evaluation and surveillance activities 8. Includes costs not assigned elsewhere such as blood safety, PEP, male circumcision, social protection, orphans and vulnerable children, and other prevention programs not classified
Time frames over which the optimization was considered	▪ 2000 – starting year for data entry ▪ 2016–20 (government's timeline for achievements of new national HIV strategic plan targets) ▪ 2020 (interim timeline for international targets) ▪ 2030 (new UNAIDS horizon for ending AIDS)	
Baseline scenario funding	1. 2014 Global AIDS Response Progress Report values	

2.3 CALIBRATION

A key stage in the Optima modeling process is a stage known as 'calibration'. Calibration represents a model validation process in which Optima-projected trends are aligned

with the historically observed trends in HIV prevalence in different population groups in a given context. Given the challenges inherent in fitting epidemiological and behavioral data, the calibration for Togo was performed manually (i.e. by varying relevant model parameters in order to attain a best-fit between model-projected and historic HIV prevalence across different population cohorts). Where data were limited, these trends were compared with the registered new diagnoses and Spectrum estimates[60].

Once the Optima model is calibrated, it can project future expected trends in the HIV epidemic as described in **Section 3**.

2.4 COST-COVERAGE-OUTCOME RELATIONSHIPS

The relationship between program spending and coverage is shown in the left panel of **Figure 2.1**. This relationship describes the level of output achieved with a specific level of financial input. In the context of these analyses, output is defined as the availability of a service to a specific proportion of the target population. Coverage refers to the number of the population reached. For example, this relationship would describe how many MSM can be provided with a standard package of services with an investment of 0 to USD 1,000,000. The relationship between coverage levels and outcome is shown in the right panel. This relationship describes the proportion of people who will adopt a specific behavior (such as condom use or consistent use of ARVs leading to viral suppression). These analyses were produced in collaboration with Togo on experts and the full set of figures can be seen in the **Annex 3**.

The cost-coverage-outcome relationships are utilized, together with the calibration projections, to run the optimization and scenario analyses described in **Sections 5, 6, 7 and 8**.

Figure 2.1 Logistic cost-outcome relationships for Togo.[61]

[60] http://www.avenirhealth.org/software-spectrum.php

[61] The black dots represent available spending and coverage data, and associated behaviors. The solid curves are the best fitting or assumed relationships.

2.5 ALLOCATIVE EFFICIENCY ANALYSIS

Efficiency analyses must be informed by local priorities. Togo is currently drafting a new national HIV strategy for 2016–20. According to the draft National HIV Strategic Plan available at the time of this analysis, the strategy for 2016–20 will aim to reduce new infections, provide comprehensive care, and ensure good governance[62]. This is to be achieved via a universal approach including targeted prevention, treatment, care and support services - all based on upholding human rights and non-discrimination.

To support these national priorities and assist Togo with sustainability planning, this report will answer the following five questions: 1) What is the trajectory of the epidemic under different scenarios, in comparison to current epidemic trends under the current HIV response? 2) How can Togo optimize the allocation of HIV funding, and how close can the country get to minimizing new HIV infections and HIV-related deaths? 3) How can Togo optimize the allocation of different levels of HIV funding, and how close will the country get to minimizing new HIV infections and HIV-related deaths? 4) What is the minimum spend required to achieve National Strategic Plan targets if resources are allocated optimally? 5) What are the long-term financial commitments to care and treatment for people living with HIV according to different investment options in the short-term?

Each of these questions is the subject of an analytical module as described in more detail below.

ANALYSIS 1: WHAT IS THE TRAJECTORY OF THE EPIDEMIC UNDER DIFFERENT SCENARIOS, IN COMPARISON TO CURRENT EPIDEMIC TRENDS UNDER THE CURRENT HIV RESPONSE RESOURCE ALLOCATION?

This analysis compares the trajectory of the epidemic and key outcomes under the current allocation of resources described in **Section 3**, with different scenarios (**Section 5)**. These scenarios include:

1. Attaining 90-90-90 targets: In this scenario it was assumed that by 2020, 90% of PLHIV will be aware of their status and 90% of diagnosed PLHIV will be on ART[63].
2. 90% PMTCT coverage: In this scenario, the possible impact of achieving 90% PMTCT coverage of all pregnant women living with HIV is explored.

In the analyses described in **Section 5,** we estimate the epidemic impact if specific outcome levels or targets are achieved, regardless of cost and coverage considerations, except for a basic estimate of the cost required to achieve the 90-90-90 targets.

[62] Togo National HIV Strategic Plan 2016-2020.

[63] Treatment efficacy in reducing new infections for PLHIV on ART was assumed to be 70%.

ANALYSIS 2: WHAT CAN BE IMPROVED BY OPTIMIZING THE ALLOCATION OF CURRENT FUNDING?

This analysis compares the trajectory of the epidemic and key outcomes under the current allocation of resources, against an optimized allocation of the same resources. For the purposes of this analysis, funding remains at current levels and is not varied. Only the way that funding is spent changes. The aim is to determine whether Togo could allocate its available resources better.

- The results of this analysis are described in **Section 6**.

ANALYSIS 3: HOW MUCH WILL IT COST TO ACHIEVE PROPOSED NATIONAL HIV STRATEGIC PLAN TARGETS?

This analysis identifies the minimum resource requirements to achieve possible national strategy targets. As the new National HIV Strategic Plan targets had not been fully defined at the time of writing, analyses were run to establish how much funding is required to a) reduce new infections and deaths by 25% and b) reduce new infections and deaths by 50%. The results of these analyses are presented in **Section 7**.

ANALYSIS 4: WHAT ARE THE LONG-TERM FINANCIAL COMMITMENTS TO CARE AND TREATMENT OF PEOPLE LIVING WITH HIV ACCORDING TO DIFFERENT INVESTMENT OPTIONS IN THE SHORT-TERM?

This analysis reviews the long-term financial impact of achieving National Strategic Plan targets. Specifically, this analysis compares the commitments one would expect to result from the current allocation of the 2014 budget, against the optimized allocation to reduce new infections and deaths by 50%, as described in section 7. The findings from this analysis are presented in **Section 8**.

2.6 LIMITATIONS OF THE ANALYSIS

All mathematical models have their strengths and limitations. Results should therefore be interpreted with the necessary caution. However, as with all modeling, this exercise used the best data available to produce guidance for decision making as the logical implication of available evidence. In particular, it is important to note that:

1. All model forecasts are subject to uncertainty. This includes assumptions regarding resources available for all programs, including ART and underlying behavioral changes. Therefore, point-estimates are indicative of trends rather than exact figures.
2. The model calibration depends as much on the quality of input data as on the quality of the model itself. The country and study teams have done everything possible to ensure the best possible data quality but it is never possible to have a complete, or completely certain dataset. The best model calibration will rarely achieve an exact match with historical data, but will closely mirror key trends.
3. Data in Togo are often not collected specifically for a 25–49 year category, but rather for a 15–49 year category, resulting in greater uncertainty around the trajectory for 25–49 year olds as there was limited disaggregated data for this age-group.

4. Surveillance of key populations in this context is complex and may result in the underestimation of the size of these populations, as well as an urban bias in the estimates.

5. There is some uncertainty in the epidemic projections for certain populations where multiple prevalence data points were available. These data sometimes showed very large decreases in HIV prevalence over a short time frame. This is may be due to a lack of external validity and consistency across survey rounds. This was accommodated through the use of 'best fits' between observed extreme data points.

6. There is uncertainty surrounding the number of registered PLHIV. In 2014, it was estimated that 57,356 (52%) had been diagnosed[64] but this is acknowledged to be an estimate as HIV-related deaths are not monitored.

7. For some population groups, behavioral data (e.g., condom use at last act) and population size estimates were limited.

8. The modeling approach used to calculate relative cost-effectiveness between programs includes assumptions about the impact of increases or decreases in availability of funding for programs. These assumptions are based on unit costs and observed ecological relationships between outcomes of program coverage or risk behavior and the amount of money spent on programs in the past, assuming that there would be some saturation in the possible effect of programs with increases in spending.

9. The cost-coverage-outcome relationships were derived from actual cost and coverage values for 2014. As unique identifier codes are not routinely used in Togo, coverage estimates were derived using triangulation of available data for certain programs and from discussions with country experts.

10. The analysis presented in this report does not determine the technical efficiency of programs as this was beyond the scope of the analysis. However, gains in technical efficiency may lead to lower unit costs and would therefore affect the optimized resource allocation described in this report.

11. Modelling the optimization of allocative efficiencies depends critically on the availability of evidence-based parameter estimates of the effectiveness and cost-efficiency of individual interventions. Interventions/programs for which these parameter estimates do not exist, such as for many of the critical enablers, will be excluded for the mathematical optimization analysis. However, this does not mean that these programs should not receive funding. In addition, there are uncertainties around parameter estimates of some of the critical clinical interventions (e.g., ART and the parameter estimates such as the preventive effect of ART), which may distort the results.

12. Effects of the programs outside the HIV endpoints including, for example, the wider health and non-health benefits of FSW and MSM programs (beyond those directly related to HIV) and the effects of reduced drug use, are not included in this model.

13. The Optima modeling approach does not seek to quantify the human rights, stigma and discrimination, ethical, legal or psychosocial implications of providing

[64] Rapport Annuel D'activite de la Reponse Nationale Contre le VIH/SIDA en 2014. In-country experts acknowledge that while this value is the best estimate regarding this indicator, it is still an estimate

or withdrawing care. The authors acknowledge that these are important aspects to consider when allocating funding to health services.

14. Other models may produce different projections than those produced by Optima. This is an underlying property when using theoretical mathematical frameworks. Different designs of the framework may generate different outcome projections. In addition, the analyses presented in this report have made use of the best available country data, experience gained from applying the Optima model in many countries, and comparisons within the WCA region, for the validation and contextualization of inputs and findings wherever possible.

3 WHAT ARE THE EXPECTED TRENDS IN THE EPIDEMIC IF CURRENT SPENDING VOLUME AND PATTERNS ARE MAINTAINED?

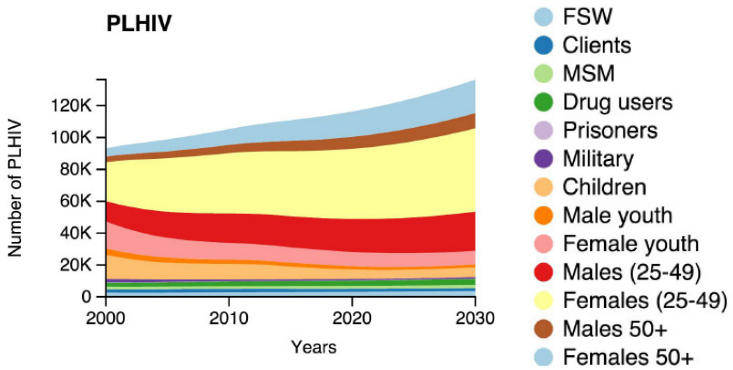
In this section, the modelled projections of the HIV epidemic are described. These results are based on the calibration process and assume that current (2014) spending levels and coverage (absolute number of PLHIV on ART) are maintained. Further calibration results are provided in the **Annex 2**.

3.1 PEOPLE LIVING WITH HIV

With current levels of funding and current allocations to HIV intervention programs maintained, the model projects that the number of people living with HIV (PLHIV) is projected to increase from a model-estimated 110,400 in 2014, to 117,318 (6%) by 2020 and 136,447 (24%) by 2030 (**Figure 3.1**). This increase is due in part to an expected stabilization in HIV incidence and an increase in Togo's population size[65]. **Figure 3.1** shows that in 2014, 60% of PLHIV were females aged 15+ years, whilst males aged 15+ years made up 33% of PLHIV.

Projecting forward to 2030, males are expected to continue to comprise around one-third of the expected PLHIV, whilst almost two-thirds of PLHIV are expected to be female. The percentage of children living with HIV is expected to reduce over this time period. Amongst both males and females in the general population, the model estimates that a larger proportion of PLHIV will be in populations older than 25 years by 2030. Key populations made up an estimated 10% of all PLHIV in 2014, and this is expected to stabilize at 9% by 2030.

Figure 3.1 Calibration of PLHIV



[65] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2002rank.html

3.2 HIV PREVALENCE

Overall prevalence is projected to decrease from modeled estimates of 1.6% in 2014 to 1.5% in 2020 and 1.3% by 2030 (**Figure A2.2**), although this percentage will be of a larger total population in 2030. Although estimated prevalence is higher among key populations than in the general population, the epidemic in most key populations is stabilizing.

Between 2014 and 2030, prevalence is expected to decrease from 16.8% to 13.8% in FSW, and as prevalence among clients is substantially influenced by FSW prevalence, prevalence among clients is projected to decrease from 2.1% to 1.3%. Prevalence is also projected to decrease among MSM from 16.6% to 13.7%, and from 4.0% to 3.2% among prisoners. Among drug users, prevalence is expected to decline from 5.3% to 4.5% and for military personnel, it is expected to decrease from 4.9% to 3.1% over the same time period. However, these prevalence estimates should be treated as indicative only. Changes in risk behaviors, mobility or interactions with epidemics in neighboring countries may influence future trends. Projections within small populations such as these will always be more sensitive to small changes in risk factors than projections calculated for larger scale epidemics.

Among some groups in the general population, prevalence is expected to stabilize, with non-significant or very small reductions between 2014 and 2030: from 0.3% to 0.1%, in children, from 0.4% to 0.2% among male youths (15–24 years), from 1.3% to 0.8% among female youths, from 2.7% to 2.3% in men aged 25–49 years, and from 4.4% to 3.9% for women of the same age. Among the general population aged 50+ years, prevalence is expected to increase very slightly between 2014 and 2030: from 2.2% to 2.3% in men and from 3.5% to 4.0% in women in this age category. This is partially due to the positive effects of ART and PLHIV living longer.

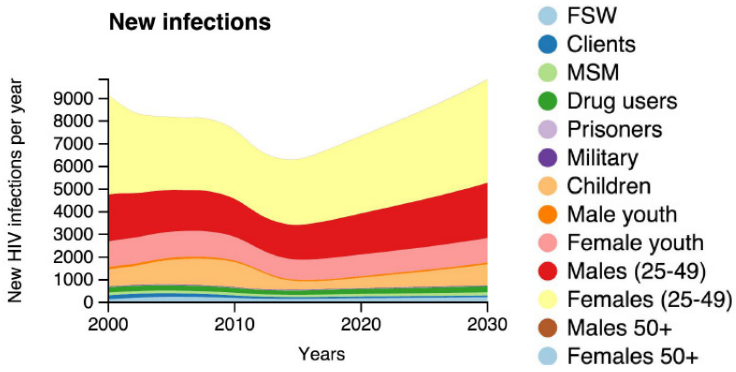
3.3 HIV INCIDENCE

HIV incidence has declined since 2000 to an estimated 0.09 per 100 person-years in 2014. The model predicts that, with the current allocation of funds, overall incidence will stabilize from 0.090 in 2014 to 0.097 per 100-person years in 2030.

New infections are projected to increase by 20% from an estimated 6,300 new infections per year in 2014 to 7,500 per year in 2020, and by 57% to an estimated 9800 per year in 2030 (**Figure 3.2**). The majority of new HIV infections in 2014 were estimated to be among females 25-49 (45%), males 25–49 (24%) and female youth (14%). These three population groups are predicted to still have the highest number of new infections in 2030: females 25-49 (46%), males 25–49 (25%) and female youth (11%).

If PMTCT coverage is not scaled up, the percentage of new infections among children is expected to increase from 6% in 2014 to 9% in 2030.

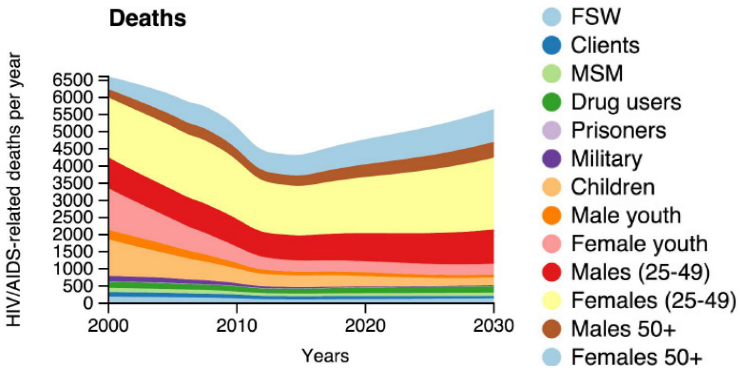
Figure 3.2 Calibrated number of new HIV infections per year



3.4 AIDS-RELATED DEATHS ARE LOW BUT PREDICTED TO INCREASE

AIDS-related deaths are estimated to have decreased to approximately 4300 deaths in 2014. However, under current coverage of programs, the number of deaths attributable to HIV is predicted to increase by 12% to 4,800 in 2020 and by 31% 5,700 (31%) by 2030 if PLHIV are not diagnosed promptly and put onto treatment[66] (**Figure 3.3**).

Figure 3.3 Calibration predicted number of deaths due to HIV in Togo[67]



3.5 THE NUMBER OF PEOPLE REQUIRING HIV TREATMENT WILL INCREASE

At the end of 2014, 33% of PLHIV were receiving HIV treatment. However, with the predicted increase in new infections, demand for treatment will rise and potentially widen the substantial existing treatment gap. Furthermore, Togo currently only provides treatment when a CD4 count is less than 500cells/mm3. However, current WHO guidelines now recommend commencing treatment for adults at any CD4 count[68]. If Togo is to adhere to international guidelines for HIV treatment, additional existing

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66 Note that in calibration, the Optima model assumes that the number of PLHIV on ART remains constant.

67 This assumes stable behaviors and coverage of services

68 WHO, September 2015 (http://www.who.int/hiv/pub/guidelines/earlyrelease-arv/en/)

PLHIV will require treatment in additional to a greater proportion of newly diagnosed PLHIV.

4 WHAT IS THE IMPACT OF PAST AND CURRENT SPENDING?

4.1 TREATMENT RECEIVES THE MAJORITY OF CURRENT FUNDING

Care and treatment including ART and HIV care, is the largest component of HIV spending in Togo, at an average of 40% of total spending since 2006 **(Figure 4.1).** In 2014, approximately 50% of total HIV spending was allocated to treatment, most of which was spent on ART **(Figure 4.1)**. As shown in **Figure 4.2**, the majority of funding for treatment in 2014 was financed from international donors.

By comparison, spending on preventive programs for key and general populations - such as condom promotion and social behaviour change communication- constituted around 15% of total HIV spending in 2014. Spending on these and other non-ART preventative programs has decreased substantially since 2006, when it represented more than 50% of HIV spending. From 2013 to 2014, total spending on key priority prevention and treatment programs declined significantly from approximately USD 14 million, to less than USD 12 million (**Figure 4.3)**. In the context of a growing population, this reduction signals a significant contraction in per capita spending.

Program management is the main indirect cost category in this context and constitutes an average of 21% of total HIV spending since 2006 **(Figure 4.1)**. Although spending on program management was reduced to 16% of total spending in 2014, this proportion remains slightly higher than total spending on preventative programs. Spending on human resource is the second largest indirect cost item, which constituted around 11% of total HIV spending in 2014. Technical efficiency analyses may assist with discerning ways in which to decrease these costs.

Figure 4.1 HIV expenditure in Togo by category[69]

[69] Source: National HIV/AIDS Spending report 2006-2014.

Figure 4.2 HIV expenditure in Togo by category and funding source for 2014[70]

Figure 4.3 Trends in spending across key priority prevention and treatment programs[71]**.**

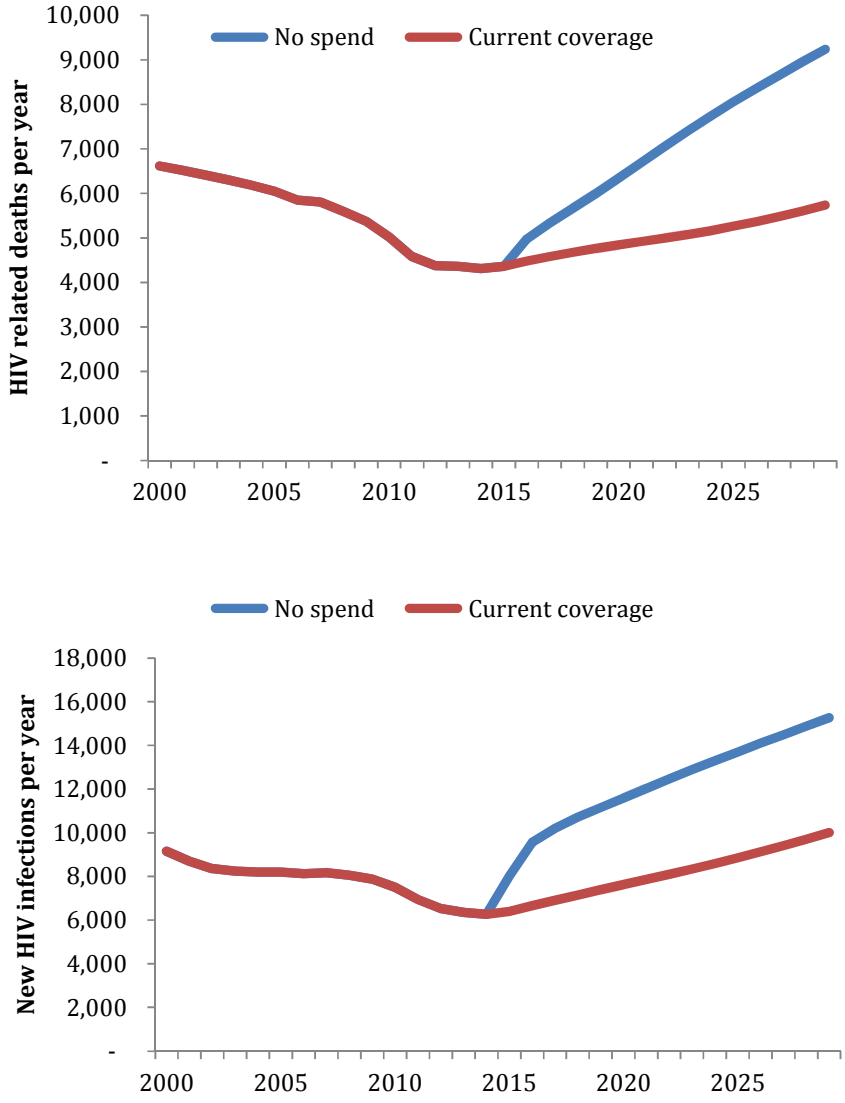
4.2 CURRENT HIV INVESTMENT AVERTS INFECTIONS AND DEATHS

Model–based projections of the epidemic demonstrate that current spending on HIV prevention and treatment programs will continue to avert new infections and deaths. In the absence of any spending on the HIV epidemic, the model estimates that 30,000 (42%) more deaths would occur and 60,600 (52%) more people would be infected by 2030 (**Figure 4.4**). This highlights the need to continue investing in an HIV response and the significant impact of current investments.

[70] Source: National HIV/AIDS Spending report 2014.

[71] HTC program mainly covers people from Key Population groups in the context of Togo.

Figure 4.4 Model-estimated impact of current spending compared to no spending on the HIV response, 2016 – 2030[72]



[72] No spending' assumes that there is no spending on the HIV response. 'Current coverage' assumes that current funding levels and allocations remain stable and achieve coverage in line with the cost-coverage-outcome curves defined in the model.

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5 PREDICTING THE TRAJECTORY OF THE HIV EPIDEMIC: COMPARING HIV RESPONSE SCENARIOS

5.1 COMPARING HIV RESPONSE SCENARIOS

In the previous section, we compared current spending levels and allocations, against a 'no spending' scenario. **Figure 4.4** demonstrates that the current response to the epidemic is reducing HIV incidence and HIV-related mortality from the levels one would expect in the absence of intervention. The Optima model predicts that this positive impact is likely to persist, and even grow, in the time period to 2030.

In this section, we ask whether reaching pre-specified targets regardless of the budget required, could further reduce prevalence, new infections and mortality. Here we compare the trajectory of the HIV epidemic by 2030 under the current HIV response, against three alternative response scenarios that are not constrained by a budget but are determined solely by targets. These scenarios were identified through consultation with local stakeholders and a range of experts. The epidemic trajectory is predicted for each of these scenarios and compared with the trajectory under current programmes, without determining the overall budget envelope required to achieve the defined targets in each scenario.

The two response scenarios used for comparison were:

1. Attaining 90-90-90 targets: In this scenario it is assumed that by 2020, 90% of PLHIV will be aware of their status and 90% of diagnosed PLHIV will be on ART[73].
2. Attaining 90% PMTCT coverage: In this scenario it is assumed that by 2020, 90% of all pregnant women living with HIV will be aware of their status, and 90% of diagnosed pregnant women living with HIV will be on ART.

Table 5.1 presents detailed information on parameters and targets specified in the alternative scenarios.

[73] Treatment efficacy in reducing new infections for PLHIV on ART was assumed to be 70%.

Table 5.1 Parameters and target values used in the alternative scenarios

TARGET POPULATION	PARAMETERS	ALTERNATIVE RESPONSE SCENARIOS*	
		Test and offer treatment (Baseline-2020)	Attaining 90% PMTCT coverage (Baseline – 2020)
FSWs	Proportion of sexual acts in which condoms are used with commercial partners	No change (93%)	N/A
	Proportion of people who are tested for HIV each year	N/A	N/A
Clients of sex workers	Proportion of sexual acts in which condoms are used with commercial partners	No change (61%)	N/A
MSM	Proportion of sexual acts in which condoms are used with casual partners	No change (86%)	N/A
	Proportion of sexual acts in which condoms are used with commercial partners	No change (67%)	N/A
	Proportion of people who are tested for HIV each year	N/A	N/A
Military	Proportion of sexual acts in which condoms are used with casual partners	No change (88%)	N/A
	Proportion of sexual acts in which condoms are used with commercial partners	No change (61%)	N/A
	Proportion of people who are tested for HIV each year	N/A	N/A
Drug users	Proportion of sexual acts in which condoms are used with casual partners	No change (27%)	N/A
	Proportion of people who are tested for HIV each year	N/A	N/A
Prisoners	Proportion of people who are tested for HIV each year	N/A	N/A
Females 15–49	Number of pregnant women receiving Option B/B+	N/A	4496–5913 (2016–20)
Number of PLHIV on ART (all populations)		34955-95028 (2014–20)	N/A
Proportion of people who are tested for HIV in each year (all populations)		52%-90%(2016-2020)	N/A

Note: * Baseline data in each scenario are from different years when the latest data was available.

The model-predicted evolution of annual new infections and deaths from 2000 to 2030, under these conditions, are shown in **Figures 5.1 and 5.2.** For the scenario of attaining 90% PMTCT coverage (**Figure 5.3**)**,** expected new infections among children for the same period is shown.

Overall, with the level and allocation of funding and coverage maintained as for 2014, the number of new HIV infections and HIV-related deaths are expected to increase. All

scenarios significantly reduce the number of new HIV infections and HIV-related deaths in comparison with the current spending and allocation. As previously mentioned however, these scenarios are not budget constrained.

Figure 5.1 Model-predicted evolution of annual new infections comparing current coverage with attaining 90-90-90 target (2000–30)

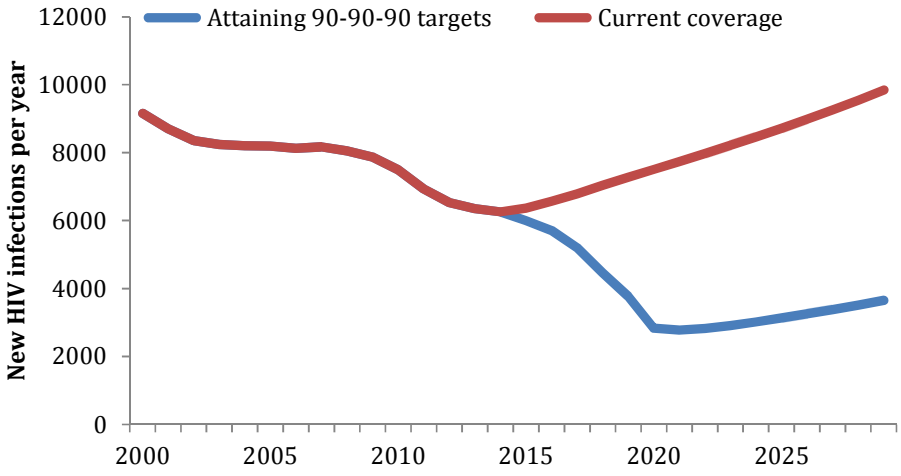


Figure 5.2 Model-predicted evolution of annual HIV-related deaths comparing current coverage with attaining 90-90-90 target scenarios (2000–30)

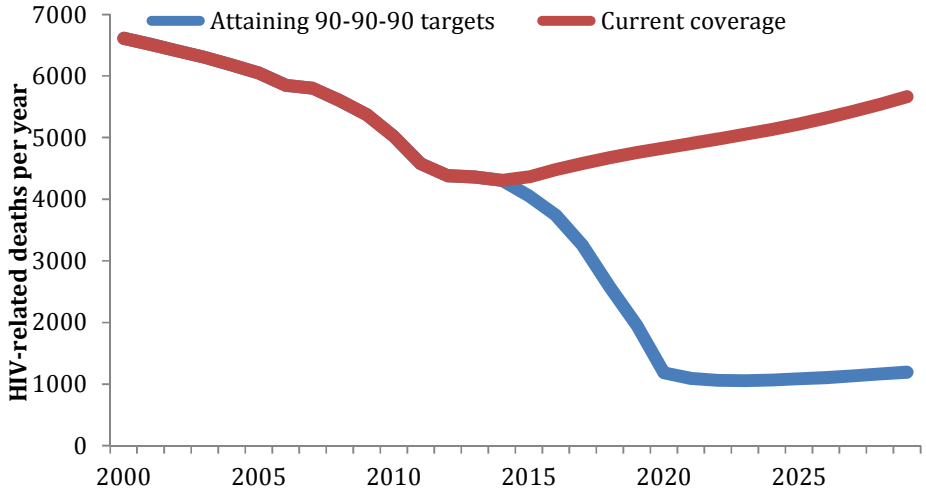
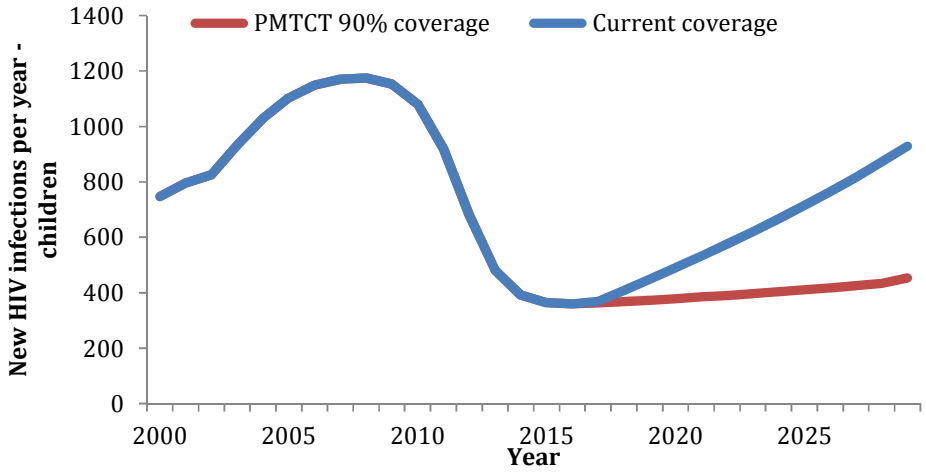


Figure 5.3 Model-predicted new infections for children comparing current coverage with attaining 90% PMTCT coverage 2020 target (2000–30)



These analyses predict that *Scenario 1*, attaining 90-90-90 targets, will substantially reduce new infections and deaths compared with the current strategy. *Scenario 1* is estimated to result in 56% or 63,500 fewer infections, and 68% or 47,900 fewer deaths by 2030, compared with current coverage.

These findings also show that attaining 90% coverage for PMTCT by 2010 (*Scenario 2*), could reduce the number of new infections among children by 35%, with 3,000 new infections averted.

5.2 ESTIMATED BUDGET REQUIRED TO ATTAIN THE 90-90-90 TARGETS

In reducing the number of deaths and new infections over time, *Scenarios 1 and* 2 are significantly more effective than the current HIV response. This demonstrates the importance of ensuring high testing and treatment coverage for all populations, including key populations. We now provide estimates for the cost required to attain the 90-90-90 targets. In order to derive these estimates, a number of assumptions needed to be applied, as noted below:

- The estimated 110,400 PLHIV in 2014, has been derived from the model calibration which takes multiple parameters into account
- The model assumes that current conditions continue beyond 2014 i.e. stable behaviors and coverage of programs
- 2014 unit costs have been applied to all years. For ART this was USD 265.35 per patient, per year[74] and for testing this was USD 3.91 per test[75]. Changes in the unit cost over time will affect these estimates.

[74] National HIV/AIDS Spending report, 2014.

[75] Coûts unitaires des services de prévention, de traitement et de soutien dans la riposte nationale contre le VIH et le Sida au Togo, Aout 2014.

- It is assumed that 52% of PLHIV, or 57,356 people, were diagnosed in 2014[76]. In-country experts acknowledge that while this value is the best available estimate for this parameter, it is remains an estimated figure.
- It was necessary to make assumptions about the value of the positive testing rate. In 2014, 4.9% of the population tested were diagnosed with HIV. In the first instance the value of the positive testing rate was assumed to be stable at 4.9% for all years. Thereafter, the positive testing rate was reduced to 3% and increased to 10% in order to explore the resultant budgetary impact.
- This analysis constitutes a starting point in understanding the costs of reaching the 90-90-90 targets. However, this estimate is static and does not include all factors that affect the HIV care cascade such as stigma and discrimination. Further work is needed in this area.

5.2.1 COST OF TESTING

In order to achieve a target of 90% of PLHIV tested and diagnosed by 2020, this would cost approximately 3.2 million if 4.9% of the tested population were diagnosed each year. The estimated cost would range between USD 5.3 million (3% positive testing rate) and USD 1.6 million (10% positive testing rate). These are cumulative costs for the period 2016–20, at 2014 unit costs, in real terms.

5.2.2 COST OF TREATMENT

Achieving a target of 90% of diagnosed PLHIV on treatment by 2020 would cost approximately USD 93.7 million for treatment (**Table 5.2**). These again are cumulative costs for the period 2016–20, at 2014 unit costs, in real terms. This is a conservative estimate, assuming a static epidemic and stable unit costs, which would benefit from further analysis.

Table 5.2 Estimated cost required for treatment to reach 90-90-90 target

YEAR	ESTIMATED NUMBER OF PLHIV (OPTIMA CALIBRATION RESULTS)	% TREATMENT COVERAGE	NUMBER OF PLHIV ON TREATMENT	ANNUAL COST TO PROVIDE TREATMENT IN 2014 REAL TERMS (USD)
2016	112,313	42.4%	47,621	12,636,057
2017	113,381	51.8%	58,731	15,584,256
2018	114,565	61.2%	70,114	18,604,462
2019	115,876	70.6%	81,808	21,707,660
2020	117,318	81.0%	95,028	25,215,395
Total 2016–20				**93,747,830**

[76] Rapport Annuel D'activite de la Reponse Nationale Contre le VIH/SIDA en 2014

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6 WHAT CAN BE IMPROVED BY OPTIMIZING THE ALLOCATION OF CURRENT FUNDING?

An optimization analysis was conducted to compare the allocation of the 2014 budget of USD 20,792,575[77] with an optimized allocation of the same budget for the time period 2016–30.

As figure 21 shows, findings of model-based analyses suggested that Togo is currently allocating its HIV budget in an efficient way. The current distribution of funding differs slightly from the model derived optimized allocation of the 2014 budget, which aims to minimize both new infections and deaths, but the gains remain too limited to significantly impact the course of the epidemic.

It should be noted however that the model assumes that the indirect cost for management and enablers are stable and these were therefore fixed as USD amounts. However, if all indirect costs were reduced by 25%, then 16,900 more PLHIV might be placed onto treatment. This could avert approximately 19,900 new infections and 15,400 deaths by 2030. As management costs make up a large proportion of indirect costs, just reducing management costs by 25% might enable an extra 10,600 people to be put onto treatment, thus averting 9,900 deaths and 11,000 new infections by 2030.

[77] This figure does not include spending on HIV. However, only direct programs such as key population programs (FSW, MSM, drug users, military, prisoner), ART, PMTCT, condoms and SBCC and HTS programs are included in the optimization analysis. The indirect programs or cost items such as management, enabling environment, monitoring and evaluation etc. were not included in the optimization analysis.

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7 HOW MUCH WILL IT COST TO ACHIEVE PROPOSED NATIONAL HIV STRATEGIC PLAN TARGETS?

The analysis in this section identifies the minimum annual resource requirements to achieve the proposed National Strategy targets described in **Section 2**. The analyses in this section aim for the full achievement of possible National HIV Strategic Plan targets, and determine the minimum investment required to achieve those goals with an optimized allocation. These analyses will assess the funding required to a) reduce new infections and deaths by 25% and b) reduce new infections and deaths by 50%.

Figure 7.1 shows the current allocation of 2014 spending and the minimum spending required - with an optimal allocation - to achieve the two targets described above. The model results presented here suggest that 32.2 million USD would need to be invested annually to achieve the first target of reducing new infections and deaths by 25%. This includes the fixed indirect costs mentioned previously in **Section 6**. This total budget is 55% more than the 2014 budget of USD 20.8 million. Similarly, this analysis estimates that new infections and deaths could be reduced by 50% with annual spending of around USD 39.2 million, which is 88% more than the 2014 spend. Table 6 shows the recommended spend across programs in order to reduce new infections and deaths by 50%.

In order to reach proposed targets of reducing new infections and deaths by 50%, the model recommends increased investments in ART, PMTCT and non-ART prevention programs, especially those targeted at FSW, drug users, prisoner and HTS programs.

Figure 7.1 Minimum annual spending required to meet selected targets

Table A1. 1 Current and optimized minimum annual spending required to meet NSP target to minimize both new infections an deaths by 50% for the period 2016–13

PROGRAM	2014 SPENDING (USD)	% OF 2014 BUDGET	ANNUAL SPEND REQUIRED TO REDUCE DEATHS AND NEW INFECTIONS BY 50% (USD)	% OF ANNUAL SPEND REQUIRED TO REDUCE DEATHS AND NEW INFECTIONS BY 50%
Condoms & SBCC	1,731,243	8.3%	418,002	1.1%
DU programs	45,020	0.2%	546,056	1.4%
Prisoner programs	1,612	0.01%	47,534	0.1%
HTS	251,929	1.2%	472,589	1.2%
FSW programs	255,960	1.2%	755,912	1.9%
MSM programs	77,234	0.4%	3,416	0.01%
Military programs	4,672	0.02%	3,239	0.01%
ART	9,275,229	44.6%	25,578,089	65.3%
PMTCT	624,169	3.0%	2,834,344	7.2%
MGMT	2,207,263	10.6%	2,207,263	5.6%

PROGRAM	2014 SPENDING (USD)	% OF 2014 BUDGET	ANNUAL SPEND REQUIRED TO REDUCE DEATHS AND NEW INFECTIONS BY 50% (USD)	% OF ANNUAL SPEND REQUIRED TO REDUCE DEATHS AND NEW INFECTIONS BY 50%
HR	2,338,274	11.2%	2,338,274	6.0%
ENV	277,017	1.3%	277,017	0.7%
M&E	1,521,866	7.3%	1,521,866	3.9%
INFR	251,300	1.2%	251,300	0.6%
STI	69,398	0.3%	70,398	0.2%
Care	1,441,228	6.9%	1,441,228	3.7%
Other	419,162	2.0%	419,162	1.1%
Total	**20,792,576**		**39,185,688**	

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8 WHAT ARE THE LONG-TERM FINANCIAL COMMITMENTS TO HIV SERVICES FOR PLHIV?

This analysis reviews the long-term financial impact of achieving the National Strategic Plan targets. Long-term impact refers to all long-term financial liabilities arising from the commitment to provide HIV and related health services to PLHIV in the future. In monetary terms, a financial commitment is the discounted cost of providing HIV services for PLHIV in a particular year. It includes HIV treatment costs, HIV related health care costs and social mitigation costs.

If the National Strategic Plan targets of reducing incidence and deaths by 50% are met by 2020, annual HIV-related response costs will increase by 41% between 2016 and 2030 due to the expected increase in the number of people on ART and the concomitant increase in life expectancy (**Figure 8.1**). The long-term costs of expanding ART as described in these analyses, ignores the income gains from a virally suppressed and therefore healthier and more productive working-aged population. The financial commitments caused by new infections each year i.e. life-time HIV care costs for newly diagnosed cases, could be reduced by 70% between 2016 and 2030 due to the expected reduction in new infections (**Figure 8.2**).

Figure 8.1 Annual HIV related spending for all old and new HIV infections up to 2030

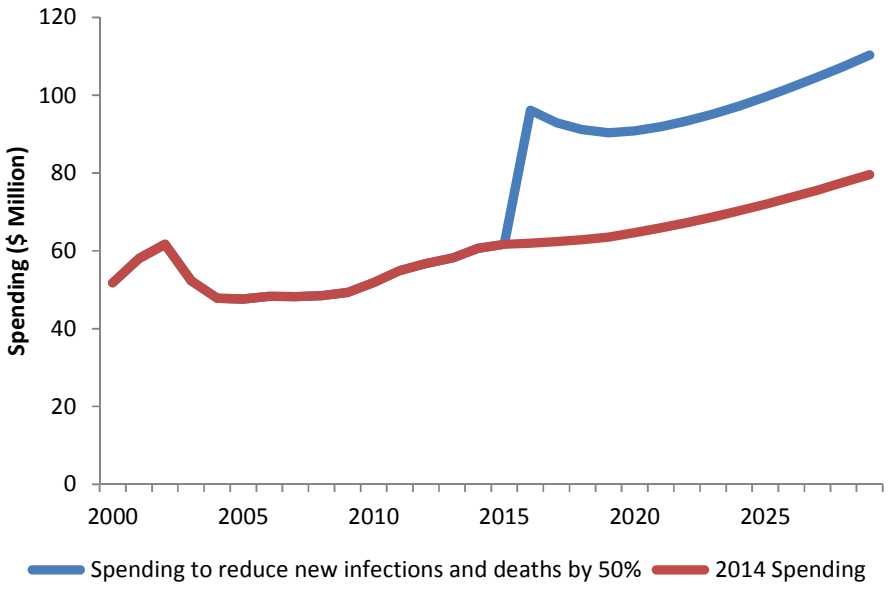
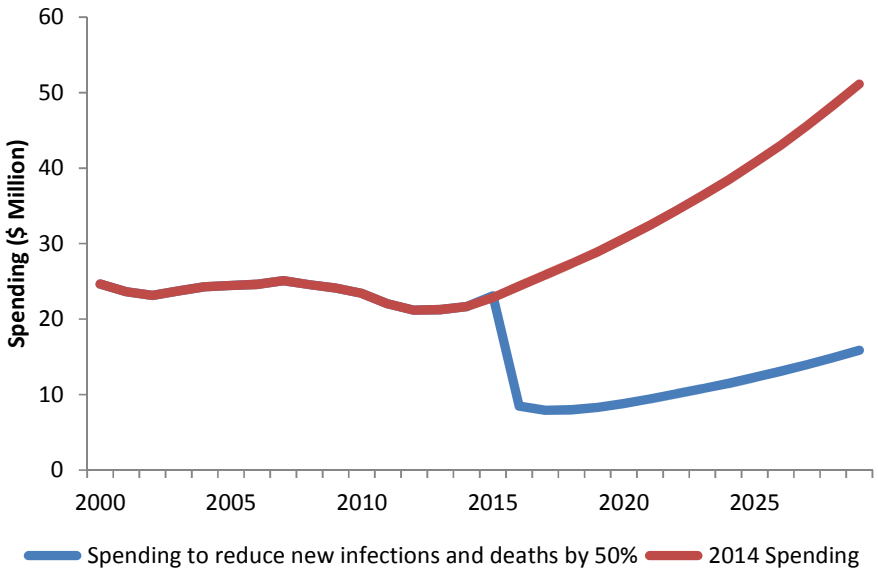


Figure 8.2 Predicted life-time HIV care costs of new diagnosed cases in each year



Program management and administration, the main indirect cost category in this context, constituted 9% of total HIV spending in 2013. This is lower than some other countries in the region but is higher than HIV care and treatment spending, which constituted 7% of total HIV spending in 2013. Although these indirect costs have been fixed in the analyses presented in this report – future work may explore opportunities to rationalize program management and administration costs, with the savings then allocated to the direct costs of the HIV response.

9 CONCLUSION

The Togolese government has responded effectively to a complex, mixed HIV epidemic. To assess HIV epidemic trends, we used Optima's epidemic module, calibrated to HIV prevalence data points available for different sub-populations in Togo. The model was also calibrated to data points on the number of people on ART from available data sources and in consultation with Togolese experts. **Analyses using this model highlight a strong risk that prevalence and incidence will continue to increase overall in Togo, if current ART coverage is not increased.** Togo's fast growing population will continue to challenge the HIV response, even in the context of stabilizing prevalence in many sub-populations.

The analyses suggest that the Togolese government's opportunities for optimization and better allocation of current HIV spending to further minimize HIV incidence, prevalence and HIV-related deaths are minimal. The findings highlight however a significant treatment gap, and in this context, argue strongly for additional funding, optimally allocated, to achieve 90-90-90 targets and respond most effectively to this epidemic.

Effective ART scale-up is needed. Coverage must be increased if global targets are to be met: In 2014, 33% of Togo's estimated 110,400 people living with HIV received treatment, compared with a global target of 81% by 2020. In order to reduce AIDS-related death s and new infections, optimizing resource allocations will require increased spending on ART.

In order to reduce the treatment gap, whilst ensuring additional funding for non-ART HIV programs for key populations, in particular FSW which are a key driver of the epidemic, a series of concomitant actions are required: reduced spending on general prevention programs targeting low-risk population, a larger budget envelope, prioritization of spending on core programs, reduced spending on indirect programs where feasible, technical efficiency gains, investment from budgets not earmarked for HIV that benefit from the broader public health impacts of key population programs.

The analysis shows indeed that in order to reduce incidence and deaths by 50%, resources should be shifted from prevention programs targeting the general low risk population to non-ART key population programs, ART and PMTCT.

Key population HIV programs would benefit from fully integrating ART initiation and adherence. As ART is an effective prevention strategy, it would be beneficial if ART was a central component of the prevention strategy and as such, integrated into the design and implementation of prevention strategies. The model recommends a proportionately higher increase of spending of key populations within PLHIV to be put onto treatment.

Additional domestic resources will be needed to sustain the HIV response. Funding for HIV in Togo has increased since 2007. However, excluding ART, preventive programs and programs targeted at key populations are primarily funded by international donors. As such, the withdrawal of international funding without a concurrent increase in domestic resources would have a significant negative impact on the HIV epidemic in Togo.

Greater technical efficiency in spending might be achieved through strategies to reduce the average spend per person reached. This is particularly true for indirect spending. Care should be taken however, that these strategies do not compromise the quality of prevention or treatment and further analyses of technical efficiency are needed before more robust conclusions can be reached.

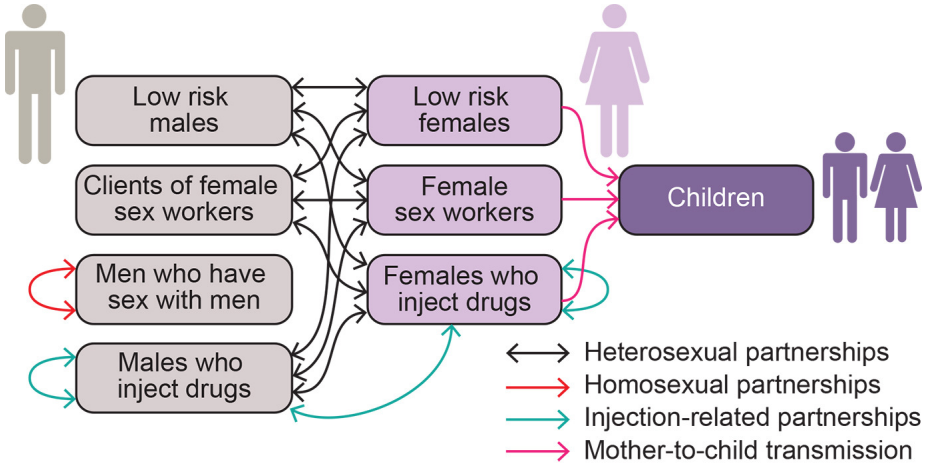
By modelling the likely trajectories of the HIV epidemic under different conditions, the analysis highlighted the significant gains already achieved with current spending in the form of new infections and deaths averted. **However, analyses of what may be needed to achieve the proposed targets of the National Strategic Plan have identified a clear need for increased investment in an optimized HIV response in Togo. All the results from this study point towards the conclusion that Togo currently doesn't have the appropriate resources to achieve its targets and that optimization gains alone cannot close this gap.**

10 ANNEXES

ANNEX1 OPTIMA MODEL: TECHNICAL SUMMARY

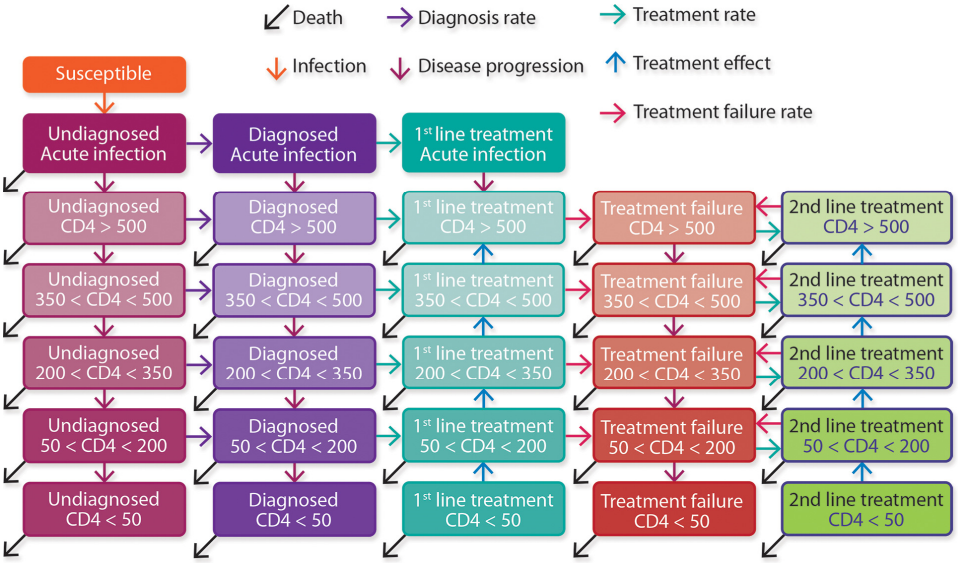
This Annex provides a brief technical overview of Optima. A more detailed summary of the model and methods is provided elsewhere.[1] Optima is based on a dynamic, population-based HIV model. Schematic A, within **Figure A1.1A** provides an example of some of the populations included in the model and mixing patterns used in Optima. Schematic B, within **Figure A1.1B** shows the disease progression implemented in the model. Optima tracks the entire population of people living with HIV (PLHIV) across 5 stages of CD4 count. These CD4 count stages are aligned to the progression of WHO treatment guidelines, namely, acute HIV infection, >500, 350–500, 200–350, 50–200, and, 50 cells per microliter. Key aspects of the antiretroviral therapy (ART) service delivery cascade are included: from infection to diagnosis, ART initiation on first-line therapy, treatment failure, subsequent lines of therapy, and HIV/AIDS-related or other death.

Figure A1.1A Example population groups and HIV transmission-related interactions in Optima.



[1] Kerr C, Stuart R, Gray R, Shattock A, Fraser N, Benedikt C, Haacker M, Berdnikov M, Mahmood AM, Jaber SA, Gorgens M, Wilson DP. Optima: a model for HIV epidemic analysis, program prioritization, and resource optimization. In: JAIDS Journal of Acquired Immune Deficiency Syndromes 03/2015.

Figure A1.1B Schematic diagram of the health state structure of the model



Note: Each compartment represents a single population group with the specified health state while each arrow represents the movement of numbers of individuals between health states. All compartments except for "susceptible" represent individuals living with HIV. Death includes all causes of death.

The model uses a linked system of ordinary differential equations to track the movement of PLHIV between HIV health states; the full set of equations is provided in the supplementary material to a summary paper on the Optima model. The overall population is partitioned in 2 ways: by population group and by HIV health state. Individuals are assigned to a given population group based on their dominant risk.[2] HIV infections occur through the interaction between different populations by regular, casual, or commercial (including transactional) sexual partnerships, through sharing of injecting equipment or through mother-to-child transmission. The force-of-infection is the rate at which uninfected individuals become infected, and it depends on the number and type of risk events to which individuals are exposed in a given period (either within their population groups or through interaction with other population groups) and the infection probability of each event. Mathematically, the force of- infection has the general form:

$$\lambda = 1 - (1 - \beta)^{n},$$

where λ is the force-of-infection, β is the transmission probability of each event, and n is the effective number of at-risk events (ie, n gives the average number of interaction events with HIV-infected people where HIV transmission may occur). The value of the transmission probability βvaries across CD4 count compartments (indirectly reflecting the high viral load at early and late stages of infection), differs for different modes of transmission (intravenous drug injection with a contaminated needle–syringe, penile–vaginal or penile–anal intercourse, and mother-to-child), and maybe reduced by

[2] However, to capture important cross-modal types of transmission, relevant behavioral parameters can be set to non-zero values (eg, males who inject drugs may engage in commercial sex; some MSM may have female sexual partners).

behavioral interventions (e.g., condom use), biological interventions (e.g., male circumcision), or ART.

There is one force-of-infection term for each type of interaction [e.g., casual sexual relationships between male sex workers and female sex workers (FSW)]; the force-of-infection for a given population will be the sum of all interaction types.[3] In addition to the force-of-infection rate, which is the number of individuals who become infected with HIV per year, there are 7 other ways individuals may change health states.[4]

The change in the number of people in each compartment is determined by the sum over the relevant rates described above, multiplied by the population size of the compartments on which they act. [5]

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[3] For sexual transmission, the force-of-infection is determined by:

- The HIV prevalence (weighted by viral load) in partner populations;
- The average number of casual, regular, and commercial homosexual and heterosexual acts per person per year;
- The proportion of these acts in which condoms are used;
- The proportion of men who are circumcised;
- The prevalence of sexually transmissible infections (which can increase HIV transmission probability);
- The proportion of acts that are covered by pre-exposure prophylaxis and post-exposure prophylaxis;
- The proportion of partners on antiretroviral treatment (ART); and
- The efficacies of condoms, male circumcision, post-exposure prophylaxis, pre-exposure prophylaxis, and ART at preventing HIV transmission.

For injecting-related transmission, the force-of-infection

is determined by:

- The HIV prevalence (weighted by viral load) in populations
- of people who use a syringe and then share it;
- The number of injections per person per year;
- The proportion of injections that use shared equipment;
- The fraction of people who inject drugs on opioid substitution therapy and its efficacy in reducing injecting behavior.

For mother-to-child transmission, the number of-infections is determined by:

- The birth rate among women living with HIV;
- The proportion of women with HIV who breastfeed;
- The probability of perinatal HIV transmission in the
- absence of intervention; and
- The proportion of women receiving prevention of mother-to- child transmission (PMTCT), including ART.

[4] First, individuals may die, either because of an average background death rate for that population (which is greater for older populations or for people who inject drugs) or because of HIV/AIDS (which depends on CD4 count). Second, in the absence of treatment, individuals progress from higher to lower CD4 counts. Third, individuals can move from undiagnosed to diagnosed states based on their HIV testing rate, which depends on CD4 count (eg, people with AIDS symptoms or primary HIV infection may have a higher testing rate) and population type (eg, FSW may test more frequently than males in the general population). Fourth, diagnosed individuals may commence ART, at a rate depending on CD4 count. Fifth, individuals may experience treatment failure because of lack of adherence to therapy or development of drug resistance, and sixth, people may initiate second and subsequent lines of treatment from treatment failure. Finally, while on successful first- or second-line treatment (ie, effective viral suppressive therapy), individuals may progress from lower to higher CD4 counts.

[5] For example, the change in the number of undiagnosed HIV-positive FSW with a CD4 count between 200 and 350 cells per microliter is:

Table A1.1 Input parameters of the model

	Biological Parameters	Behavioral Parameters	Epidemiological/Other Parameters
Population parameters	Background death rate		Population sizes (T, P)
HIV-related parameters	Sexual HIV transmissibilities* (H)		
	STI-related transmissibility increase*	Number of sexual partners* (T, P, S)	
	Condom efficacy*	Number of acts per partner* (S)	HIV prevalence (T, P)
	Circumcision efficacy*	Condom usage probability* (T, P)	STI prevalence (T, P)
	HIV health state progression rates (H)	Circumcision probability* (T)	
	HIV-related death rates (H)		
MTCT parameters	Mother-to-child transmission probability*	Birth rate*	
		PMTCT access rate* (T)	
Injection-related parameters	Injecting HIV transmissibility*	Number of injections* (T)	
	Syringe cleaning efficacy*	Syringe sharing probability* (T)	
	Drug-related death rate	Syringe cleaning probability*	
		Methadone treatment probability (T)	
Treatment parameters	ART efficacy in reducing infectiousness*	HIV testing rates (T, P, H)	Number of people on ART (T)
	ART failure rates		
Economic parameters	Health utilities		Costs of all prevention, care and treatment programs, enablers and management (T, I)
			Cost-outcome curves (T, I)
			Discounting and inflation rates (T)
			Health care costs

*Parameter is used to calculate the force-of-infection.
H, parameter depends on health state; I, parameter depends on intervention type; P, parameter value depends on population group; S, parameter depends on sexual partnership type; STI, sexually transmitted infection; T, parameter value changes over time.

Each compartment (B, boxes) corresponds to a single differential equation in the model, and each rate (Fig. A1.1B, arrows) corresponds to a single term in that equation. **Table A1.1** lists the parameters used in Optima; most of these are for calculating the force-of-infection. We interpret empirical estimates for model parameter values in Bayesian terms as previous distributions. The model must then be calibrated, which is the process of finding posterior distributions of the model parameter values such that the model generates accurate estimates of HIV prevalence, the number of people on treatment, and any other epidemiological data that are available (e.g., HIV-related deaths). The calibration can be performed automatically, manually, or a combination of both. This process of model calibration and validation should normally be performed in consultation with governments in the countries in which the model is being applied.

HIV RESOURCE OPTIMIZATION AND PROGRAM COVERAGE TARGETS

A novel component of Optima is its ability to calculate allocations of resources that optimally address one or more HIV-related objectives (e.g., impact-level targets in a country's HIV national strategic plan). Because Optima also calculates the coverage levels required to achieve these targets, it can be used to inform HIV strategic planning and the determination of program coverage levels. The key assumptions of resource optimization are the relationships between (1) the cost of HIV programs for specific

$$\frac{dU_{\mathrm{FSW}_{200-350}}}{dt} = U_{\mathrm{FSW}_{350-500}}\tau_{350-500} - U_{\mathrm{FSW}_{200-350}}\left(\mu_{200-350} + \tau_{200-350} + \eta_{\mathrm{FSW}_{350-500}}\right),$$

where $U_{FSW2002350}$ is the current number of undiagnosed HIV-positive FSW with a CD4 count between 200 and 350 cells per microliter, $U_{FSW3502500}$ is the same population but with higher CD4 count (350–500 cells/mL), t is the disease progression rate for the given CD4 count (where 1/t is the average time to lose 150 CD4 cells/mL), m is the death rate, and h is the HIV testing rate. (Note: this example does not consider movement between populations, such as FSW returning to the general female population and vice versa— something which is also included in Optima.)

target populations, (2) the resulting coverage levels of targeted populations with these HIV programs, and (3) how these coverage levels of HIV programs for targeted populations influence behavioral and clinical outcomes. Such relationships are required to understand how incremental changes in spending (marginal costs) affect HIV epidemics.[6] Logistic functions can incorporate initial start-up costs and allow changes in behavior to saturate at high spending levels, thus better reflecting program reality. The logistic function has the form:

$$L(x) = A + \frac{B - A}{1 + e^{-(x - C)/D}},$$

where L(x) relates spending to coverage, x is the amount of funding for the program, A is the lower asymptote value (adjusted to match the value of L when there is no spending on a program), B is the upper asymptote value (for very high spending), C is the midpoint, and D is the steepness of the transition from A to B. For our fits, we typically choose saturation values of the coverage to match behavioral data in countries with heavily funded HIV responses.[7] To perform the optimization, Optima uses a global parameter search algorithm called Bayesian adaptive locally linear stochastic descent (BALLSD). BALLSD is similar to simulated annealing in that it makes stochastic downhill steps in parameter space from an initial starting point. However, unlike simulated annealing, BALLSD chooses future step sizes and directions based on the outcome of previous steps. For certain classes of optimization problems, we have shown that BALLSD can determine optimal solutions with fewer function evaluations than traditional optimization methods, including gradient descent and simulated annealing.

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[6] A traditional approach is to apply unit cost values to inform a linear relationship between money spent and coverage attained. This is a reasonable assumption for programs like an established ART program that no longer incurs start-up or initiation costs, but less appropriate for condom promotion and behavior change communication programs. Most HIV programs typically have initial setup costs, followed by a more effective scale-up with increased funding. However, there are saturation effects for very high coverage levels because these require increased incremental costs because of demand generation and related activities for the most difficult-to-reach groups. Optima uses a logistic function fitted to available input data to model cost–coverage curves (See Annex 3).

[7] Program coverage for zero spending, or behavioral outcomes for zero coverage of formal programs, is inferred using data from early on in the epidemic or just before significant investment in HIV programs. Practically, we also discussed the zero and high spending cases with local experts who can advise on private sector HIV service delivery outside the governments' expenditure tracking systems. For each HIV program, we derive one set of logistic curves that relate funding to program coverage levels and another set of curves (generally linear relationships) between coverage levels and clinical or behavioral outcomes (ie, the impacts that HIV strategies aim to achieve).

UNCERTAINTY ANALYSES

Optima uses a Markov chain Monte Carlo (MCMC) algorithm for performing automatic calibration and for computing uncertainties in the model fit to epidemiological data. With this algorithm, the model is run many (typically 1000–10,000) times to generate a range of epidemic projections; their differences represent uncertainty in the expected epidemiological trajectories. The most important assumptions in the optimization analysis are associated with the cost–coverage and coverage– outcome curves. To incorporate uncertainty in these curves, users define upper and lower limits for both coverage and behavior for no spending and for very high spending.[8]

[8] All available historical spending data and achieved outcomes of spending, data from comparable settings, experience, and extensive discussion with stakeholders in the country of application can be used to inform these ranges. All logistic curves within these ranges are then allowable and are incorporated into uncertainty analyses of Optima. These cost–coverage and coverage–outcome curves are thus reconciled with the epidemiological, behavioral, and biological data in a Bayesian optimal way, thereby allowing the calculation of unified uncertainty estimates.

ANNEX 2 CALIBRATION FIGURES

Figure A2.1 Calibration of HIV prevalence among key populations and the overall HIV prevalence[1]

[1] Black dots represent available data for the number of people on ART. Lines attached to these discs represent uncertainty bounds. The solid curve is the best fitting simulation of total ART patient numbers.

Figure A2.1 Calibration of HIV prevalence among key populations and the overall HIV prevalence[2] (continued)

In the calibration process, model parameters were varied in order to obtain the most accurate fit from the available data for FSW, clients, MSM, drug users, prisoners, military personnel, male youth, female youth, females 25–49 and males 25–49 populations. Data for children, males 50+ and females 50+ populations were very limited and therefore the model was not calibrated against them but instead, model-derived estimates were utilized. In the case of fitting the prevalence in FSW, clients, MSM and male and female youth, there were large spreads in the historic data. Therefore, average estimates were used to derive the fitted curves (**Figure A2.2**).

[2] Black dots represent available data for the number of people on ART. Lines attached to these discs represent uncertainty bounds. The solid curve is the best fitting simulation of total ART patient numbers.

Figure A2.2 Model calibration to overall Incidence of HIV

Figure A2.3 Model calibration of number of DALYs

Figure A2.4 Model calibration of number of HIV diagnoses

Figure A2.5 Model calibration of number on treatment overall

ANNEX 3 COST-COVERAGE OUTCOME CURVES

Table A3.1 Selected behaviors affected by HIV programs

HIV Program	▪ Targeted Behavior (correlating parameter in model)
Programs for female sex workers and clients (package)	▪ Proportion of sexual acts in which condoms are used with commercial partners (FSW) ▪ Proportion of FSW who are tested for HIV each year
Programs for men who have sex with men (package)	▪ Proportion of sexual acts in which condoms are used with casual partners (MSM) ▪ Proportion of MSM who are tested for HIV each year
Programs for military personnel (package)	▪ Proportion of sexual acts in which condoms are used with casual partners ▪ Proportion of military personnel who are tested for HIV each year
Programs for drug users (package)	▪ Proportion of sexual acts in which condoms are used with casual partners (drug users) ▪ Proportion of drug users who are tested for HIV each year
Programs for prisoners (package)	▪ Proportion of people tested for HIV each year (prisoners)
PMTCT	▪ Number of HIV positive pregnant mothers receiving Option B/B+ (all selected populations)
Condom promotion and distribution and Social Behavior Change Communication (SBCC) (package)	▪ Proportion of sexual acts in which condoms are used with casual partners (male youth) ▪ Proportion of sexual acts in which condoms are used with casual partners (female youth) ▪ Proportion of sexual acts in which condoms are used with casual partners (males 25-49) ▪ Proportion of sexual acts in which condoms are used with casual partners (females 25-49)
HIV testing and counseling (general population)	▪ Proportion of male youth who are tested for HIV each year ▪ Proportion of female youth) who are tested for HIV each year ▪ Proportion of males 25-49 who are tested for HIV each year ▪ Proportion of females 25-49 who are tested for HIV each year ▪ Proportion of males 50+) who are tested for HIV each year ▪ Proportion of females 50+ who are tested for HIV each year
Antiretroviral therapy	▪ Number of people on ART (all population groups)

COST-COVERAGE OUTCOME CURVES FOR FSW PROGRAMS

Figure A3. 1 FSW – number covered by sex worker programs each year

Figure A3. 2 FSW – proportion of people who are tested for HIV each year

Figure A3. 3 FSW - Proportion of sexual acts in which condoms are used with commercial partners

COST-COVERAGE OUTCOME CURVES FOR MSM PROGRAMS

Figure A3. 4 MSM – number of people covered by the MSM programs

Figure A3. 5 MSM – proportion of sexual acts in which condoms are used with casual partners

Figure A3. 6 MSM – proportion of people tested for HIV each year

COST-COVERAGE OUTCOME CURVES FOR MILITARY PERSONNEL PROGRAMS

Figure A3. 7 Military personnel – number of people covered by the military programs

Figure A3. 8 Military personnel – proportion of sexual acts in which condoms are used with casual partners

Figure A3. 9 Military personnel – proportion of people tested for HIV each year

COST-COVERAGE OUTCOME CURVE FOR PMTCT PROGRAMS

Figure A3. 10 PMTCT therapy – number of people covered

COST-COVERAGE OUTCOME CURVE FOR DRUG USERS PROGRAMS

Figure A3. 11 Drug users – proportion of people covered by drug user programs

Figure A3. 12 Drug users – proportion of sexual acts in which condoms are used with casual partners

Figure A3. 13 Drug users – proportion of people who are tested for HIV each year

COST-COVERAGE OUTCOME CURVES FOR PRISONERS PROGRAMS

Figure A3. 14 Prisoners – proportion of people covered by prisoner programs

Figure A3. 15 Prisoners– proportion of people who are tested for HIV each year

COST-COVERAGE OUTCOME CURVES FOR GENERAL POPULATION MALE AND FEMALE POPULATION GROUPS

Figure A3. 16 General population – proportion of sexual acts in which condoms have been used with casual partners

Figure A3. 17 Male youth population – proportion of sexual acts in which condoms have been used with casual partners

Figure A3. 18 Female youth population – proportion of sexual acts in which condoms have been used with casual partners

Figure A3. 19 Males 25-49 population – proportion of sexual acts in which condoms have been used with casual partners

Figure A3. 20 Females 25-49 population – proportion of sexual acts in which condoms have been used with casual partners

Figure A3. 21 General population – proportion of people tested for HIV

Figure A3. 22 Male youth population – proportion of people tested

Figure A3. 23 Female youth population – proportion of people tested

Figure A3. 24 Males 25-49 population – proportion of people tested

Figure A3. 25 Female 25-49 population – proportion of people tested

Figure A3. 26 Males 50+ population – proportion of people tested

Figure A3. 27 Females 50+ population – proportion of people tested

COST-COVERAGE OUTCOME CURVE FOR ART

Figure A3. 28 Antiretroviral therapy – number of people covered (all population groups)

EX 4 DATA TABLES

Population size (Thousands)

ION SIZE (THOUSANDS)																
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
	Best	12.4	12.8	13.2	13.6	14.1	14.5	14.9	15.3	15.8	16.2	16.7	17.1	17.6	17.9	18.6
ts	Best	67.6	69.8	72.2	74.7	77.2	79.9	82.5	85.2	88.1	91.0	94.0	97.1	100.2	103.5	106.8
	Best	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
s	Best	40.8	40.8	40.8	40.8	40.8	40.8	40.8	40.8	40.8	40.8	61	59	59	59	40.8
	Best	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	4.1	4.3	4.1	4.3	4.3
	Best	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
	Best	216.1	220.8	225.7	230.7	235.8	241.2	247.5	253.0	260.3	267	273	280.9	288	295	301.9
n	Best	46	47.5	49.1	50.6	52.1	52.6	54.8	56	57.2	58.4	58.6	59.8	61.0	62.3	64.6
uth	Best	50.8	52.2	53.7	55.1	56.5	57.9	59.0	60.2	61.4	62.6	63.8	64.9	66.1	67.3	68.7
-49)	Best	509.6	529.8	551.5	574.7	599.2	615.4	650.7	678.0	706.5	735.9	755.5	787.2	819.164	851.7	894
25-49)	Best	641.3	663.4	686.6	710.9	736.2	762.6	788.8	816.2	844.5	873.8	903.9	934.2	965.7	998.1	1030.1
	Best	200.6	205.1	209.7	214.6	219.7	225	230.2	235.8	241.7	247.9	254.4	261.6	269.4	277.6	286.4
0+	Best	248.2	253.8	259.6	265.8	272.3	279.2	285.9	293.2	300.9	309.1	317.8	327.4	337.6	348.6	360.2

HIV prevalence (percentage)

ALENCE (PERCENTAGE)																	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
	High												15.1			13.5	OR	
	Best						29.5						13.1			11.7	OR	
	Low												11.1			9.89	OR	
	High												3.6			2.6	OR	
ts	Best												2.5			1.8	OR	
	Low												1.4			0.8	OR	
	High												23.8			16.3	OR	
	Best												19.6			13	OR	
	Low												15.9			10.1	OR	
	High																OR	
s	Best												5.5				OR	
	Low																OR	
	High																OR	
	Best												4.3				OR	
	Low																OR	
	High			16				11.3			9.3					4.7	OR	
	Best			13.78				9.7			7.7					3.8	OR	
	Low			12				7.7			6.1					2.9	OR	

HIV prevalence (percentage) (continued)

ALENCE (PERCENTAGE)																	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
	High																*OR*	
	Best																*OR*	0
	Low																*OR*	
n	High																*OR*	
	Best													0.6	0.5	0.3	*OR*	
	Low																*OR*	
uth	High																*OR*	
	Best							3.38						2.4	2.4	0.8	*OR*	
	Low																*OR*	
	High																*OR*	
	Best															2.65	*OR*	
	Low																*OR*	
25-49)	High																*OR*	
	Best															4.34	*OR*	
	Low																*OR*	
+)	High																*OR*	
	Best																*OR*	0.
	Low																*OR*	

HIV prevalence (percentage) (continued)

ALENCE (PERCENTAGE)																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
50+) High																*OR*	
Best																*OR*	4.
Low																*OR*	

Testing and treatment

AND TREATMENT																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
SW	0.88												8.8	11.3	48.2	*OR*	
SW Clients	0.43												4.3	3.7	3.1	*OR*	
MSM	0.59												5.9	4.7	8.0	*OR*	
Drug Users	0.02												0.2	0.5	0.6	*OR*	
Prisoners	0.7												7.0	18.7	18.4	*OR*	
Military	1.68												16.8	16.8	16.8	*OR*	
Children	0.04												0.4	0.4	0.3	*OR*	
Male Youth	0.34												3.4	3.3	2.2		
Female Youth	1.36												13.6	14.6	13.4		
Males (25-49)	0.69												6.9	5.9	5.0		
Females (25-49)	1.29												12.9	12.6	12.3		
Males (50+)	0.2												2.0	1.5	1.4		
Females (50+)	0.13												1.3	1.1	1.0		

Testing and treatment (continued)

AND TREATMENT	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
y of a person being h CD4 <200 per	40														80	*OR*	
atment	0	0	35	142	1002	1,961	4,865	4,419	8,653	11,571	17,664	25,413	28,737	30,666	34,955	*OR*	
t eligibility criterion	200	200	200	200	200	200	200	200	200	200	350	350	350	350	350	*OR*	
FSW																*OR*	
FSW Clients																*OR*	
MSM																*OR*	
Drug Users																*OR*	
Prisoners																*OR*	
e Military																*OR*	
Children																*OR*	
y Male Youth																*OR*	
ure is Female Youth																*OR*	
Males (25-49)																*OR*	
Females (25-49)																*OR*	
Males (50+)																*Or*	
Females (50+)																*OR*	
n on PMTCT (Option B/B+)						720	910	1,036	1,699	1,986	3,126	4,173	4,411	4,478	4,496	*OR*	

Testing and treatment (continued)

AND TREATMENT																
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Assur
FSW	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15		*OR*
Female Youth	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.17	*OR*
Females 25-49	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.15	0.15	0.15		*OR*
Females 50+																*OR*
sitive women who breastfeed							87	79	69	77	83	89	93	94	96	*OR*

Optional indicators

L INDICATORS															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
f HIV tests per year						44,005	82,006	88,938	99,541	133,989	206,173	267,173	309,736	310,189	2
f HIV diagnoses per						5,281	8,201	9,621	9,904	7,669	13,994	11,364	17,775	15,634	1
stimate of new HIV per year	13,096	12,315	11,667	10,892	10,151	9,620	9,109	8,707	8,101	7,552	6,925	5,440	4.995	4,712	
stimate of HIV e	3.48	3.54	3.55	3.51	3.44	3.35	3.26	3.15	3.20	2.89	2.78	2.68	2.59	2.5	
f HIV-related	5,052	5,680	6,277	6,753	6,958	7,046	6,640	6,988	7,330	7,051	6,279	4,943	4,386	4,137	
f people initiating ear													6,999	6,586	

Sexual acts per person per year

CTS PER PERSON PER YEAR

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumpt
FSW																*OR*	31.0
FSW Clients																*OR*	32.0
MSM																*OR*	41.0
Drug Users												35.1				*OR*	
Prisoners																*OR*	0.0
Military			38.7	29.5		71.6										*OR*	
Children																*OR*	0.0
Male Youth															3.0	*OR*	
Female Youth															12.0	*OR*	
Males (25-49)															32.0	*OR*	
Females (25-49)															28.0	*OR*	
Males (50+)															32.0	*OR*	
Females (50+)															22.0	*OR*	

exual acts per person per year (Cont.)

CTS PER PERSON PER YEAR																
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Assumpti**
FSW															*OR*	7.0
FSW Clients															*OR*	7.0
MSM							19.2				21.2				*OR*	
Drug Users												20.8			*OR*	
Prisoners												0.6			*OR*	
Military			4.3	4.1		4.8				22.4					*OR*	
Children															*OR*	0.0
Male Youth															16.0	*OR*
Female Youth															5.0	*OR*
Males (25-49)															7.0	*OR*
Females (25-49)															7.0	*OR*
Males (50+)															2.0	*OR*
Females (50+)															6.0	*OR*

exual acts per person per year (continued)

CTS PER PERSON PER YEAR

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assump
FSW												1924.0			2134.1	*OR*	
FSW Clients						15.7						23.5			27.7	*OR*	
MSM															59.0	*OR*	
Drug Users																*OR*	0.0
Prisoners																*OR*	0.0
Military																*OR*	0.2
Children																*OR*	0.0
Male Youth																*OR*	0.0
Female Youth																*OR*	0.0
Males (25-49)																*OR*	0.0
Females (25-49)																*OR*	0.0
Males (50+)																*OR*	0.0
Females (50+)																*OR*	0.0

Condom use, and circumcision probability

USE, AND CIRCUMCISION PROBABILITY

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assump
	FSW																*OR*	3
	FSW Clients																*OR*	6
	MSM										44	69	56			71	*OR*	
	Drug Users												27				*OR*	
	Prisoners																*OR*	
se	Military			41	68		80					68					*OR*	
lar	Children																*OR*	0
	Male Youth															8	*OR*	
	Female Youth															6	*OR*	
	Males (25-49)															6	*OR*	
	Females (25-49)															3	*OR*	
	Males (50+)															3	*OR*	
	Females (50+)															2	*OR*	
	FSW															40	*OR*	
se	FSW Clients												61				*OR*	
al	MSM										38	69	56			86	*OR*	
	Drug Users												27				*OR*	
	Prisoners												0				*OR*	

Condom use, and circumcision probability (continued)

USE, AND CIRCUMCISION PROBABILITY

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assump
	Military			84	94		99	75		52		88					*OR*	
	Children																*OR*	
	Male Youth														63	57	*OR*	
	Female Youth														59	51	*OR*	
	Males (25-49)												50			65	*OR*	
	Females (25-49)												29			30	*OR*	
	Males (50+)															29	*OR*	
	Females (50+)															13	*OR*	
	FSW										90		91			93	*OR*	
	FSW Clients				12		7									61	*OR*	
	MSM											67					*OR*	
	Drug Users																*OR*	
se	Prisoners																*OR*	
al	Military																*OR*	61
	Children																*OR*	
	Male Youth																*OR*	
	Female Youth																*OR*	
	Males (25-49)																*OR*	
	Females (25-49)																*OR*	

Condom use, and circumcision probability (continued)

USE, AND CIRCUMCISION PROBABILITY

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assump
	Males (50+)																*OR*	
	Females (50+)																*OR*	
on	FSW Clients																*OR*	98
y	MSM																*OR*	98
	Drug Users																OR	98
	Prisoners																*OR*	98
	Military																*OR*	98
	Children																*OR*	97
	Male Youth															97	*OR*	
	Males (25-49)															98	*OR*	
	Males (50+)															98	*OR*	

Non-HIV deaths, STIs and TB prevalence (percentage)

DEATHS, STIS AND TB PREVALENCE (PERCENTAGE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
FSW	1.09	1.05	1.02	0.98	0.95	1.13	1.07	1.03	1.00	0.96	0.88	0.85	0.82	0.79
FSW Clients	0.58	0.56	0.54	0.52	0.50	0.59	0.56	0.54	0.52	0.50	0.46	0.45	0.43	0.41
MSM	0.58	0.56	0.54	0.52	0.50	0.59	0.56	0.54	0.52	0.50	0.46	0.45	0.43	0.41
Drug Users	0.87	0.83	0.80	0.77	0.74	0.88	0.84	0.81	0.78	0.75	0.69	0.67	0.64	0.62
Prisoners	1.15	1.11	1.07	1.03	0.99	1.17	1.12	1.08	1.03	0.99	0.93	0.89	0.86	0.83
Military	0.48	0.46	0.45	0.44	0.43	0.45	0.44	0.43	0.42	0.41	0.34	0.34	0.33	0.32
Children	1.37	1.34	1.32	1.29	1.26	1.15	1.12	1.09	1.06	1.03	0.92	0.90	0.87	0.85
Male Youth	0.48	0.46	0.45	0.44	0.43	0.45	0.44	0.43	0.42	0.41	0.34	0.34	0.33	0.32
Female Youth	0.47	0.46	0.45	0.44	0.43	0.46	0.45	0.44	0.43	0.42	0.35	0.34	0.34	0.33
Males (25-49)	0.58	0.56	0.54	0.52	0.50	0.59	0.56	0.54	0.52	0.50	0.46	0.45	0.43	0.41
Females (25-49)	0.54	0.53	0.51	0.49	0.47	0.56	0.53	0.52	0.50	0.48	0.44	0.42	0.41	0.40
Males (50+)	4.19	4.09	4.00	3.91	3.82	4.12	4.08	3.98	3.89	3.79	3.83	3.72	3.62	3.51
Females (50+)	3.94	3.85	3.77	3.68	3.59	3.86	3.77	3.68	3.59	3.49	3.47	3.37	3.26	3.16

Non-HIV deaths, STIs and TB prevalence (percentage) (continued)

DEATHS, STIS AND TB PREVALENCE (PERCENTAGE) (CONTINUED)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assu
FSW															26.0	*OR*	
FSW Clients																*OR*	5
MSM														1.4		*OR*	
Drug Users																*OR*	3
Prisoners																*OR*	3
Military																*OR*	3
Children																*OR*	0
Male Youth															1.1	*OR*	
Female Youth															8.8	*OR*	
Males (25-49)															2.0	*OR*	
Females (25-49)															10.7	*OR*	
Males (50+)															0.5	*OR*	
Females (50+)															7.1	*OR*	
FSW												62			42	*OR*	
FSW Clients																*OR*	6
MSM																*OR*	6
Drug Users																*OR*	3
Prisoners																*OR*	5
Military																*OR*	3
Children																*OR*	
Male Youth															1.5	*OR*	
Female Youth															11.8	*OR*	

Non-HIV deaths, STIs and TB prevalence (percentage) (continued)

DEATHS, STIS AND TB PREVALENCE (PERCENTAGE) (CONTINUED)								
	Males (25-49)				10.6	10.0	2.0	*OR*
	Females (25-49)						12.0	*OR*
	Males (50+)						2.3	*OR*
	Females (50+)						8.3	*OR*
sis	FSW					0.3		*OR*
e	FSW Clients							*OR*
	MSM							*OR*
	Drug Users							*OR*
	Prisoners					0.5		*OR*
	Military							*OR*
	Children							*OR*
	Male Youth							*OR*
	Female Youth							*OR*
	Males (25-49)	0.1		0.1	0.1	0.1		*OR*
	Females (25-49)	0.1		0.1	0.1	0.1		*OR*
	Males (50+)							*OR*
	Females (50+)							*OR*

Injecting drug use parameters

G DRUG USE PARAMETERS

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Assum
	FSW																*OR*
	FSW Clients																*OR*
	MSM																*OR*
	Drug Users												6.5				*OR*
	Prisoners																*OR*
	Military																*OR*
per	Children																*OR*
r year	Male Youth																*OR*
	Female Youth																*OR*
	Males (25-49)																*OR*
	Females (25-49)																*OR*
	Males (50+)																*OR*
	Females (50+)																*OR*
o of	FSW																*OR*
o	FSW Clients																*OR*
y	MSM																*OR*
ringe	Drug Users												24				*OR*
	Prisoners																*OR*

Injecting drug use parameters (continued)

G DRUG USE PARAMETERS

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assur
Military																OR	
Children																OR	
Male Youth																OR	
Female Youth																OR	
Males (25-49)																OR	
Females (25-49)																OR	
Males (50+)																OR	
Females (50+)																OR	

Transitions

IONS

	FSW	FSW clients	MSM	Drug Users	Prisoners	Military	Children	Male Youth	Female Youth	Males (25-49)	Females (25-49)	Males (50+)	Fe
FSW													
FSW Clients													
MSM													
Drug Users													
Prisoners													
Military													
Children								30	30				
Male Youth										10			

Transitions (continued)

ONS

		FSW	FSW clients	MSM	Drug Users	Prisoners	Military	Children	Male Youth	Female Youth	Males (25-49)	Females (25-49)	Males (50+)	Fe
d	Female Youth											10		
s	Males (25-49)												25	
	Females (25-49)													
re	Males (50+)													
t)	Females (50+)													
	FSW											18		
	FSW Clients												40	
	MSM													
	Drug Users										28			
ed	Prisoners										2.5			
s	Military										25			
	Children													
re	Male Youth													
t)	Female Youth													
	Males (25-49)													
	Females (25-49)													
	Males (50+)													
	Females (50+)													

0 Partnerships

SHIPS

	FSW	FSW clients	MSM	Drug Users	Prisoners	Military	Children	Male Youth	Female Youth	Males (25-49)	Females (25-49)	Males (50+)	Fe
FSW													
FSW Clients	1								5		5		
MSM			5						1		2		
Drug Users									1		2		
Prisoners													
Military									1		2		
Children													
Male Youth	1								3				
Female Youth													
Males (25-49)	1								3		6		
Females (25-49)													
Males (50+)											1		
Females (50+													
FSW													
FSW Clients	1								5		3		
MSM			7.5						1		1		
Drug Users									1		1		
Prisoners					1								
Military									1		1		
Children													
Male Youth	1								5				
Female Youth													

0 Partnerships (continued)

SHIPS

	FSW	FSW clients	MSM	Drug Users	Prisoners	Military	Children	Male Youth	Female Youth	Males (25-49)	Females (25-49)	Males (50+)	F
Males (25-49)	1								5		3		
Females (25-49)													
Males (50+)											1		
Females (50+)													
FSW													
FSW Clients	1												
MSM			1										
Drug Users													
Prisoners													
Military	1												
Children													
Male Youth													
Female Youth													
Males (25-49)													
Females (25-49)													
Males (50+)													
Females (50+)													
FSW													
FSW Clients													
MSM													
Drug Users				1									
Prisoners													

0 Partnerships (continued)

LSHIPS

	FSW	FSW clients	MSM	Drug Users	Prisoners	Military	Children	Male Youth	Female Youth	Males (25-49)	Females (25-49)	Males (50+)	F
Military													
Children													
Male Youth													
Female Youth													
Males (25-49)													
Females (25-49)													
Males (50+)													
Females (50+)													