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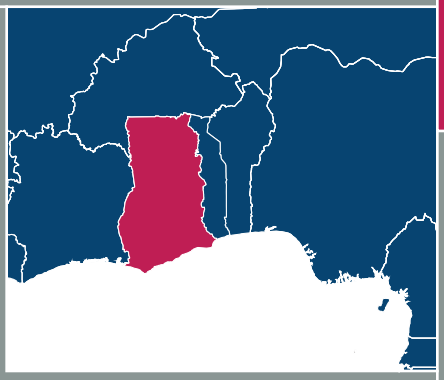
THE COSTS AND IMPACTS OF INVESTING IN THE HIV RESPONSE IN GHANA



This publication was prepared by Arin Dutta, Alexander Paxton, and Ashley Kallarakal of the Health Policy Project.

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The Costs and Impacts of Investing in the HIV Response in Ghana

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EXECUTIVE SUMMARY

Background

At the end of 2013 an estimated 189,930–206,280 adults and 34,560–36,250 children were living with HIV in Ghana. There is strong evidence to suggest a disproportionately higher HIV prevalence among certain key population groups, such as men who have sex with men (MSM) and female sex workers (FSWs). Ghana's epidemic continues to evolve. The USAID- and PEPFAR-supported Health Policy Project (HPP) partnered with the Ghana AIDS Commission (GAC) to conduct a focused analysis of the future effectiveness of HIV prevention in the country related to possible funding from external partners. This report offers information on the targets and highlights cost-effective decisions Ghana can make over the coming years. It comes at an opportune time as the country's current National Strategic Plan (NSP) for HIV and AIDS comes to a close in 2015.

Methodology

Using the Goals model, a mathematical model integrated into the well-known Spectrum Policy Modeling System, the study team examined how four scenarios corresponding to different levels of uncertain future HIV funding in Ghana would affect the scale-up and health impact of certain key HIV interventions. We calculated the total cost of the HIV program in Ghana for 2014–2020, given the direct service delivery costs under each of the four scenarios, and applied additional estimated costs for the management of the HIV response. We estimated impact over the same period in terms of the number of new HIV infections and AIDS-related deaths averted. Incremental cost-effectiveness ratios (ICERs) were computed as a metric to compare the costs and outcomes of different scenarios.

The four scenarios differed in their coverage assumptions for key prevention and treatment interventions in Ghana. Scenario 1, the *Baseline* scenario extended the reported 2013 coverages of specific interventions through 2020 without any increase, a representation of the status quo to which subsequent scenarios can be compared. Scenario 2, *New Funding Model targets (NFM)*, reflected the coverage targets that can be achieved within the limits of the resources allocated for Ghana's application to the Global Fund's New Funding Model mechanism, accounting for aligned public funding and other domestic sources. Scenario 3, the *NFM targets plus above allocation,* allowed additional program coverage as enabled by domestic and other sources plus financing from the Global Fund above the currently allocated NFM limit for the country. Scenario 4, the *National Strategic Plan (NSP)* scenario, reflected the continuation of high levels of coverage for a limited number of interventions, with assumptions provided by stakeholders which were extended past 2017. These targets were in the spirit of the universal access approach in the original NSP document.

Results

HIV infections

In 2014, the baseline year, it was estimated that there would be 10,820 new HIV infections among Ghanaians of all ages, a figure which is similar across all of the scenarios. By 2015, differences were already noticeable across scenarios. By 2020, the annual number of new infections was significantly lower in the *NFM targets, NFM targets plus above allocation*, and *NSP* scenarios compared to *Baseline*. For the entire 2014–2020 period, the highest cumulative number of new infections (about 73,190) was seen in the *Baseline* scenario, while the fewest new infections occurred in the *NSP* scenario (about 50,460). Comparing these two scenarios, 22,725 infections can be averted over 2014–2020 with the ambitious scale-up of interventions under the NSP targets. The two NFM scenarios avert about 12,900 and 16,160 infections compared with *Baseline*, respectively.

AIDS deaths averted

In 2014, we estimated 10,215 HIV- and AIDS-related deaths per year among Ghanaians living with HIV. In the *Baseline* scenario, this number steadily increases each year until 2020, when an estimated 12,700 AIDS-related deaths are projected to occur. By 2020, with a scale-up of HIV treatment, the number of AIDS deaths among adults is significantly reduced. For the entire period across the *NFM targets, NFM targets plus above allocation*, and *NSP* scenarios, approximately 11,435, 20,170, and 40,760 AIDS deaths are averted, respectively, compared to the *Baseline* scenario.

Direct costs

Under the coverage assumptions of the *NFM targets* scenario, the costs of service delivery from 2014 to 2020 for the interventions we modeled will rise to US$54 million per year by 2017 and stay near that level, with a total cost of US$383 million. This is US$110 million more than the total projected costs under the *Baseline* scenario. If Ghana were to implement the higher targets under the *NFM targets plus above allocation* scenario, the additional costs compared to the *NFM targets* scenario would be US$21 million for the entire period. The highest-cost *NSP* scenario ranges from US$62–72 million per year for 2015–2020, with a total cost of US$450 million for the entire 2014–2020 period.

Cost-effectiveness

Greater coverage enabled higher impact in the model. All the scale-up scenarios are more effective in prevention than the *Baseline* scenario. When compared to the *Baseline* scenario, the additional impact and costs under the *NFM targets* scenario imply an ICER of US$5,150 per AIDS-related death averted, and US$8,520 per new HIV infection averted. When measuring quality-adjusted life years (QALYs) gained, the *NFM targets* and *NSP* scenarios achieve ICERs of US$1,360 and US$770 per life year gained compared with *Baseline.* Given Ghana's per capita gross domestic product (US$1,853), we conclude that the increase of coverage under the scale-up scenarios is very cost-effective in terms of QALYs. We also compared the scale-up scenarios to each other, which suggested that the higher range of targets under the *NFM targets plus above allocation* and *NSP* scenarios are very cost-effective to consider from a life years gained perspective, over and above the *NFM targets* scenario, if resources permit.

Discussion

Although HIV prevalence appears to be in a slow decline in Ghana, there is still a significant mixed epidemic in the country which requires targeted investments to further reduce HIV incidence and AIDS-related mortality. From 2014 to 2020, the higher annual coverage targets for key interventions enabled by securing funding under the current NFM allocation will prevent approximately 12,900 more new infections and 21,370 more AIDS-related deaths than the status quo. Continuing the ambitious targets of the National Strategic Plan 2011–2015 in future years would enable even greater impact, which appears very cost-effective from a mortality averted perspective. These results strongly support the government of Ghana and its development partners continuing to expand investments in key HIV interventions as they consider the next strategy.

ABBREVIATIONS

AIDS	acquired immune deficiency syndrome
AIM	AIDS Impact Model
ANC	antenatal clinic
ART	antiretroviral therapy
ARV	antiretroviral
CBO	community-based organization
CCM	country coordinating mechanism
CSW	commercial sex worker
FSW	female sex worker
GAC	Ghana AIDS Commission
GNI	gross national income
HIV	human immunodeficiency virus
HPP	Health Policy Project
HTC	HIV testing and counseling
ICER	incremental cost-effectiveness ratio
IEC	information, education, and communication
MARP	most-at-risk population
MAT	medication-assisted treatment
MICS	Multiple Indicator Cluster Survey
MOT	modes of transmission
MSM	men who have sex with men
NACP	National AIDS/STI Control Programme
NESP	needle and syringe exchanges and related programming
NFM	New Funding Model
NSP	national strategic plan
OI	opportunistic infection
PEP	post-exposure prophylaxis
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PLHIV	people living with HIV
PMTCT	prevention of mother-to-child transmission
PrEP	pre-exposure prophylaxis
PWID	people who inject drugs
QALY	quality-adjusted life year
STI	sexually transmitted infection
TB	tuberculosis
UNAIDS	United Nations Joint Programme on HIV/AIDS
UNGASS	United Nations General Assembly Special Session (on HIV/AIDS)
USAID	United States Agency for International Development
VCT	voluntary counseling and testing

1. INTRODUCTION

The recent global emphasis on sustainable funding and the need for better-targeted investments in the HIV response led stakeholders in Ghana to seek a comparative analysis of what could be achieved in prevention and mortality reduction at different levels of coverage and costs for key interventions. These results were requested to inform the "investment case" for a concept note proposal submitted by Ghana to the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) in October 2014 under the latter's New Funding Model (NFM) mechanism. In response to this request, collaborative technical support was extended by the USAID- and PEPFAR-supported Health Policy Project (HPP). The analysis was conducted to allow policymakers to weigh the costs and benefits of increasing coverage of certain key interventions across HIV prevention and treatment. The short-term goal was to provide results for the NFM proposal. Since the current HIV strategic plan ends in 2015, the report can inform the next strategy.

Status of the Epidemic in Ghana

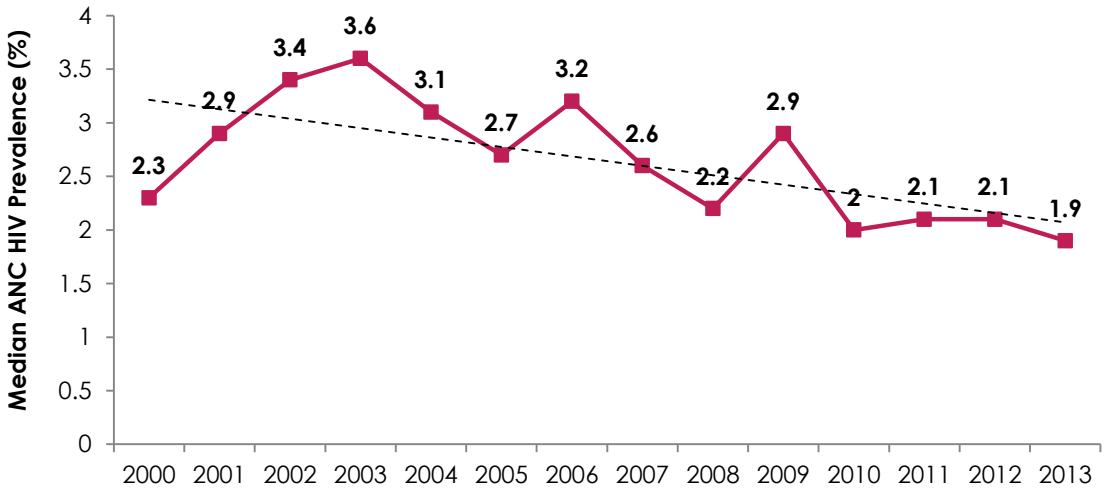
The first case of HIV in Ghana was detected in 1986. The HIV epidemic in Ghana is a mature, mixed epidemic (see Box 1). In 2013, Ghana's nationwide adult HIV prevalence was 1.3 percent in the general population [2].

NACP has been conducting HIV sentinel surveillance since 1990. Annual HIV sentinel surveys began in 1994 at antenatal clinics (ANCs) for pregnant women and sexually transmitted infection (STI) centers for patients with STIs. According to the 2013 round of annual HIV sentinel surveys of antenatal clinic attendees, the median estimate of HIV prevalence among pregnant women was 1.9 percent (range 1.26–2.51). This estimate has decreased since 2003 when it peaked at 3.6 percent (Figure 1). However, prevalence seems to have changed little since 2010.

Box 1: Mixed epidemics are those where HIV transmission continues in both key populations at higher risk, e.g., sex workers and men who have sex with men, as well as in the general population. Cessation of transmission in either key or general population groups would not necessarily stop the epidemic.

Source: [1]

Figure 1: Median HIV prevalence (%) at antenatal clinics with linear trend: Ghana, 2000–2013

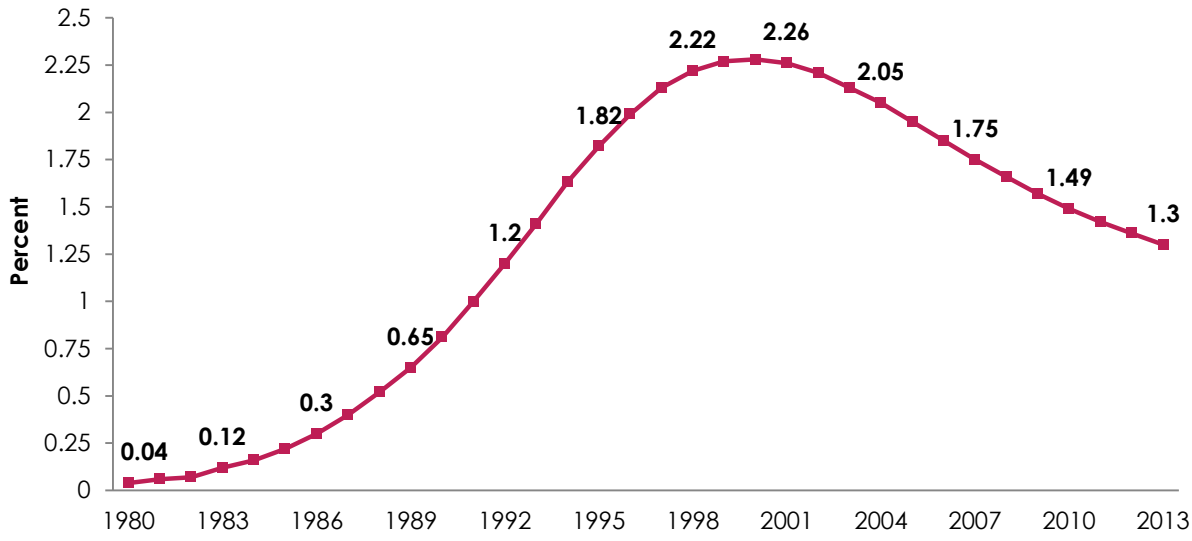


Source: [4]. Dashed line shows the linear trend.

Available data and modeling related to HIV incidence suggest that Ghana has a mixed epidemic, comprised of a low-level generalized epidemic coupled with a higher-prevalence epidemic among key population groups. Key populations identified as being at most at-risk for acquiring and transmitting HIV in Ghana as defined by the NSP include female sex workers (FSWs), men who have sex with men (MSM), people who inject drugs (PWID), and prison inmates [5].

HIV prevalence among women attending ANCs steadily declined until a jump in 2009 (Figure 1) but seems to have flattened thereafter [6]. Estimated adult prevalence peaked at about 2.3 percent early in the last decade and declined to an estimated 1.3 percent in 2013 (range: 0.97–1.74). The overall estimate of people living with HIV and AIDS (PLHIV) is about 224,500, including 34,550 children ages 0–14 [2]. In the general population, HIV prevalence is higher among females than males, and median HIV prevalence levels among pregnant women in 2013 were higher in urban settings (2.2%) than in rural areas (1.3%) [3,7]. Overall HIV prevalence is highest in the Eastern region [7].

Figure 2: Adult (ages 15–49) HIV prevalence over time in Ghana, 1980–2013



Source: National AIM projection [2]

Based on the analysis of the approved country-specific implementation of the AIDS Impact Model (AIM) within the Spectrum suite, Ghana had an estimated 7,810 new HIV infections in 2013 (range: 2,125–16,570) [2]. The national AIM projection suggests that the total number of new infections per year (incidence) may have declined in Ghana during 2014, to about 5,970. Based on sentinel survey data, the estimated prevalence in the 15–24 age group has been declining overall since 2009 (from 2.1% to 1.2 % in 2013) [7]. The AIM model works by translating the results of sentinel surveillance directly into national prevalence estimates using statistical techniques; therefore, prevalence estimates from AIM do not directly incorporate the impacts of key interventions. Despite including estimates of intervention coverage, the *effects* of these interventions are only indirectly observed through changes in prevalence and incidence over time. The range in the AIM results suggests underlying uncertainty, as the results are model-derived and incorporate many possible results from an algorithm used to convert sentinel surveillance and other data into incidence estimates. In this report, we also provide estimates of future HIV incidence at the national level in Ghana from other modeling analyses that are sensitive to the future coverage of interventions.

A critical input for aligning future HIV prevention policies to evidence is the disaggregation of the current HIV incidence by risk groups, which also reflects the reality of Ghana's mixed epidemic. The AIM cannot provide this information without the Goals model, but a new modes of transmission analysis by GAC and partners suggests that 28 percent of new HIV infections in the 15–49 age group in Ghana occurred among FSWs, MSM, PWID, and their sexual partners, and the partners of the clients of FSWs [8]. These proportions are further examined in this report and compared to results from new modeling. Additionally, it has been reported that 80 percent of new HIV infections in Ghana are through sexual transmission rather than mother-to-child or parenteral transmission [3].

The possibility of high incidence among key populations is supported by currently disproportionate levels of HIV burden among these groups and their partners. Integrated bio-behavioral surveillance surveys (IBBSS) among FSWs are conducted every two to three years in Accra and Kumasi cities and indicate high, though declining, HIV prevalence [6]. The 2011 IBBSS round—a nationwide two-stage probability proportional to size survey—suggested an average HIV prevalence of 11 percent among FSWs in Ghana, with a range of 4 to 16 percent across regions, with double-digit prevalence in the Greater Accra, Ashanti, and Northern regions [9]. However, 23 percent of FSWs surveyed in the 2011 IBBSS refused HIV testing, suggesting that the true prevalence may be higher.

In Ghana, prevention policies aimed at protecting FSWs and their clients from acquiring HIV are usually cognizant of significant seroprevalence differences based on behavior [10]. Studies in Kumasi and Accra have routinely found HIV prevalence among FSWs who are "seaters" (fixed locations, e.g., brothels) to be higher than that among "roamers" (no fixed location), with ranges of 39–52 percent and 24–37 percent, respectively. In the 2011 IBBSS, HIV prevalence was about 21 percent among seaters and 7 percent among roamers [9]. However, a mapping exercise carried out in support of the IBBSS concluded that there were likely only about 1,000 seater FSWs in the country, compared to approximately 52,000 FSWs overall.

There are limited data on HIV prevalence among MSM in Ghana. Ghana's first IBBSS among MSM, conducted in 2006, found HIV prevalence of 25 percent in the Greater Accra region [11]. Results from a 2011 IBBSS—the Ghana Men's Study—suggested that 17.5 percent of MSM in Ghana were living with HIV [12]. The 2014 modes of transmission study estimated that, although MSM are a small fraction of the overall male population (34,470 or 0.36%), they would bear the burden of 4 percent of all new infections in the 15–49 age group [8,13].

Data for HIV prevalence among incarcerated populations and PWID are even more limited. Among prisoners, 1.5 percent of males and 12 percent of females are estimated to have HIV. The only data on PWID are also from prison settings. A 2008 study suggested that 11 percent of prisoners who were injecting drugs were HIV positive [3].

National HIV and AIDS Strategic Plan: 2011–2015

The National AIDS/STI Control Programme (NACP) within the Disease Control Unit of the Ministry of Health is mandated to manage prevention and control of the HIV epidemic. The Ghana AIDS Commission (GAC) coordinates the national multisectoral response, working across ministries, the private sector, and civil society institutions, and is involved in all aspects of priority-setting and stewardship. Ghana is currently implementing the National HIV and AIDS Strategic Plan 2011–2015 (NSP), which sets ambitious targets for the response.

The NSP was developed between June and November 2010, and is the result of strategic conversations with all partners and stakeholders involved in Ghana's national HIV and AIDS response. While the NSP outlines key objectives and activities to be achieved in preventing new infections among key populations, GAC also produced a supplemental strategy, the National Most at Risk Populations Strategic Plan 2011–2015, to further elaborate activities for key populations.

The final drafts of the NSP and the National MARP Strategic Plans outline the activities and funding required to achieve the following key outcomes by 2015:

- Reduce the rate of mother-to-child transmission of HIV to less than 5 percent
- Reduce new infections among FSWs, MSM, PWID, and prisoners by 50 percent
- Increase the percentage of individuals tested for HIV and receiving results to 18 percent for women and 15 percent for men
- Increase the percentage of men and women using condoms during high-risk sex by 50 percent
- Increase the proportion of adults and children eligible for and receiving ART to 85 percent
- Increase the percentage of people with accepting attitudes toward PLHIV to 50 percent

The NSP also addresses three main challenges and gaps in financing the planned HIV response:

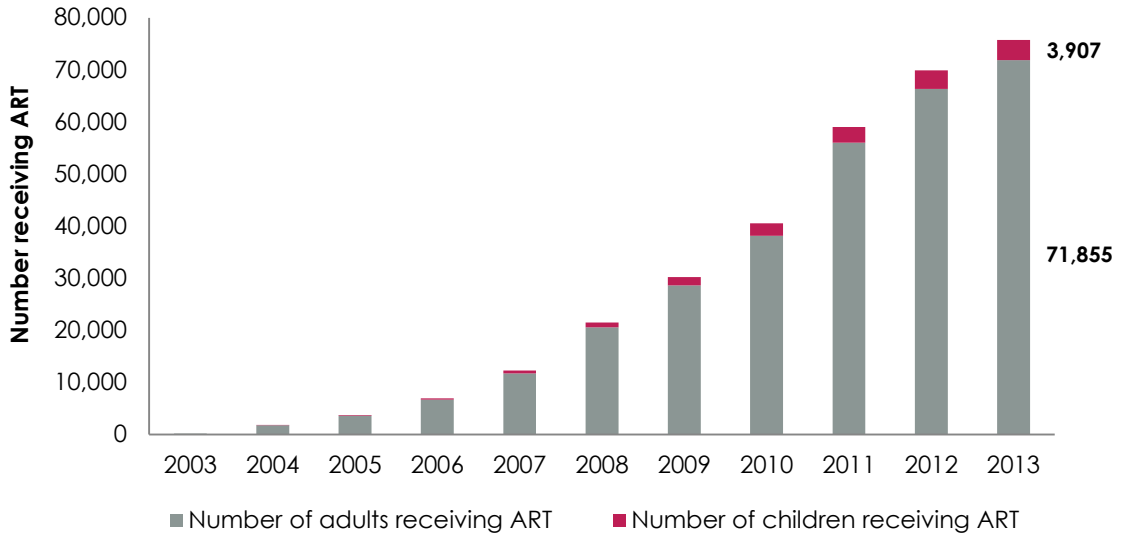
1. Lack of a resource mobilization strategy
2. Weakness of mechanisms for coordination of funding channels and sources
3. Need for stronger measures for improving costing and budgeting processes

Status of Key Interventions

Antiretroviral treatment

Since the initiation of antiretroviral therapy (ART) services in 2003, Ghana has continued to scale up clinical services for PLHIV, including ART (Figure 3). The number of sites providing ART services increased rapidly, from three sites in two districts in 2003, to 175 sites across 118 districts in 2013. From 2008 to 2015, Ghana implemented an ART initiation policy linked to the threshold of a CD4 count less than or equal to 350 cells/mm^3 [4]. In 2015, the policy's threshold is expected to shift to a CD4 count of less than or equal to 500 cells/mm^3. This policy change will also affect the estimated need for ART among eligible adults and children. At the end of 2013, under the previous guideline, the estimated need for ART was 125,396 individuals, 8,350 of whom were children ages 0–14 [4]. There were 75,762 PLHIV on treatment in late 2013—approximately 34 percent of all PLHIV in Ghana.

Figure 3: Antiretroviral treatment over time in Ghana, 2003–2013



Source: [2,4]

Future coverage targets are discussed later in this report. In 2013, about 14,300 PLHIV initiated treatment, 72 percent of whom were women [3]. The ultimate sustainability of the ART program depends on improvements in the quality of services as well as a balanced and dependable financing arrangement. However, in the short term, Ghana faces significant programmatic challenges, including a potential gap in commodity supply following a fire that destroyed a significant portion of the antiretroviral stocks in early 2015 [14], and possible financing shortfalls from 2016 onward.

Prevention of mother-to-child transmission

Ghana first adopted the policy of using antiretrovirals (ARVs) for prevention of mother-to-child transmission (PMTCT) in 2006. Over subsequent years, the PMTCT effort was significantly scaled up. A PMTCT-specific scale-up plan was adopted in 2010, with a target of providing 95 percent of HIV-positive pregnant women with effective PMTCT by 2015 [3]. However, losses in the ANC to PMTCT continuum of services meant that such high coverage levels were not achieved, though PMTCT service numbers have increased. In 2009, PMTCT services were offered at national, regional, district, and health center level facilities in both public and private health facilities. Success in increasing coverage has been attributed to decentralizing PMTCT services to the community level through community-based health planning services. The number of PMTCT centers increased from 135 in 2005 to 1,656 functional sites by 2012. The number of pregnant women counseled and tested as part of ANC increased from 257,466 in 2008 to 492,622 in 2013. The number of HIV-positive pregnant women who received ARVs increased from 5,485 in 2010 to 7,266 by 2013 [3]. Based on the nationally approved estimate of HIV-positive pregnant women in those years from the Ghana AIM file, this meant an increase in coverage from 53 percent to 62 percent [4]. However, for programmatic planning GAC routinely uses an estimate for annual PMTCT need that is 1.6 times greater than the Spectrum estimate. Applying this alternate estimate of need, PMTCT coverage was just 39 percent in 2013. In terms of HIV-exposed infants being offered ARV-based prophylaxis, performance could still be improved: coverage was only 37 percent in 2013 compared with a target of 80 percent [3,15].

HIV testing and counseling

Compared to the NSP target of HIV testing and counseling (HTC) for 1.1 million individuals per year from 2011 to 2013, performance has been significantly lower, though still at significant volume given the scale of Ghana's epidemic. In 2013, approximately 668,929 individuals were tested for HIV and counseled, most of whom were pregnant women [3]. The decline may partly be attributed to a limited number of testing kits and few trained health workers. The number of sites providing HTC services was 1,655 by 2013 [29]. Without increasing the geographic penetration of testing services, it may be difficult to increase ART coverage, especially among hard-to-reach populations.

Prevention in key populations

Given the likelihood that a large proportion of new infections will occur among members of key populations and their partners, effective prevention in these groups is a priority for achieving the NSP target of a 50 percent reduction in incidence. There is also recognition among stakeholders that a larger share of the prevention budget, especially for behavioral prevention, should be targeted to key populations and that actual expenditures in these areas should match commitments.

Across all key population groups, the use of HTC increased from 17,256 to 24,062 between 2011 and 2012, which implies a greater likelihood of linking HIV-positive individuals from key populations to care and treatment [3]. Evidence suggests condom availability and use have increased among key populations, and specifically that FSWs' exposure to prevention programming led to an increase in condom use from 51 percent to 58 percent in 2013 [3]. In the male population, the 2011 IBBSS study found relatively high levels of condom use at last sex with a commercial sex partner (78–83%) among demographic groups considered to contribute disproportionately to clients of FSWs—truck helpers, port workers, miners, etc. [9]. Consistent condom use rates by FSW clients with their non-regular, non-commercial partners were much lower (22–37%).

FSWs: Ghana has a history of prevention programming among FSWs, delivered through close collaboration among Ghanaian implementers, the government, and PEPFAR [10]. Against an estimate of about 52,000 FSWs [9], prevention-related information and services had reached about 46,130 by late 2013, according to data compiled by GAC [3,15]. This implied coverage of 88 percent if these were all unique individuals, though a lack of unique identifiers for those reached makes this difficult to verify. Aggregated service delivery reports can also be compared with results from the IBBSS. Results from the 2011 IBBSS suggest that for 63 percent of FSWs, nongovernmental organizations were the source of HIV and AIDS prevention information, while 54 percent had contact with a peer educator in the 12 months prior to the survey [9]. HIV testing coverage within the 12 months before the survey was 67 percent.

MSM: Recent efforts have expanded the methods by which MSM are reached with prevention messages. By late 2013, 11,920 of 30,580 MSM in Ghana had been reached by implementers via in-person outreach services [15]. This implied coverage of 39 percent for traditional forms of peer outreach, again with the caveat of a lack of unique identifiers. This figure could increase to 80 percent if the additional unique individuals reached through social media were considered [3].

Other prevention interventions in the general population

In addition to the scale-up of ART, which has considerable prevention benefits for sexual transmission, Ghana has invested in basic interventions such as blood safety and prevention among youth. Currently, 207,900 blood units are tested for HIV and blood-transmissible diseases, of a possible 250,000 blood units used per year [15]. This implies a blood safety level of 83 percent. Education interventions developed by the Ghana Education Service and partners currently reach children across all levels of the school system. This includes the HIV Alert School project which was reported to have certified 32 percent of schools in the 2011/12 school year [3]. Out-of-school youth may be more vulnerable, and are at

considerably higher risk of acquiring HIV. There is little information on the coverage of prevention interventions among this group.

Condom promotion and distribution are key components of HIV prevention among the general population, offering dual protective benefits for both family planning and HIV prevention. The number of male and female condoms distributed declined sharply from 19.4 million in 2012 to 4.7 million in 2013, due to stockouts [3]. Recent reports have also suggested that there were problems with the quality of condoms procured under the 2010–2013 Global Fund grant, which may be relevant when considering potential effectiveness for dual protection [16].

Process and Outline for this Report

The NSP Midterm Evaluation highlights that 80 percent of national HIV program funding is externally supported by PEPFAR and the Global Fund. It was anticipated that potential resources from the NFM grant would be critical to maintain and expand the coverage for key care, treatment, and prevention interventions from 2015 to 2017. Therefore, results on the potential impact were essential for Ghana to build an "investment case" for the proposed approach in the NFM proposal.

A scope of work to provide analytical support to the NFM process was generated by stakeholders in Ghana in mid-2014, involving GAC, UNAIDS, and PEPFAR, and was shared with members of the Country Coordinating Mechanism (CCM) for Global Fund grants. The scope was accepted for technical assistance by HPP. For the analysis, HPP partnered with GAC and other stakeholders. The final modified scope was confirmed in July 2014 and the HPP team visited Accra in August 2014 to collect data and meet with key respondents. Draft results were shared in September 2014.

This analysis analyzed the trend of the HIV epidemic in Ghana from AIM and used the Goals model to compute the effects of different policy choices related to scaling up HIV prevention and treatment interventions. The costs of programmatic scale-up were computed separately.

The HPP team examined different scenarios for scaling up key interventions under differing assumptions about funding and policy priorities. For each scenario, we looked at the effect on HIV incidence and AIDS-related mortality.

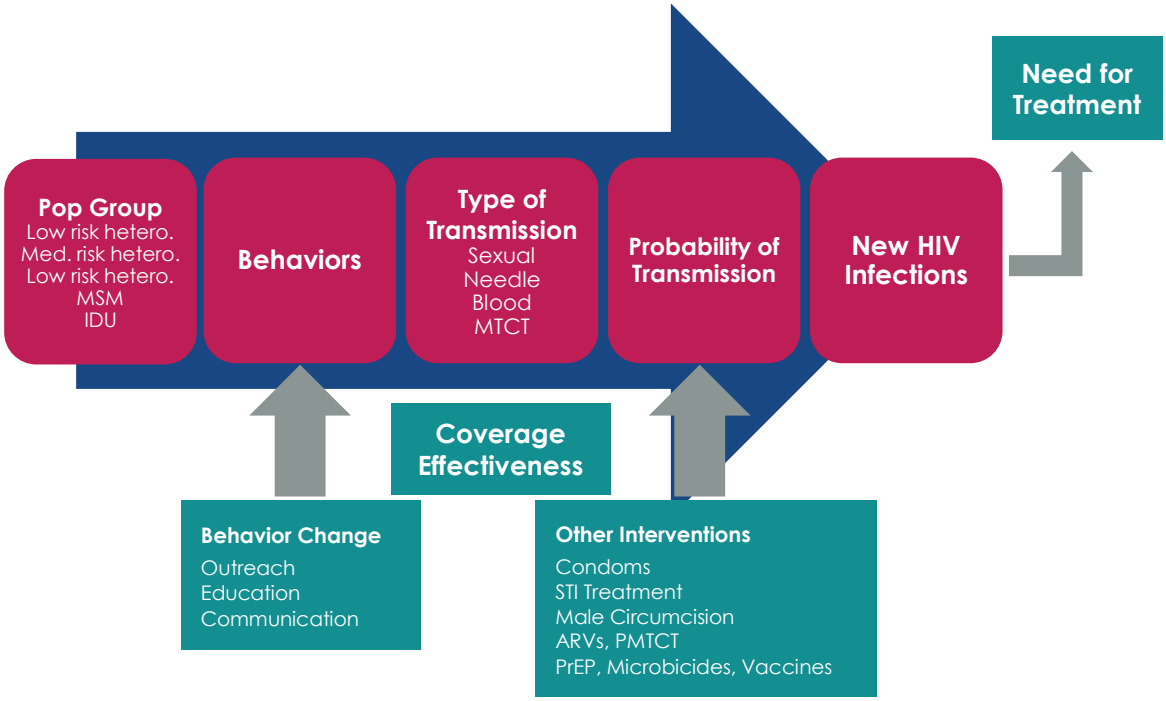
2. METHODOLOGY

This study used two key methodologies: financial analysis of the costs of the HIV response, focusing on certain key interventions, and mathematical modeling of the effects of key interventions on the epidemic. For the former, we conducted a cost analysis of the targets set forth by the NSP and other documents, deriving different coverage scenarios and using country-specific unit costs provided by stakeholders. For the latter, we used the Goals mathematical model, which has been previously applied in Ghana to answer similar research questions [17].

The Goals Model

Goals is a module within the Spectrum Policy Modeling System. Spectrum is an integrated modeling suite which helps to develop demographic and epidemiological projections for several disease conditions across countries, including HIV. The Spectrum suite has been used widely in sub-Saharan Africa, and the AIDS Impact Model (AIM) is regularly used in Ghana to develop the national HIV estimates [4]. Within Spectrum, the demographic projection is calibrated routinely by government and technical partners using local census data, and this is the starting point for estimating the population-level impacts of the HIV epidemic. This process was also followed in Ghana, with modification to the need for PMTCT, described in more detail in the "Model fitting for Goals" section below. The Spectrum suite has been described elsewhere in more detail [18]. Goals interacts with demographic and epidemiological data derived from other Spectrum modules, including AIM. These include such data as demographic projections and the numbers of individuals in various age and gender groups relevant for estimating the risk of HIV transmission, historical HIV prevalence, HIV-positive individuals in different groups based on CD4 count, and the numbers of adults needing and receiving ART based on country guidelines. Figure 4 shows the overall structure of the model.

Figure 4: Schematic depiction of the Goals model*



* Interventions shown are a subset of all interventions that can be modeled. In Ghana, voluntary male circumcision, pre-exposure prophylaxis (PrEP), microbicides, and vaccines were not modeled.

When fully populated with data, Goals simulates an HIV epidemic among adults ages 15–49, based on the likelihood and frequency of sexual and injecting risk behaviors, and the increase in the possibility of HIV transmission when individuals engage in these behaviors. Goals does not directly estimate HIV infections related to mother-to-child transmission, or the effect of PMTCT on this channel of infection. When used in conjunction with AIM and with data on the scale-up of PMTCT, these additional infections can also be modeled. This report considers infections among adults ages 15–49 only.

In Goals, all data related to adult behavior are entered by the user and are context specific. The likelihood and magnitude of risk behaviors can be modified by key prevention interventions. The greater the coverage of these interventions in any given year, the greater the reduction in likelihood and/or frequency of the risk behaviors and, consequently, the greater the reduction in the total number of instances of HIV transmission. Coverage levels for interventions are usually based on national targets and can be modified to set different scenarios. Coverage is expressed as the percentage of the risk group that receives the intervention in a given year. In summary, Goals simulates an HIV epidemic by estimating the number of new HIV infections occurring in various population risk groups according to their behaviors and the coverage and effectiveness of interventions.

The Goals model recognizes that not all risk groups in the population have similar behaviors, so population-wide averages should not be used. The population groups are divided into: low-, medium-, and high-risk heterosexuals across both genders; PWID of both genders; and MSM. FSWs are considered to be the high-risk female heterosexual risk group. Male clients of FSWs are considered to be the high-risk male heterosexual risk group. Risk in the case of heterosexual contact is defined in Goals as the number of sexual partners and, if data are available, in reported rates of consistent condom use or condom use at last sex. These factors are used to distinguish risk groups. Users of the Goals model provide the population size for each group, by gender, and then specify the characteristics of the expected risk behavior for each group, again by gender.

Estimating the effect of HIV prevention interventions in the Goals model

Goals can estimate the direct effect of reduced HIV incidence from expanding behavioral, biomedical, and harm-reduction interventions. There are two main channels of effect. First, behavioral interventions can reduce the probability and magnitude of risky sexual behaviors. For example, outreach programs focusing on FSWs can reduce the probability that condoms will not be used in commercial sex. Similarly, a youth-focused behavior change and communication program can reduce the average number of sexual partners for at-risk youth.

Second, a biomedical intervention can reduce the biological possibility of acquiring HIV for uninfected individuals who engage in unprotected sexual intercourse. In the biomedical category, the most important and widespread effect globally is that of reduced infectiousness for HIV-positive patients who are on ART. This is based on previous studies that show a reduction in infectiousness for patients responding to treatment as their viral load reduces [19]. Goals does not assume or involve parameters linked to a reduction in the possibility of parenteral transmission of HIV, i.e., related to unsafe injecting behavior, when PWID receive ART.

As an additional biomedical effect, Goals can model the effect of male circumcision. Circumcision has been proven to offer some protection to the male uninfected partner in heterosexual relationships [20].

Impact of behavioral interventions on risk of infection

In Goals, an "impact matrix" translates the level of coverage of key behavioral and harm-reduction interventions into reductions in risk behaviors from their baseline value for a specific risk group (e.g., FSWs, medium-risk heterosexuals, etc.). The default impact matrix provided with Goals contains effect parameters derived from a periodically updated and extensive literature review focused on countries with

a high HIV burden. A range of values for impact matrix parameters is possible, given that studies yield different estimates of effect. From this range, three variants of the parameters—average, lower quartile, and upper quartile—can be selected for analysis and readily applied. The impact matrix commonly used for analysis is the "average" variant, the parameters of which are shown in Table 1.

Table 1. Impact matrix of key prevention interventions for high-risk groups in Goals

Intervention	Reduction in condom non-use*				Reduction in number of sexual partners			
	High-risk het.	Medium-risk het.	Low-risk het.	MSM	High-risk het.	Medium-risk het.	Low-risk het.	MSM
HTC**	-34%	-16%	-18.3%	-	-60.5%	-2.4%	-	-
Condom program	-76%#	-18.9%	-24.2%	-	-	-6.5%	-	-
FSW program	-36.5%	N/A			-38.1%	N/A		
MSM program	N/A			-25.3%	N/A			-

Note: "Het." is an abbreviation used here for heterosexual. FSW and MSM programs refer to comprehensive prevention packages. * This is modeled as condom non-use to rule out mathematical inconsistency. ** Effect for those newly identified as HIV positive only. # Clients of FSWs. Source: Goals default impact matrix.

The specific values are suggested by sources from the literature that draw from low- and middle-income countries' experience, as documented in reports and journal articles. The effects reflect standard, guideline-based implementation of each intervention, though not at the level of service delivery quality seen in developed-country contexts. The model allows for uncertainty analysis related to the parameters in Table 1. Such uncertainty analysis is very important in describing the possible range of effects on HIV incidence, especially since the parameters in Table 1 are not known with certainty and can be considered only as average values across a variety of countries and implementation contexts.

Data Collection and Model Fitting

Goals-related demographic, behavioral, and epidemiological data

The sources for behavioral and epidemiological inputs were specific to Ghana. These included the Ghana Demographic and Health Survey 2008 (GDHS 2008), the Multiple Indicator Cluster Survey 2011 (MICS); and the most recent IBBSS reports for FSWs, clients, and MSM. The data were validated with stakeholders.

For the Goals model, the reproductive-age population (ages 15–49) is divided into nine groups based on sex and risk factors for HIV transmission. The groups are defined below.

Males ages 15–49

- Not sexually active—no reported sexual partners in the prior 12 months
- Low risk—one reported partner in the prior 12 months
- Medium risk—two or more reported partners in the prior 12 months
- High risk—reported paying for sex in prior 12 months
- Men who have sex with men

Females ages 15–49

- Not sexually active—no reported sexual partners in the prior 12 months
- Low risk—one reported partner in prior 12 months
- Medium risk—two or more reported partners in prior 12 months
- High risk—female sex workers

The inputs chosen for the modeling are shown in Table 2. A comparison with previous estimates is shown in Annex A. A critical difference from previous estimates is in the estimate for medium-risk women, who are a much smaller proportion of the adult female population for the Goals model used in this report; this is supported by data from the GDHS and in line with the declining trend in ANC prevalence, etc. Modes of transmission (MOT) studies conducted in 2009 and 2014 used a higher estimate for people engaging in casual heterosexual sex, though these MOT models do not disaggregate this group by gender.

Table 2. Risk groups used in Goals modeling as percentages of related demographic segments

Goals model risk group	Males		Females	
	Percentage of 15–49 male population (range)	Source	Percentage of 15–49 female population (range)	Source
Not sexually active	**35%** (30–39)	[21], [22]	**29%** (26–32)	[21], [22]
Low risk	**52%** (49–54)	[21], [22]	**69%** (67–72)	[21], [22]
Medium risk	**11%** (10–13)	[21], [22]	**1.1%** (1–1.9)	[21], [22]
High risk: males: clients; females: FSWs	**2%** (1.4–3)	[21], [22]	**0.8%** (51,937* FSWs from 6,522,286 Women 15–49)	[9]
MSM	**0.5%****	[12]	N/A	
Total	**100%**		**100%**	

* GAC suggested using the upper bound of the FSW population size in 2011 (58,920) for future population size estimates [15]. Therefore, we used 51,937 as the baseline figure for 2013, and 58,920 for purposes of estimating future intervention coverage. ** Baseline population based on 30,579 from IBBSS. A similar upper-bound estimate of 34,470 was used to develop future intervention coverage for scenarios.

Model fitting for Goals

A common step in Goals analysis is to "fit" the model by varying its key parameters related to behavior and certain epidemiological aspects until it predicts the historical epidemic with the same trend and accuracy as another model or other external source of HIV incidence and prevalence data. This step is important for two reasons. First, it helps to improve the Goals model's structure so that it reflects the underlying patterns of the country's epidemic and can better predict the future course of the epidemic, against which the effects of prevention interventions will be assessed. Second, it can identify key differences between mathematical models, which can help to better interpret the findings and identify potentially important behavioral and epidemiological parameters that should be monitored when developing the Goals model for future years. In this context, the "historical epidemic" refers to the HIV epidemic in the years prior to the year for which the Goals model begins its prediction. In the current analysis for Ghana, this means the period from the start of the country's epidemic (1986) to the year prior to the period of interest: 2013. A modeling fit exercise was conducted for 1986 to 2013 to compare the Goals model output to AIM.

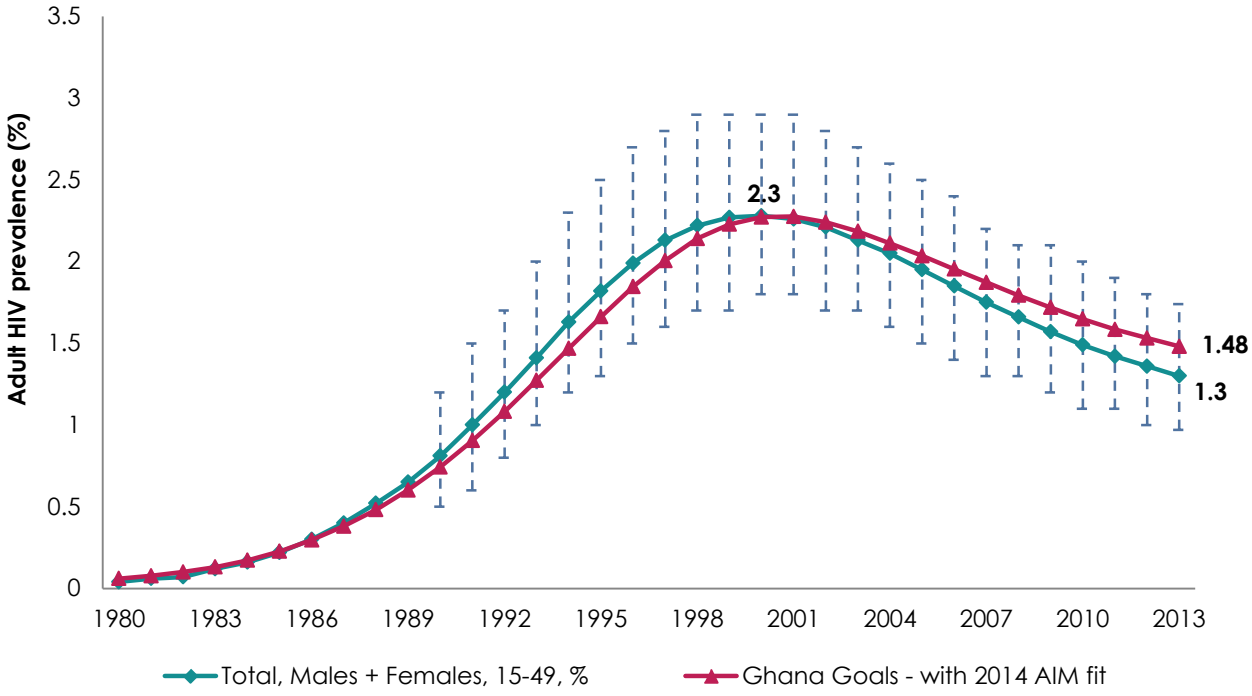
As part of the fitting exercise, historical prevalence of risk factors for HIV transmission and historical coverage of transmission-preventing behaviors are input into the model to recreate the epidemic and match the historical HIV prevalence among the general population and important population subgroups. The risk factors considered include the number of sexual partners per person, sex acts per partner, prevalence of STIs, condom use, age at first sex, and percentage married. Each factor is disaggregated by risk group.

During preliminary discussions, the Ghana CCM and NACP expressed a desire to modify the estimated need for PMTCT services from the country's accepted AIM file. The rationale was that the underlying

demographic estimates underestimated fertility and the annual number of pregnancies in Ghana. Based on a joint stakeholder meeting on this subject, there was a request to modify the Spectrum file so the number of pregnancies was equivalent to 4 percent of the total population in any given year. We adjusted the underlying fertility assumptions in Spectrum to match this request, which had a significant effect on the need for PMTCT in AIM because it altered the pregnancies in the underlying demographic model. This resulted in a 58 percent increase in the estimated need in 2013 from 11,857 mothers needing PMTCT to 18,788.

Figure 5 shows the overall result of model fitting in the general population. The re-created epidemic in Goals closely follows the historical epidemic from the national AIM estimates file. Both models peak in 2000 at 2.3 percent adult prevalence, with a sharp reduction in subsequent years. While the Goals fitted curve is slightly higher after 2002, it is still well within the 95 percent confidence interval depicted by the error bars in Figure 5. This suggests that the Goals model predictions are based on a good representation of the historical epidemic in Ghana. The results of the fitting were presented to the GAC and CCM stakeholders before additional results were calculated.

Figure 5. Model fitting in Goals: HIV prevalence among adults ages 15–49 in Ghana, 1980–2013

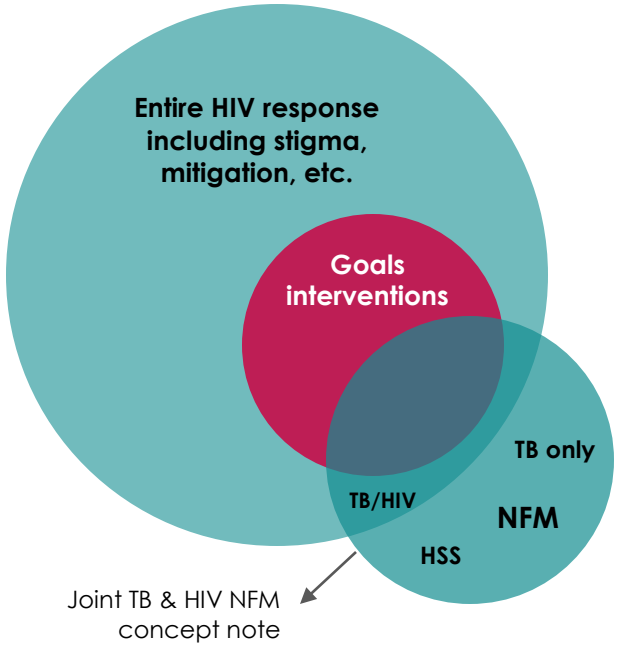


Source: Authors' estimates using the Goals model, [2]. Dashed lines show the confidence interval around the AIM projection of adult HIV prevalence (males and females) from the national projection file.

Coverage scenarios

Not all interventions in the NSP feature in the NFM concept note, nor do they appear in Goals. While the Goals modeling analysis is aimed at informing the NFM concept note, not all of the interventions targeted in the concept note feature in Goals modeling, which is driven by the design and focus of the model. The modeled interventions include ART, PMTCT, FSW outreach, MSM outreach, condom provision, and voluntary counseling and testing services. Figure 6 shows the conceptual differences.

Figure 6. Conceptual diagram for the relative inclusion of interventions and costs across current Goals model, the NSP, and the NFM concept note



Source: Authors

For the critical interventions modeled in Goals, we analyzed four scenarios. These differ in their coverage assumptions for key preventive and treatment interventions in Ghana for the 2014–2020 period. These scenarios are designed to compare the costs and impacts of the coverage targets proposed under the NFM allocation and the NFM above allocation funding. The differences between the scenarios are summarized in Table 3 (p. 15).

Scenario 1: Baseline scenario

Scenario 1, the *Baseline* scenario, reflects unchanged funding for key interventions from 2013 levels. For this scenario, the absolute numbers receiving services for each intervention were held constant, using the most recent estimate of coverage from programmatic data sources. If these sources were unavailable, the most appropriate estimates from literature were used.

According to data from NACP, 71,855 adults were receiving ART in 2013. This implies that 35 percent of adult PLHIV were on treatment and 64 percent of adults living with HIV needed ART, given baseline eligibility. These proportions are based on HIV population estimates from the national AIM estimates. In the *Baseline* scenario, the number of adults on ART was kept constant through 2020; however the percentage coverage may vary slightly due to year-on-year changes in the HIV-positive population. The number of women receiving PMTCT services—given the changes to fertility-related parameters in Spectrum as per stakeholder input—was estimated at 39 percent of the need at baseline (2013), compared with 62 percent reported elsewhere using the original, unadjusted AIM files (see "Model fitting for Goals" for explanation) [4].

Baseline coverage levels for behavioral interventions serving key populations were based on estimates from the recent IBBSS and targets from GAC [15]. The estimated annual coverage for a package of behavioral prevention interventions among FSWs was estimated at 78 percent for the *Baseline* scenario (using an upper-bound population size of 58,920) and 35 percent for MSM (see Table 3).

In addition to the key interventions above, the Goals model also included estimates of HTC coverage and condom provision. It was assumed that in the *Baseline* scenario, 5 percent of the adult population received HTC services each year, and 19 percent of adults were provided with a full year's supply of condoms (assumed to be 110 condoms for costing purposes).

Across all scale-up scenarios except *Baseline*, full implementation of Option B+ starting in 2014 implies that 100 percent of pregnant women with HIV would begin receiving ART for life from 2015 to 2020.

Scenario 2: New Funding Model (NFM) targets

Under the NFM, a country can apply for funding for a three-year grant period for an amount up to the country allocation limit set by the Global Fund to support additional high-impact interventions. The country can determine the division among the three diseases funded by the Global Fund, within the limit. Based on the NFM funding envelope for Ghana, the CCM collaborated with consultants to determine the maximum number of recipients for key interventions from 2015 to 2017 under the within-allocation NFM funding envelope, accounting for country priorities. These numerical targets were derived after the support from domestic public and other sources had already been considered. For example, based on consultations with the Ghana CCM, 17 percent of ART services could be funded from domestic sources in 2015, and this proportion would increase to 34 percent by 2017 (see Annex A, Table A.1). For use with the Goals model, these numerical targets were converted into percentages of the applicable underlying population as needed, using the appropriate population size estimates for each target population. For HTC and condom interventions, coverage was assumed to be in line with NSP goals. Targets were kept constant at 2017 values for 2018–2020. Targets for 2020 are listed below and shown in Table 3.

- ART coverage increase from 35 percent to 59 percent
- PMTCT coverage increase from 35 percent to 100 percent
- FSW coverage increase from 78 percent to 91 percent
- MSM coverage increase from 35 percent to 80 percent
- HTC coverage increase from 5 percent to 8 percent

In order to reach these goals, Ghana will have to combine both NFM and domestic resources as per Annex Table A.1. For example, in order to achieve 59 percent coverage for ART, up to 20 percent of eligible PLHIV would need to be funded through non-NFM sources by 2017.

Scenario 3: NFM targets with above-allocation funding

A country may apply for funding above the NFM allocation. Funds above the allocation are not guaranteed and would come from a competitive pool (also known as "incentive funding") accessible to all countries in the same epidemiological and country income group as Ghana. The Ghana CCM and stakeholders determined additional numerical targets for this competitive pool of funding (see Annex A, Table A.1), which we converted to coverage percentages (see Table 3).

- ART coverage increase from 35 percent to 66 percent
- PMTCT coverage increase from 35 percent to 100 percent
- FSW coverage increase from 78 percent to 95 percent
- MSM coverage increase from 35 percent to 90 percent
- HTC coverage increase from 5 percent to 8 percent

Scenario 4: National Strategic Plan

This scenario projects an increase in all the key intervention coverage targets; the coverage objectives established by GAC and the National Quantitative Program Data Set 2015–2017 are achieved [15] (see Table 3). According to the GAC vision, 90 percent of all PLHIV who know their status should be on ART by 2016, in line with the UNAIDS "90-90-90" initiative targets. Data are lacking on the proportion of Ghanaian PLHIV who know their status now and in the future, so it was assumed that the 90 percent coverage is applied to PLHIV. Not accounting for knowledge of status may lead to overestimating the number of PLHIV who can be reached with ART. We used the numerical targets calculated by GAC and the CCM for the NFM grant to represent 90-90-90 targets (see Annex A, Table A.1). These numerical targets do not necessarily achieve 90 percent coverage of all PLHIV in 2016 or up to 2019, given the re-estimated number of PLHIV in Spectrum version 5.22 with the December 2014 country data package.

Based on the re-estimated number of PLHIV, the 90 percent coverage vision is achieved by 2020. Under the NSP, by 2017, 90 percent of FSWs and 85 percent of MSM would be reached with the full package of recommended services. This would increase to 95 percent and 90 percent, respectively, by 2020.

- ART coverage increase from 35 percent to 90 percent
- PMTCT coverage increase from 35 percent to 100 percent
- FSW coverage increase from 78 percent to 95 percent
- MSM coverage increase from 35 percent to 90 percent
- HTC coverage increase from 5 percent to 8 percent

Table 3. Coverage assumptions for Goals modeling interventions (percentage of group)

1. Baseline (flat)								
Intervention	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ART[1]*	*35*	35	35	35	*36*	*37*	*37*	*38*
PMTCT**	*35*	35	35	35	35	35	35	35
FSW[2]	*78*	78	78	78	78	78	78	78
MSM[2]	*35*	35	35	35	35	35	35	35
HTC	*5*	5	5	5	5	5	5	5
Condoms[2]	*19*	19	19	19	19	19	19	19
2. NFM Targets								
Intervention	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ART*	*35*	37	44	52	59	59	59	59
PMTCT**	*35*	100	100	100	100	100	100	100
FSW[2]	*78*	78	77	82	87	88	90	91
MSM[2]	*35*	35	64	72	75	77	78	80
HTC	*5*	9	12	8	8	8	8	8
Condoms[2]	*19*	19	19	19	19	19	19	19
3. NFM Targets with Above-Allocation Funding								
Intervention	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ART*	*35*	35	38	51	60	66	66	66
PMTCT**	*35*	100	100	100	100	100	100	100

FSW[2]	*78*	78	80	85	90	92	93	95
MSM[2]	*35*	35	80	85	85	87	88	90
HTC	*5*	9	12	8	8	8	8	8
Condoms[2]	*19*	19	19	19	19	19	19	19
4. National Strategic Plan (NSP)								
Intervention	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ART*	*35*	43	80	81	81	89	89	90
PMTCT**	*35*	100	100	100	100	100	100	100
FSW[2]	*78*	79	80	85	90	92	93	95
MSM[2]	*35*	57	80	85	85	87	88	90
HTC	*5*	9	12	8	8	8	8	8
Condoms[2]	*19*	19	19	19	19	19	19	19

[1] Kept constant at 71,855 adults on ART per year. Percentage increases are due to variations in annual total number of PLHIV. [2] FSW refers to a FSW behavior-change/outreach package; MSM refers to a peer-led outreach package. Condoms refers to reaching adults with a condom plus information education and communication intervention. * Estimated as a percent of PLHIV, not of those eligible given a CD4 count threshold for initiating ART. For entry into the Goals model, strictly numerical targets of adults on ART were used. ** The underlying number of pregnant women living with HIV was revised based on stakeholder input on fertility. Coverage will not reflect previous national estimates for PMTCT need. All analyses were performed using Spectrum version 5.22 (March 2015).

Unit cost data

Using coverage and unit cost data, the Goals model calculates the direct costs of service delivery for the modeled interventions. The following unit costs, consistent with the NFM budget, were used. As directed by stakeholders, they were primarily sourced from prior analyses conducted in Ghana [23]. See additional details in Annex A.

Table 4. Unit costs of selected components for key interventions

Service	US$ per person year	Sources
Adult ART, first line	**128**	[23]
Adult ART, second line	**1,021**	[23]
Laboratory tests for patients on ART	**58**	[23]
Cotrimoxazole	**31**	[23]
Nutritional support	**79**	World Food Programme
HTC	**6.5**	Authors' calculation
Condom, male	**0.031** each	Ghana USAID/DELIVER project
FSW service package (x6 contacts)	**17.8** per contact	[24,25]
MSM service package (x4 contacts)	**21** per contact	[24,25]
PMTCT (all costs excluding ART)	**42**	Authors' calculation

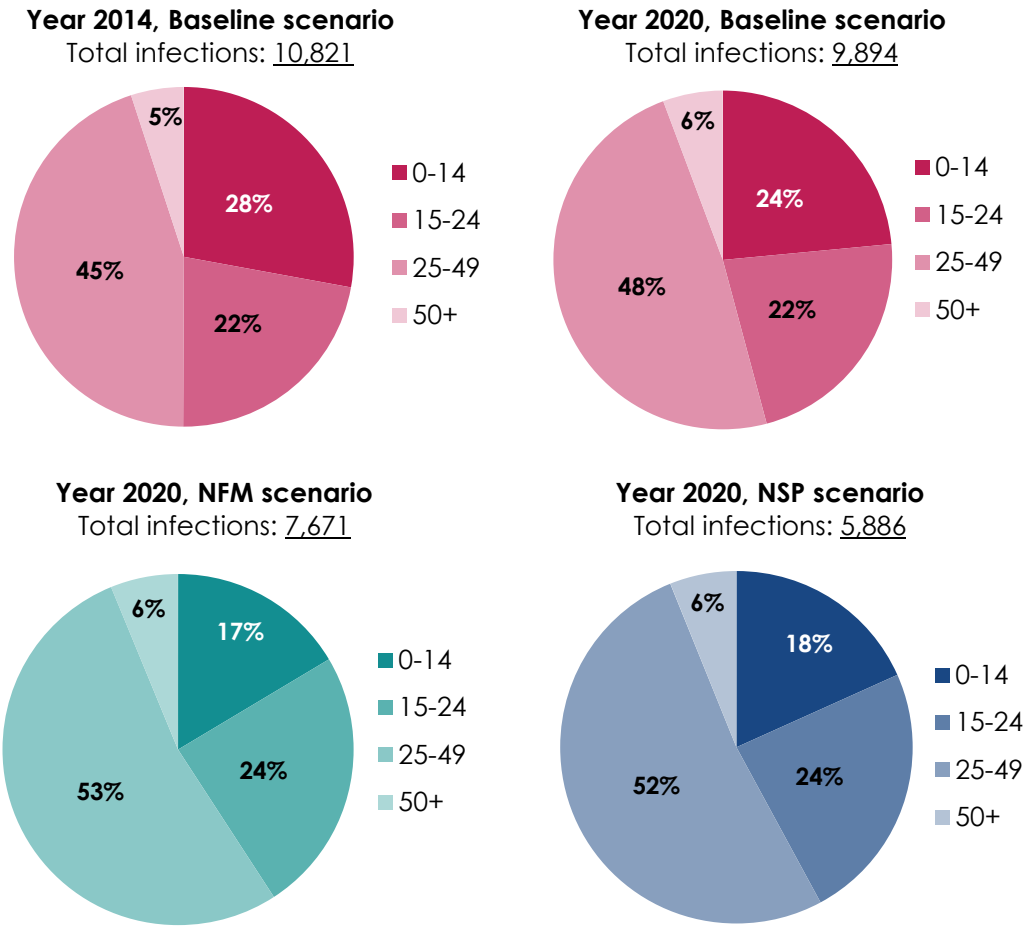
3. RESULTS

Modes of transmission

New infections by age group

The study team used AIM and Goals to investigate total new infections in different ways. In this context, "modes of transmission" refers to the distribution of new infections across different groups in the population. Figure 7 shows the total new infections in Ghana, at the beginning and end of the period, comparing three of the four scenarios. Review of the baseline chart for 2014 suggests that 50 percent of the incidence was in the younger segments of the population, with about one-quarter of infections occurring in the 0–14 age group (within which 100% of infections occurred prior to age 4, i.e., mother-to-child transmission). Across scenarios, by the end of the period, the proportion of incidence occurring in the under-25 demographic declined to the range of 41–46 percent. The reduction in incidence in the youngest age group occurred due to the increasing effectiveness of PMTCT, with almost all pregnant women with HIV receiving ART.

Figure 7. Comparison of new infections by age and scenario across time



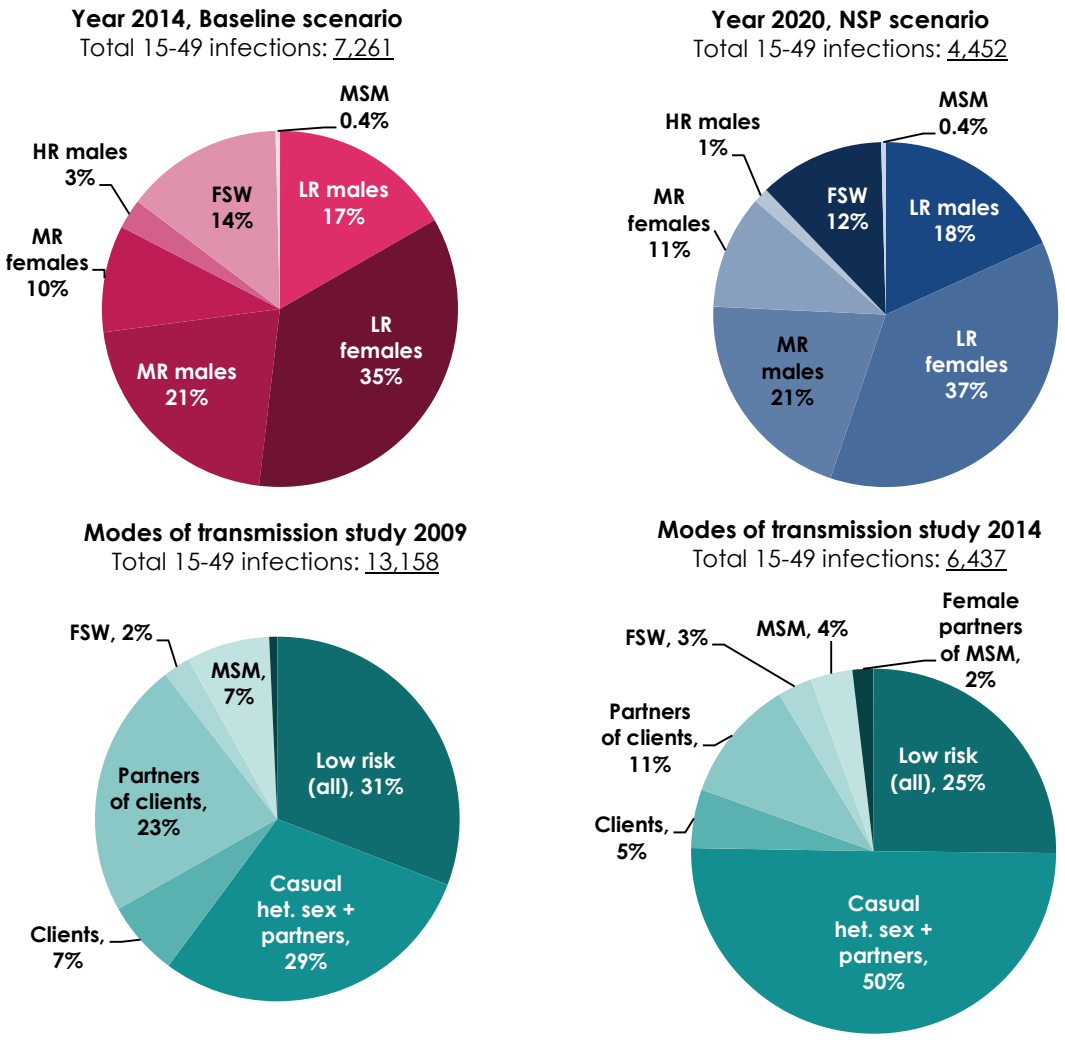
Source: Authors' analysis

Incidence in the youngest age group, which is wholly vertical, would be much lower without the changes to the fertility assumptions in our models that were requested by stakeholders.

New infections by risk group

Modes of transmission (MOT) are more commonly studied with a focus on risk groups disaggregated by risk behavior, both sexual and injecting. We did not model injecting drug use in this analysis due to a lack of new data, though prior studies have pointed to the presence of PWID in Ghana [8,13]. Also, compared to the traditional modes of transmission analyses, Goals does not distinguish populations such as partners of clients or female partners of MSM, nor does it include a group such as "casual heterosexual sex." Given these caveats, we compared results from our analysis only to similar risk groups from the 2009 and 2014 modes of transmission studies (Figure 8). Both Goals and the MOT studies estimate new infections in the 15–49 age groups.

Figure 8. Comparison of annual new infections in adults ages 15–49 by risk group and scenario



Source: Authors' analysis, [13]. MR: medium risk; LR: low risk; HR: high risk; het.: heterosexual.

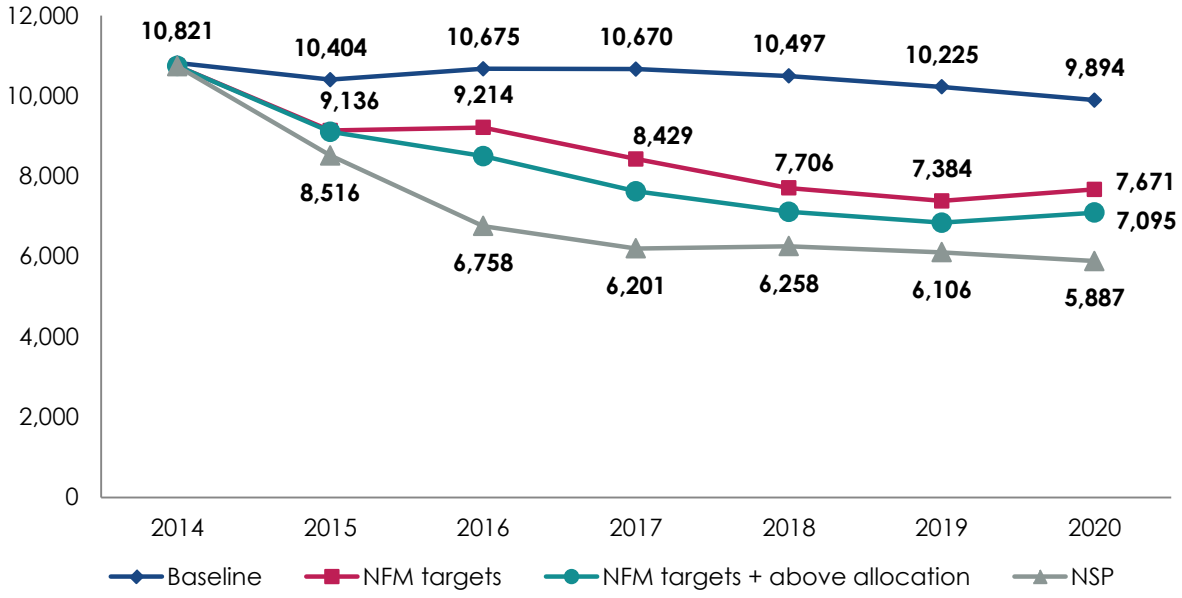
Key populations at higher risk (FSWs, MSM, and clients) constitute 12 percent of the incidence in comparable groups in the 2014 study [8], 16 percent in the 2009 study [13], and 15–17 percent in our analysis, depending on scenario and year. In our study, these groups constitute 2 percent of the adult (ages 15–49) population. In the 2009 and 2014 MOT studies, they constitute 5 percent of the total adult population, excluding PWID. In our Goals modeling about 31 percent of incidence occurs in "medium-risk" males and females, which is comparable to the incidence fraction of 29 percent for "casual heterosexual sex and partners" from the 2009 study but much lower than the 50 percent in the 2014 MOT study. There is a large difference between the MOT studies and the Goals model in the proportion of incidence among MSM, even though we used a larger value as the estimate of MSM as a proportion of the adult male population (see Annex A). There is concern that MOT studies, which share a similar underlying mathematical equation with the Goals model while widely varying in data and assumptions, may underestimate the total incidence in key populations, especially in concentrated epidemics [26] [27]. Such concerns are partially mitigated in the current Goals modeling analysis of Ghana's mixed HIV epidemic because we have a lower population share of these groups yet generate a higher proportional incidence fraction.

Health Impact

New HIV Infections

The numbers of new HIV infections for the scenarios modeled in Goals are shown in Figure 9. Under the *Baseline* scenario, the total number of new HIV infections per year will still decline over time due to the overall reduction in the underlying HIV-positive population due to mortality. By scaling up intervention coverage under NFM funding, new infections per year are reduced more dramatically. With the NFM targets enabled by the within-allocation funding, 12,900 new HIV infections are averted from 2014 to 2020 compared with the *Baseline* scenario. In the scenario representing NFM targets under potential above-allocation funds, new infections averted compared with baseline could increase by 3,250 during this period, primarily through gains in the early years. Finally, achieving all the NSP targets would avert 22,725 infections compared with maintaining the status quo.

Figure 9. Projected annual number of new HIV infections (all ages) by scenario, 2014–2020

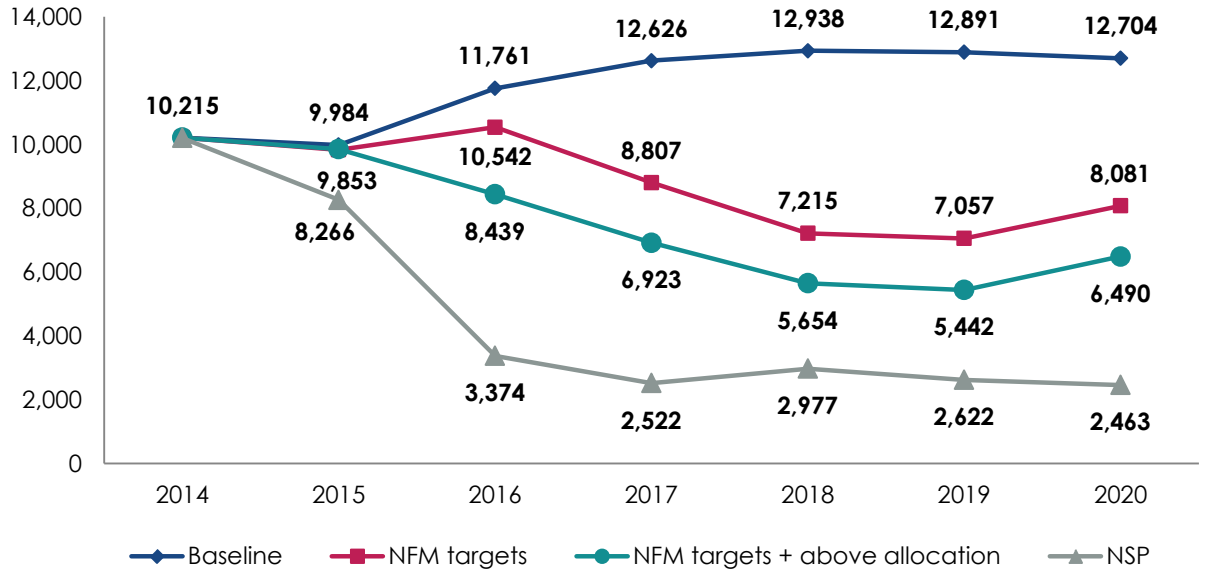


Source: Authors' analysis

AIDS-related mortality

Under the *Baseline* coverage scenario, AIDS-related deaths are projected to increase from approximately 10,215 in 2014 to 12,700 in 2020 (Figure 10). Applying the increased ART figures under the NFM within-allocation funding toward achieving the NSP would reduce annual mortality to 8,080 in 2020, a reduction of 35 percent from 2014. Over the entire period, the NFM scenario results in 11,435 lives saved compared with the *Baseline* scenario. In the scenario incorporating incentive funding above the current NFM allocation, a further expansion of ART coverage could avert an additional 8,735 deaths compared to the previous *NFM* scenario. The *NSP* scenario's ambitious ART targets would avert nearly 40,760 deaths compared with the *Baseline* scenario.

Figure 10. Projected number of annual AIDS-related deaths by scenario, 2014–2020



Source: Authors' analysis

One implication of the results in Figure 7 and Figure 8 is that as coverage levels of the interventions increase, new infections and deaths do not decrease at the same rate. A plausible explanation is that the decrease in mortality results in a greater PLHIV population with a non-zero risk of transmitting new infections. Therefore, as ART coverage is scaled up, the expected reduction in infectivity is partially offset by the larger population with HIV.

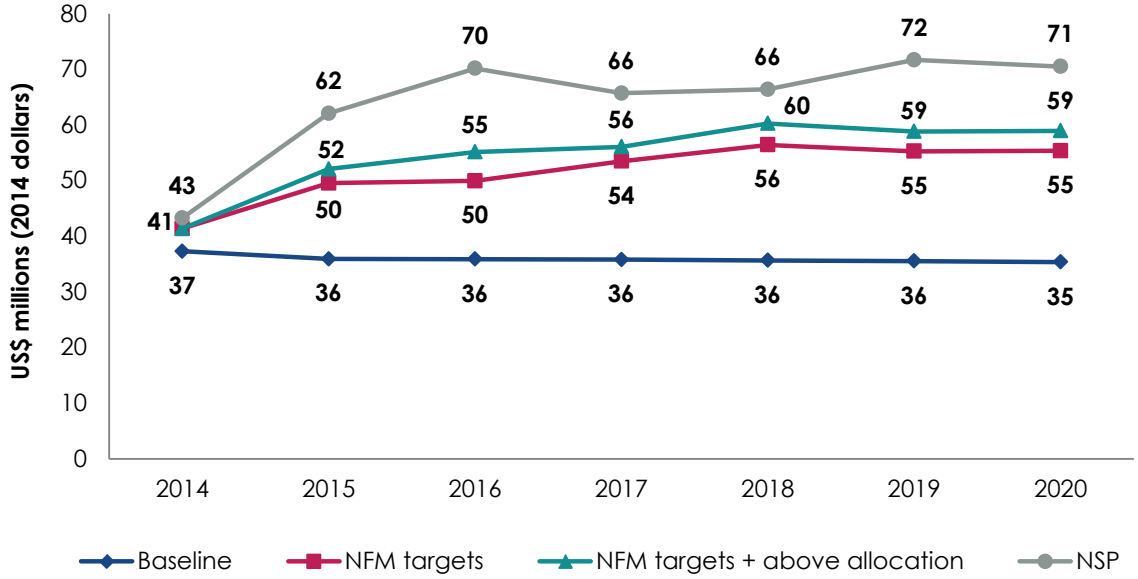
Total Costs

We calculated the total cost of the HIV program in Ghana based on the direct service delivery costs under each of the four scenarios, using the unit costs per person per year as shown in Table 4. The costs for key population interventions include some direct program costs in addition to service delivery (see Annex A). The cost results were also used for cost-effectiveness analysis. The Goals model costing only accounts for interventions for which we have unit costs, and the unit costs as entered are only related to the direct costs of service provision (drugs and commodities) and are subject to the caveats and limitations of the original studies cited [23,24]. As shown in Figure 6, the Goals modeling conducted for the current report only concerns a subset of interventions which are neither analogous to the full tuberculosis/HIV concept note for the Global Fund NFM as submitted by Ghana, nor a full representation of interventions under the

NSP. Therefore, the costs projected by Goals will be a subset of the costs of the overall HIV response and will not be representative of the total HIV resource need.

Under the coverage assumptions of the *NFM* scenario related to within-allocation targets, the direct costs of service delivery for the Goals interventions will rise to US$54 million by 2017 (Figure 11), while the *NSP* scenario in the same year would cost US$66 million. The *Baseline* scenario is stable at a cost of US$35–37 million per year, given its invariant coverage. The fiscal space for the country to deliver key HIV interventions was not observed, so we cannot comment on whether a particular scenario is more financially feasible. However, the targets of the *NSP* scenario and the *NFM targets plus above allocation* scenarios were not fully funded at the time this report was written.

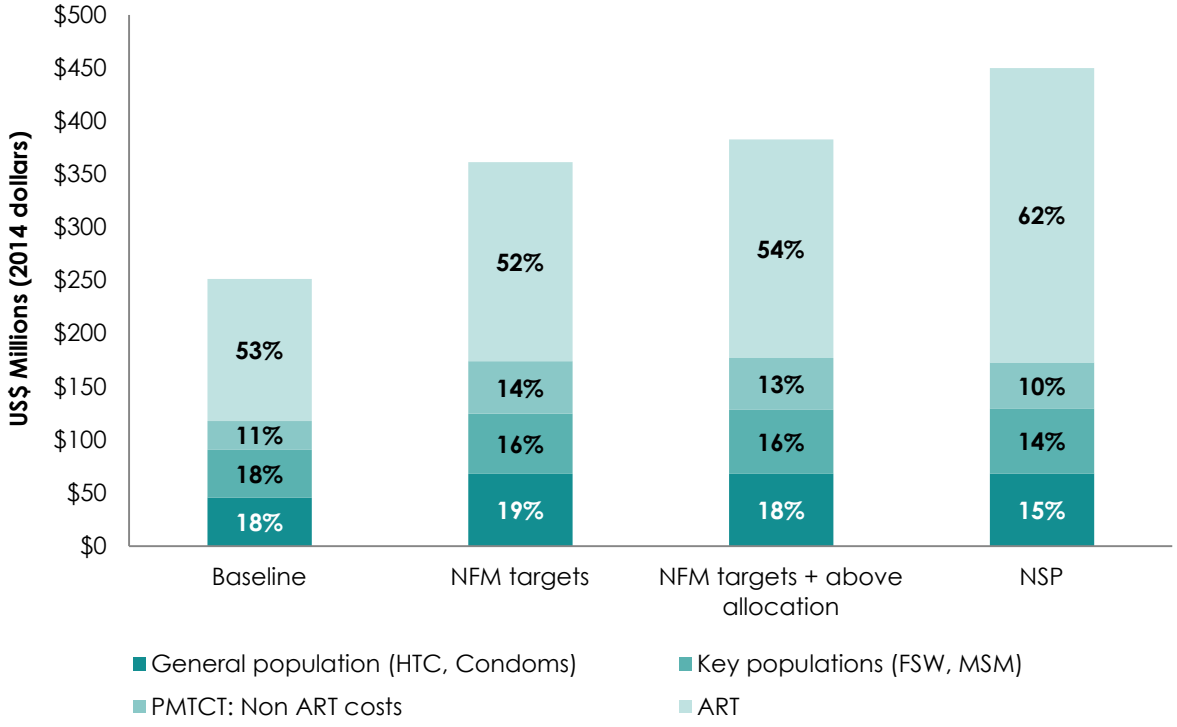
Figure 11. Projected annual costs of interventions, by scenario, 2014–2020



Source: Authors' calculations

The overall costs for 2014–2020 in Figure 12 can be compared to the priorities of the response. Not all of the general population prevention interventions have been costed. Total costs for the period range from US$252–450 million across the scenarios. The cost of key population interventions—14–18 percent across scenarios—seems rational, given that these groups are associated with 15–17 percent of incidence. Spending on ART has the largest share in each scenario (pediatric ART was not costed). This intervention has impacts in averting mortality as well as infections. The *NSP* scenario, with its rapid scale-up of ART, shows the largest share for this intervention in overall costs.

Figure 12. Total costs for the period 2014–2020, by scenario and intervention grouping



Source: Authors' calculations

Incremental Cost-Effectiveness

The incremental cost-effectiveness ratio (ICER) is an accepted metric to compare the costs and outcomes of different health policy options. By dividing the incremental cost by the incremental health benefits, the ICER can be interpreted as the average cost per additional unit of health that is paid moving between scenarios. Table 5 summarizes the results. Comparing the *NFM* scenario to the *Baseline* scenario on costs and HIV infections averted, the ICER is US$8,522 per infection averted. With a similar comparison, the ICER for the *NSP* scenario is US$8,733 per infection averted, and for the *NFM targets plus above allocation*, the ICER is US$8,128 per infection averted. These results suggest that it is more cost-effective to consider the additional targets enabled by the potential above-allocation amounts versus the higher targets in the *NSP* scenario, from a prevention perspective.

We also considered perspectives on mortality averted and quality-adjusted life years (QALYs) gained. Considering AIDS deaths averted and the incremental cost, the *NSP* scenario has an ICER of US$3,915 per death averted versus the *Baseline* scenario, which is the lowest. Conducting this comparison with QALYs estimated using AIM, the ICER value falls to US$771 per QALY gained, which can be compared with Ghana's 2013 gross domestic product per capita (US$1,853) [28]. Given that this value will be lower even if we convert the income level to 2014 dollars, from a QALY perspective, the NSP scale-up is "very cost-effective" applying World Health Organization standards for cost-effectiveness of health interventions. If Ghana is able to secure the resources to pursue targets under the *NFM* scenario (within-allocation resource envelope), acceleration to higher-level scenario targets would also be very cost-effective given ICERs of about US$500 or below (Table 5).

Table 5. ICER: US$ per HIV infection averted, per AIDS-related death averted, and per QALY gained (in 2014 dollars)

US$ per infection averted	New HIV Infections	Averted vs. Baseline	Averted vs. NFM	Total cost (US$ mil.)	ICER vs. Baseline (US$)	ICER vs. NFM (US$)
Baseline	73,186	-	-	$252	-	-
NFM targets	60,284	12,902	-	$362	**$8,522**	-
NFM targets with above allocation	57,028	16,158	3,256	$383	**$8,128**	$6,569
NSP	50,462	22,724	9,822	$450	**$8,733**	$9,010
US$ per AIDS death averted	**AIDS deaths**	**Averted vs. Baseline**	**Averted vs. NFM**	**Total cost (US$ mil.)***	**ICER vs. Baseline (US$)**	**ICER vs. NFM (US$)**
Baseline	83,119	-	-	$252	-	-
NFM targets	61,751	21,368	-	$362	**$5,146**	-
NFM targets with above allocation	53,016	30,103	8,735	$383	**$4,363**	$2,449
NSP	32,428	50,691	29,323	$450	**$3,915**	$3,018
US$ per QALY gained	**QALYs (millions)**	**Gained vs. Baseline**	**Gained vs. NFM**	**Total cost (US$ mil.)**	**ICER vs. Baseline (US$)**	**ICER vs. NFM (US$)**
Baseline	201.3	-	-	$252	-	-
NFM targets	201.38	81,036		$362	**$1,357**	-
NFM targets with above allocation	201.43	125,984	44,948	$383	**$1,043**	$476
NSP	201.56	257,483	176,447	$450	**$771**	$502

* Mil.: millions

Discussion

Although HIV prevalence seems to be declining in Ghana, there is a need for targeted investments to avert HIV incidence and AIDS-related mortality. Continuing the status quo level of investments in key interventions for 2014–2020 is costly, with an average annual new infection level of more than 10,000 in the population as a whole. With targeted investments in key treatment and behavioral prevention interventions, Ghana can reduce its total HIV incidence to an average of 7,000 new infections per year or even fewer, depending on the scale of coverage. The country can also reduce the annual level of AIDS-related mortality from an average of 12,000 deaths per year to an average range of 3,000 per year with the highest scenario range of currently planned targets.

As Ghana begins to plan for a new HIV and AIDS strategic plan for the years after 2015, it will need to conduct similar analytical exercises to understand future investments with different scenarios and allocations across interventions. A broader set of interventions should also be considered, across behavioral, biomedical, and structural interventions, which may yield higher or different benefits. This analysis, which focused on variations in different options for targeting a potential grant from the Global Fund, answered very specific questions. As targets and funding realities change, the results of this analysis will need to be reinterpreted.

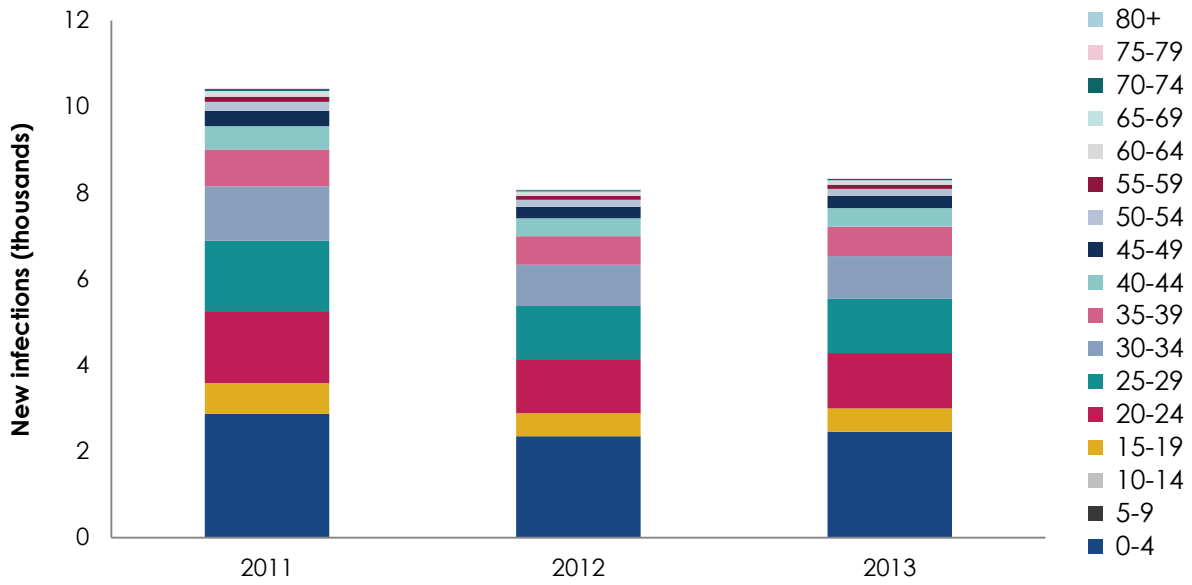
Ghana has an advantage in possessing detailed data on the behavior and HIV seroprevalence among different HIV groups, enabled by a high-quality sentinel surveillance network and regular integrated bio-behavioral surveys. This enables Ghanaian stakeholders to ask questions that can drive evidence-based prevention policy for the country's evolving mixed epidemic. Ghana can drive change to achieve large reductions in incidence and HIV-related mortality.

Limitations

Like any modeling analysis, this analysis using the Goals model is subject to uncertainties and limitations in the underlying data and epidemiological assumptions. The current report is based on a particular set of behavioral, epidemiological, and impact parameters, which cannot be known with certainty. As such, the results discussed above are also subject to uncertainty and to the structure of the Goals model and the limitations therein. Finally, the scenarios here lacked firm targets for years after 2017, as these were not an explicit part of the NFM process. As Ghana conducts planning exercises for the next strategic plan, these targets can be updated to repeat this form of modeling analysis.

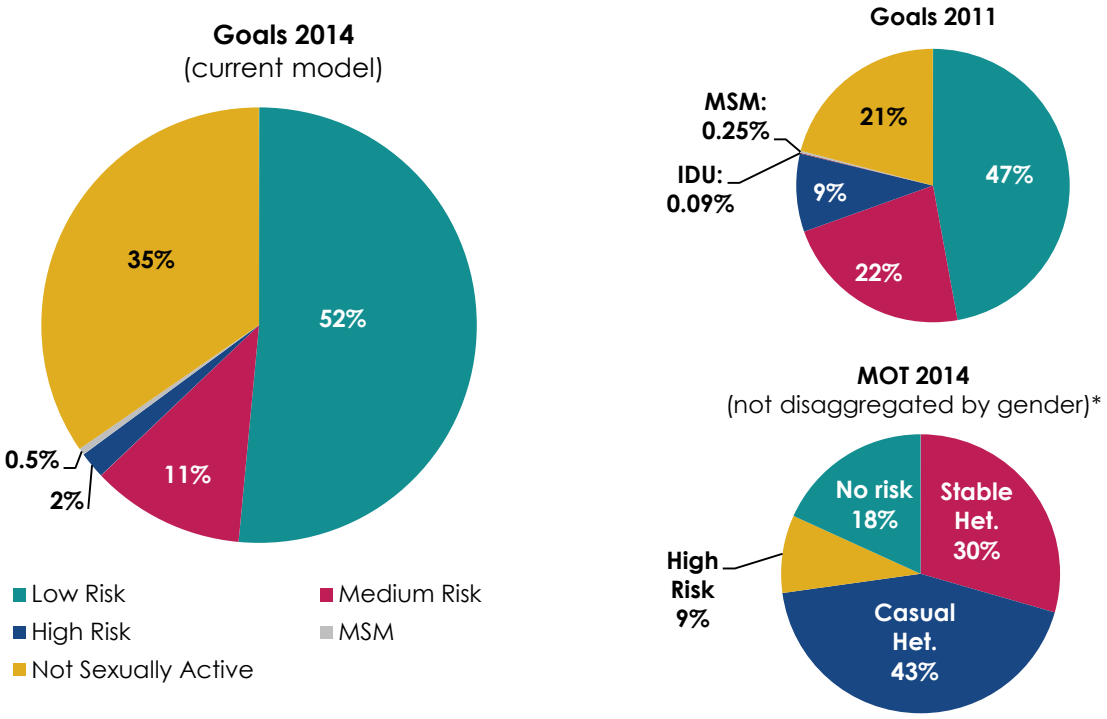
ANNEX A. ADDITIONAL INFORMATION

Figure A.1 Sources of new infections by age, 2011–2013, from the Ghana AIDS Impact Model



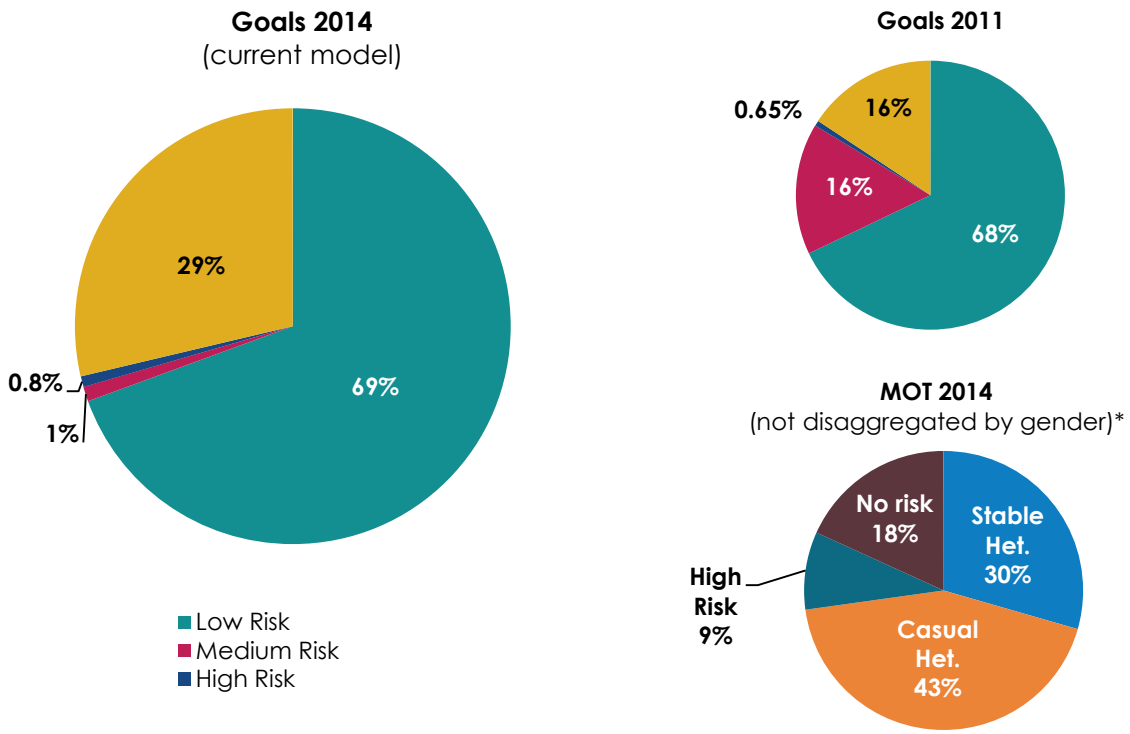
Source: [2]

Figure A.2 Risk groups as a percentage of males ages 15–49—comparison across Ghana-centric models



Note: Goals model chart legends are the same across 2011 and 2014.
Sources: Authors, [8,13,17] * Het: heterosexual. High risk: FSWs, MSM, clients of FSWs, and their partners.

Figure A.3 Risk groups as a percentage of females ages 15–49—comparison across Ghana-centric models



Note: Goals model chart legends are the same across 2011 and 2014.
Sources: Authors, [8,13,17] * Het: heterosexual. High risk: FSWs, MSM, clients of FSWs, and their partners.

Table A.1. Total coverage of key interventions for NFM grant scenarios, 2015–2017

Intervention	2015	2016	2017	Notes
Scenario 2: NFM targets				
ART	90,820	105,878	120,936	17–34% funded by domestic (increasing over 2015–17)
FSW	45,086	48,032	50,978	48–55% funded by PEPFAR (declining over 2015–17)
MSM	22,214	24,761	25,932	55–64% funded by PEPFAR (declining over 2015–17)
Scenario 3: NFM targets with above allocation funding				
ART	104,666	122,031	135,774	With above allocation, targets are 112–115% of Scenario 2
FSW	47,136	50,082	53,028	With above allocation, targets are 104–105% of Scenario 2
MSM	27,575	29,299	29,299	With above allocation, targets are 113–124% of Scenario 2
Scenario 4: NSP targets (as per the NFM concept note)				
ART	166,735	171,850	175,339	90% of PLHIV as per the NFM plan's estimate of PLHIV

Source: Ghana AIDS Commission, Ghana Country Coordinating Mechanism (CCM) 2014

Table A.2 Direct service delivery costs (DSDC) and other direct program costs (ODPC)

FSW contacts	Unit cost US$	DSDC	ODPC	MSM contacts	Unit cost US$	DSDC	ODPC
Outreach	15	9%	28%	Outreach	20	29%	25%
Mobile HTC	24	43%	18%	Mobile HTC	29	50%	18%
Drop-in counseling	18	13%	27%	Drop- in counseling	18	20%	27%
Drop-in clinic STI	17	12%	27%	Drop-in clinic STI	17	18%	27%
Drop-in clinic HTC	22	31%	21%	Drop-in clinic HTC	21	33%	22%

Source: [24]

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