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Allocation of HIV Resources towards Maximizing the Impact of Funding in Selected Eastern European and Central Asian Countries

ARMENIA

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Allocation of HIV resources towards maximizing the impact of funding

Executive Summary

The Eastern European and Central Asian region continues to have the fastest increasing HIV epidemic in the world (1). The COVID-19 pandemic and the on-going war in Ukraine threaten economic growth and progress towards HIV targets. To ensure that progress against the HIV epidemic can continue, it is vital to make cost-effective funding allocation decisions to maximize the impact of HIV programs. An allocative efficiency analysis was conducted in partnership with the Armenia National Center for Infectious Diseases, Ministry of Health of Armenia, the Global Fund, UNAIDS, Swiss Tropical and Public Health Institute, and the Burnet Institute.

Summary and key recommendations for HIV resource optimization include:

- Historically Armenia has had a concentrated HIV epidemic predominantly among people who inject drugs, however surveys show a decline in HIV prevalence in this group from 10.7% in 2010 to 2.6% in 2021 (2, 3). The largest proportion of new infections are now occurring among seasonal labor migrants and their partners.
- In 2021 an estimated US$1.9M was spent on targeted HIV interventions, with prevention programs focusing on key populations accounting for 70% of this.
- In a baseline scenario where 2021 spending on programs was maintained, including a fixed annual spending on antiretroviral therapy (ART), there were estimated to be 1,359 new HIV infections, 1,177 HIV-related deaths and 29,412 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **Optimizing spending would involve scaling up ART and prevention programs for migrants ahead of prevention programs focusing on female sex workers and men who have sex with men.** This optimization prioritizes high impact interventions that address the current treatment gap. It is estimated only half of migrants living with HIV are diagnosed. Increasing diagnosis and treatment among migrants at highest risk could curb new infections.
- Optimized reallocation of 2021 spending can advance epidemic gains without additional resources and was estimated to avert 495 new infections (36%), 426 deaths (36%) and 10,267 DALYs (35%) over 2023-2030 relative to the baseline scenario of continued 2021 spending.
- **With additional resources available, priorities were identified as continued scale up of prevention programs focusing on migrants, followed by programs for men who have sex with men and prisoners**.
- Moving from the 66-88-91[1] care cascade modeled in 2021 to reach the 95-95-95 targets by 2030 will require progress particularly in increasing diagnoses and linking and retaining people on treatment. The optimized expansion of current programs at 300% of 2021 targeted spending is projected to be insufficient to reach the 95% diagnosis target by 2030, and novel programs may be needed to reach undiagnosed people living with HIV more cost-efficiently. Meeting the 95% treatment and 95% viral suppression targets will require continued expansion of ART coverage through ongoing increases in spending, or decreases in procurement costs, and novel programs to improve linkage to care and treatment adherence that are not costed in this analysis.

[1] Fitted through model calibration specifically for this analysis and may slightly differ from reported estimates.

1 Background

In 2021 Armenia had an estimated population of 2.9 million (4) and an estimated 4,850 people living with HIV (5). In Armenia key populations disproportionately affected by HIV include men who have sex with men (MSM, HIV prevalence 5.0% in 2021) (2), people who inject drugs (PWID, HIV prevalence 2.6% in 2021) (2) seasonal labor migrants and their partners (estimated HIV prevalence 1.5% in 2018) (6), and female sex workers (FSW, HIV prevalence 0.2% in 2021) (2).

In the early stages of the HIV epidemic the primary mode of transmission was through injecting drug use; however, since 2005 the HIV prevalence among PWID has been in decline, with integrated biological-behavioral surveillance (IBBS) surveys estimating prevalence to have decreased from 10.7% in 2010 to 2.6% in 2021 due to the scale up of needle and syringe programs and opioid substitution therapy (2, 3). Since 2006, new HIV infections have primarily occurred through heterosexual transmission (7), especially among labor migrants. Nearly 60% of registered HIV cases between 2013 to 2017 were among seasonal labor migrants (8). Many people leave Armenia annually to work in other countries, most notably Russia, with a higher HIV prevalence and contract HIV abroad (7). Social exclusion, limited access to health care, and host country legislation may increase vulnerability of migrants to HIV (7). While many people are diagnosed with HIV when they return to Armenia, Armenia also receives returning migrants who have been deported from Russia due to their HIV status (8). In addition to the seasonal labor migrants, Armenia is currently experiencing a large wave of immigration from Russia and Ukraine, corresponding with an increase in new HIV cases detected among newly arrived population (9).

Armenia has a very high proportion of late diagnoses, with 60% of new HIV diagnoses having a CD4 count below 350/mm^3 in 2021 (10) and just over half of people living with HIV diagnosed (11). It is estimated that nearly 25% of diagnosed people living with HIV are not on treatment (5).

In January 2022, Armenia adopted the 2022-2026 National Program on HIV/AIDS Prevention. It is a continuation of the previous national HIV program to provide an effective HIV response to end AIDS by 2030. In 2021, the total annual spending on HIV programs amounted to US$3.8M based on the 2021 UNAIDS Global AIDS Monitoring (GAM) report (12), of which domestic contributions accounted for 39% (12).

Previous HIV allocative efficiency analyses were conducted in 2014 and 2019 using the Optima HIV model, with support from the World Bank, UNAIDS, the Global Fund, and other partners (13, 14). This is the third Optima HIV analysis in Armenia which was conducted to identify priorities for HIV resources, according to the objectives below, based on the latest demographic, epidemiological and programmatic data.

2 Objectives

Objective 1. What is the **optimized resource allocation** by targeted HIV intervention to minimize HIV infections and deaths by 2030 under five funding scenarios of 50, 75, 100, 125 and 150 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?

Objective 2. If national governments do not scale up HIV programs identified for prioritization under optimized allocation for different funding envelopes, what will the impact be on the epidemic by 2030? That is, what is the **opportunity lost to avert HIV infections, deaths** and disability-adjusted life years (DALYs)?

Objective 3. What is the **most efficient HIV resource allocation for best achieving 95-95-95 targets** by 2030, and what is the level of resources required for achieving these targets? What is the number of HIV infections prevented and deaths averted under this scenario?

3 Methodology

An allocative efficacy modeling analysis was undertaken in collaboration with the National Center for Infectious Diseases and Ministry of Health of Armenia. Epidemiological and program data were provided by the country team and validated during a regional workshop that was held in September 2022 in Istanbul, Turkey. Country teams were consulted before and after the workshop on data collation and validation, objective and scenario building, and results validation. Demographic, epidemiological, behavioral, programmatic, and expenditure data from various sources including Statistical Committee of the Republic of Armenia, UNAIDS Global AIDS Monitoring (GAM) and National AIDS Spending Assessment reports, IBBS surveys, national reports and systems were collated. In Armenia, baseline spending was derived from the 2021 GAM and supplementary program data (12). Budget optimizations were based on targeted HIV spending for programs with a direct and quantifiable impact on HIV parameters included in the model, represented by US$1.9M of the total annual spending. The allocative efficacy analysis was conducted using Optima HIV, an epidemiological model of HIV transmission overlayed with a programmatic component and a resource optimization algorithm. The model was developed by the Optima Consortium for Decision Science in partnership with the World Bank, and a detailed description of the Optima HIV model is available in Kerr et al (15).

3.1 Populations and HIV programs

Populations and HIV programs considered in this analysis were:

- Key populations

    - Female sex workers (FSW)
    - Clients of sex workers (Clients)
    - Men who have sex with men (MSM)
    - People who inject drugs, male (PWID)
    - Seasonal labor migrants, male (Migrants)
    - Prisoners, male (Prisoners)
- General populations
    - Male 0-14 (M0-14)
    - Female 0-14 (F0-14)
    - Male 15-49 (M15-49)
    - Female 15-49 (F15-49)
    - Male 50+ (M50+)
    - Female 50+ (F50+)
- Targeted HIV programs
    - Antiretroviral therapy (ART)
    - Prevention of mother-to-child transmission (PMTCT)
    - Opioid substitution therapy (OST)
    - HIV testing services for the general population (HTS)
    - HIV testing and prevention programs for female sex workers (FSW programs)
    - HIV testing and prevention programs for men who have sex with men (MSM programs)
    - HIV testing and prevention programs for people who inject drugs, including needle-syringe programs (NSP & PWID)
    - HIV testing and prevention programs for migrants (Migrants)
    - HIV testing and prevention programs for prisoners (Prisoners)
    - Pre-exposure prophylaxis (PrEP) for female sex workers and men who have sex with men

3.2 Model constraints

Within the optimization analyses, no one on treatment, including ART, PMTCT, or OST, can be removed from treatment, unless by natural attrition. All other programs were constrained to not reduce by more than 50%, unless optimizing a reduced budget.

3.3 Treatment retention parameters

The model did not include any defined HIV programs aimed at improving linkage or retention in treatment, adherence or viral suppression. Objective 1 (optimizing spending across programs to minimize infections and deaths) maintained the most recent values for time to be linked to care, loss-to-follow-up, return to care and viral suppression until 2030. Subsequently, the projected care cascade with optimized spending may underestimate the second and third pillars if additional programs that are not in the model are implemented or scaled-up.

Unlike Objective 1, which maintained most recent values for a number of care parameters, the optimization in Objective 3 (achieving 95-95-95 targets) *assumed* that the proportion of diagnosed people on treatment and the proportion of people on treatment with viral suppression would linearly increase to reach 95% by 2030. Objective 3 therefore includes the impact of improvements to reach the treatment and viral suppression targets but not the cost of programs required to achieve these gains, which would require further work to quantify.

3.4 Model weightings

Objective 1 weightings to minimize new HIV infections and HIV-related deaths by 2030 were weighted as 1 to 5 for infections to deaths. Objective 3 weightings were to maximize the proportion of people living with HIV diagnosed and aware of their status.

4 Findings

4.1 Objective 1

*What is the **optimized resource allocation** by targeted HIV intervention to minimize HIV infections and deaths by 2030 under five funding scenarios of 50, 75, 100, 125 and 150 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?*

2021 HIV spending. In Armenia total spending on HIIV from domestic and international sources was US$3.8M in 2021, incorporating US$1.9M targeted HIV spending for the programs considered above and US$1.9M non-targeted spending. The majority (70%) of targeted spending was for prevention programs for key populations, followed by ART (17%) and smaller proportions for OST and HTS programs (Figure 2; Table A5). Non-targeted spending, which was not included in the optimization analysis, encompassed human resources, management and logistics costs, monitoring and evaluation, programs supporting health systems strengthening and an enabling environment, some HIV care costs and other non-targeted HIV programs (Table A6).

Resource needs to maintain 2021 ART coverage. The modeled care cascade estimate of ART coverage among diagnosed people living with HIV in 2021 was 88%. If ART unit costs (US$120 in 2021) and current coverage of other HIV programs remained constant, annual ART spending would need to increase by US$90,392 (29% of 2021 ART spending) during the period of 2022 to 2030 to maintain a constant proportion of people who are diagnosed on treatment. Maintaining the "status quo" proportion of people who are diagnosed on treatment will therefore require additional future investment in HIV (Figure 1a), further reductions in ART unit costs, or reallocation of resources from other HIV programs.

To compare scenarios with optimized allocation of resources within a fixed budget envelope, a counterfactual "Baseline" of fixed annual spending on ART was used. This would result in different epidemic projections to maintaining fixed coverage (Figure 1b) but means that optimizations consider how the needs for additional treatment can be met.

Comprehensive strategic information was not available to define the combination of factors leading to people not being retained in care and on treatment, and specific programs to improve linkage to care or treatment adherence were not modeled or costed in this analysis. Although treatment is available to all diagnosed people living with HIV in Armenia, there is a gap in strategic information where some diagnosed people living with HIV are neither reported to be on treatment nor lost to follow-up. It was assumed that additional spending on ART would be able to return these people to treatment, but further exploration of the limitations in achieving higher coverage of treatment may be necessary (including migration and acceptability of treatment regimens).

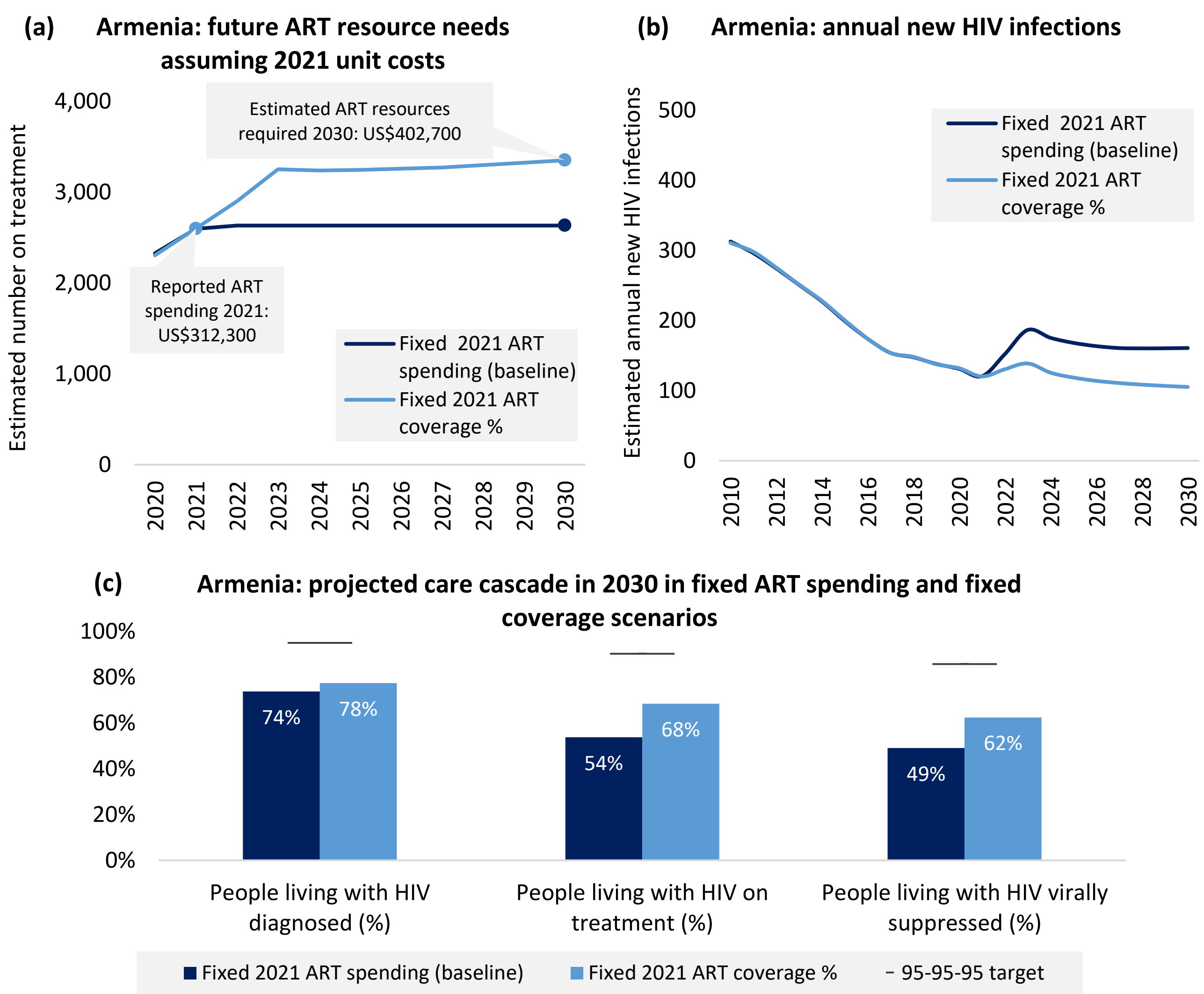

Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021

proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant; (b) Estimated number of annual new HIV infections if ART spending is fixed until 2030 (baseline) compared to if ART proportional coverage is fixed; and (c) Projected HIV care cascade among all people living with HIV if ART spending is fixed at 2021 values compared to if ART coverage is fixed at 2021 values. ART, antiretroviral therapy.

Baseline scenario. In the baseline scenario maintaining 2021 spending on programs with fixed allocations, the model projects that there would be 1,359 new HIV infections, 1,177 HIV-related deaths and 29,412 HIV-attributable DALYs over 2023-2030 (Table 1). Without additional spending on ART, the HIV care cascade was projected to be "74-73-91" in the year 2030 (i.e. 74% of people diagnosed, 73% of diagnosed people on treatment and 91% of people on treatment virally suppressed) (Figure 1).

Optimized reallocation of 2021 spending. Optimization of 2021 spending identified that additional impact may be possible by reallocating FSW, MSM and PWID prevention and testing program spending to enable scale-up of ART for all populations and prevention and testing programs for migrants – consistent with the recommendations from previous analyses. Prevention and testing programs for FSW, MSM and PWID were deprioritized in the optimization not because they are not effective or important, but because with limited funding migrant programs and ART were more cost-effective. Modeled care cascade estimates suggest a high proportion of FSW (87%), MSM (95%) and PWID (94%) living with HIV have been diagnosed and are receiving treatment (84%, 85% and 84% respectively), whereas it is estimated only half of migrants living with HIV were diagnosed in 2021. However, it is important to note that prevention programs for key populations may have benefits outside of HIV, especially in the case of NSP. Routine surveillance data indicate that HIV prevalence amongst migrants was only 1% in 2018 (6), but due to the large number of migrants, the model estimated that 30% of new HIV infections occurred in this group. It is assumed that the increase in incoming migrants affected by the conflict in Ukraine over the next few years is leading to increased HIV prevalence among migrants (9). If more migrants were reached by the prevention programs and were able to access treatment, this could prevent new infections.

Allocation of HIV resources towards maximizing the impact of funding

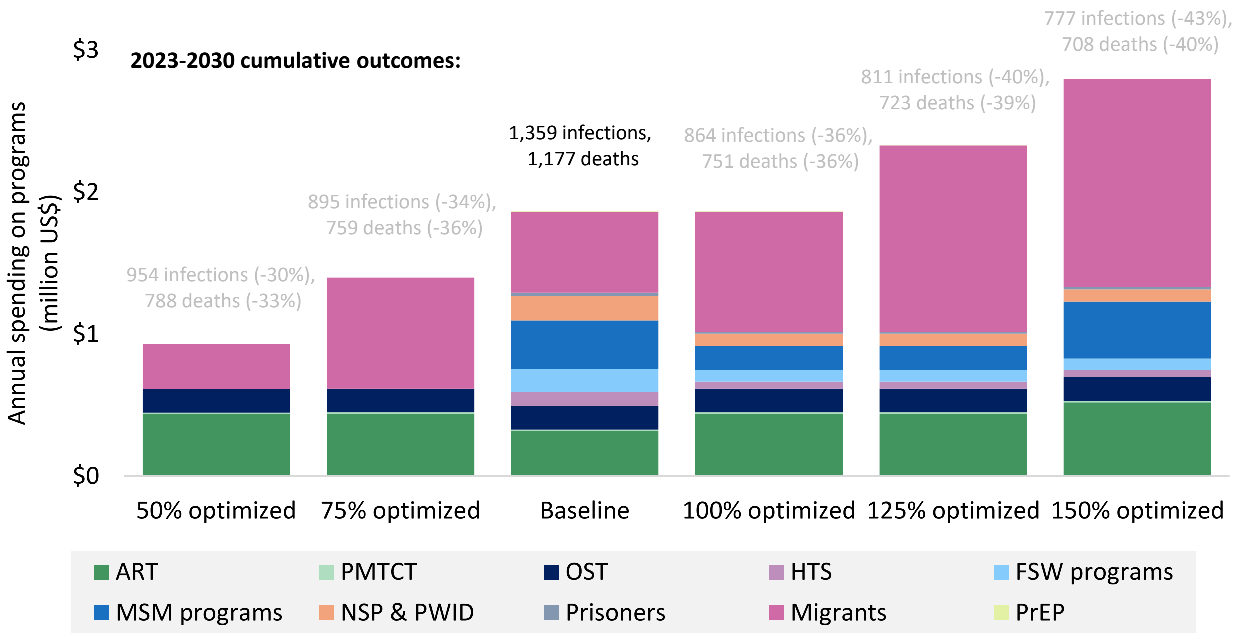

Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030. Percentage optimized refers to the percentage of baseline HIV spending (i.e. 2021 spending). ART, antiretroviral therapy; HTS, HIV testing program targeting general population; PMTCT, prevention of mother to child transmission; FSW, female sex worker; MSM, men who have sex with men; NSP & PWID, programs for people who inject drugs, including needle-syringe programs; PrEP, pre-exposure prophylaxis; OST, opioid substitution therapy.

Optimized resource allocation at different budget levels. As the total budget envelope increased, the priorities were identified as continued scale up of prevention programs for migrants, followed by programs for MSM and prisoners.

If funding were reduced, priorities were identified as maintaining migrant testing and prevention programs, and as many people on treatment as possible.

Impact of optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending averted 495 new infections (36%), 426 deaths (36%) and 10,267 DALYs (35%) over 2023-2030. This benefit increases to 43% infections, 40% deaths and 39% DALYs averted with an optimized 150% budget (Figure 3;Table 1).

Beyond 150% budget the modeled programs had all reached close to their saturation levels, and increased investment had diminishing returns. At this level of spending different approaches may be needed to reach those not accessible by current services.

Increased impact was possible in the model even with 50% optimized spending compared to the baseline (Figure 3), since the reallocation of (reduced) funds was still able to increase treatment by 30%. This highlights the importance of increasing treatment coverage though whatever mechanisms are available.

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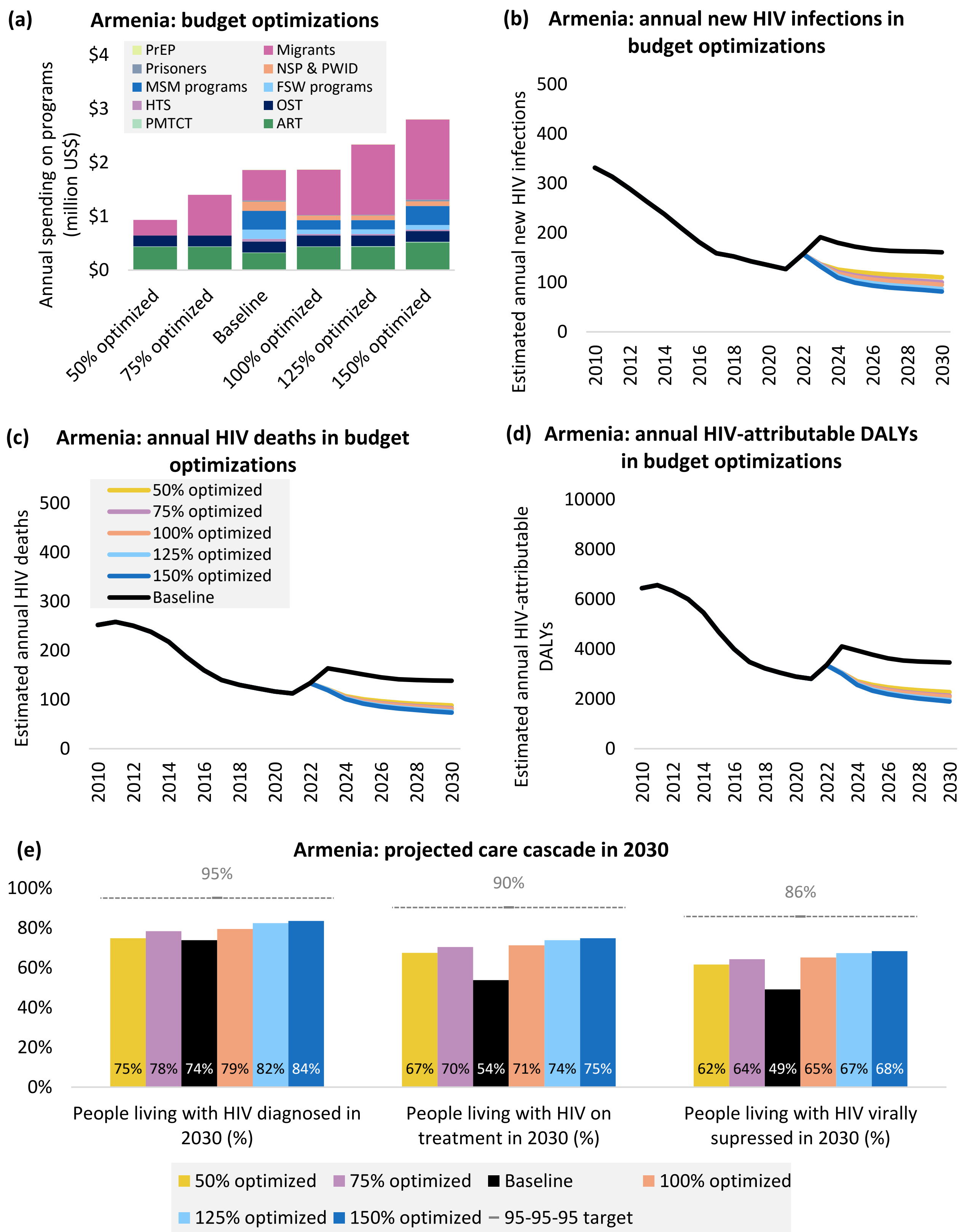

Figure 3. Model outcomes from budget optimization scenarios aiming to minimize infections and deaths. Note that jumps in deaths, infections and DALYs in 2022 are a result of a large increase in migrants from

Russia and Ukraine. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of estimated 2021 spending; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years (DALYs); and (e) projected care cascade for the year 2030 among all people living with HIV. ART, antiretroviral therapy; HTS, HIV testing program targeting general population; PMTCT, prevention of mother to child transmission; FSW, female sex worker; MSM, men who have sex with men; NSP & PWID, programs for people who inject drugs, including needle-syringe programs; PrEP, pre-exposure prophylaxis; OST, opioid substitution therapy.

4.2 Objective 2

If national governments do not scale up HIV programs identified for prioritization under optimized allocation for different funding envelopes, what will the impact be on the epidemic by 2030? That is, what is the ***opportunity lost to avert HIV infections, deaths*** *and DALYs?*

Zero HIV spending. The continued investment in HIV programs is essential to avoid epidemic rebound. In a scenario with no HIV spending from 2023, the model estimates that there would be 2,859 (+110%) more new infections, 2,497 (+112%) more deaths and 58,956 (+100%) more DALYs over 2023-2030 compared to the baseline scenario of fixed annual spending on programs (Table 1).

Table 1. Cumulative new HIV infection, HIV-related deaths, HIV-related DALYs between 2023-2030 under different scenarios, and differences in impacts compared to the baseline scenario of fixed 2021 spending on programs.

	Cumulative new HIV infections 2023-2030	Cumulative HIV deaths 2023-2030	Cumulative HIV DALYs 2023-2030	Difference in infections from baseline	Difference in deaths from baseline	Difference in DALYs from baseline
No HIV spending from 2023	2,859	2,497	58,956	110%	112%	100%
50% optimized	954	788	20,114	-30%	-33%	-32%
75% optimized	895	759	19,341	-34%	-36%	-34%
Baseline	1,359	1,177	29,412			
100% optimized	864	751	19,145	-36%	-36%	-35%
125% optimized	811	723	18,414	-40%	-39%	-37%
150% optimized	777	708	18,032	-43%	-40%	-39%
95-95-95*	683	655	16,907	-50%	-44%	-43%

*Optimization was only able to reach 86-95-95; refer to section 4.3.
Percentage optimized refers to percentage of baseline spending.

4.3 Objective 3

What is the ***most efficient HIV resource allocation for best achieving 95-95-95 targets*** *by 2030, and what is the level of resources required for achieving these targets? What is the number of HIV infections prevented and deaths averted under this scenario?*

Based on both baseline and 100% optimized spending, Armenia's care cascade is not projected to reach 95-95-95 targets by 2030 (equivalent to 95-90-86 of all people living with HIV) (Figure 4e).

Increasing resources by an additional US$3.7M per annum, or a total 300% of targeted HIV spending, will only increase diagnosis of people living with HIV to 86% by 2030. In Armenia reaching the diagnosis target is challenged by the continual arrival of migrants with undiagnosed infection and challenges in early detection even with high program coverage. Although incentive-based strategies to improve HIV testing among migrants through primary health care services have been effective in Armenia (16), new or expanded strategies may be needed. Although not modeled, delivery approaches and modalities for HTS can also be strategically utilized to more cost-effectively reach undiagnosed people living with HIV, such as through index testing and social network testing strategies, tailored demand creation, task shifting and HIV self testing, and focused provider-initiated testing (17).

No programs were modelled to improve linkage and retention in treatment, adherence, and viral suppression, and thus the cost of reaching the second and third cascade pillars is unknown. In addition to ART spending, novel programs may be necessary in Armenia to improve linkage to care, treatment adherence and retention to achieve 95% treatment coverage and 95% viral suppression.

Achieving "86-95-95" in this optimized scenario could avert 676 new infections (50%), 522 deaths (44%) and 12,505 DALYs (43%) compared to the baseline scenario of fixed 2021 spending on programs and no improvements to linkage to care or treatment adherence (Figure 4).

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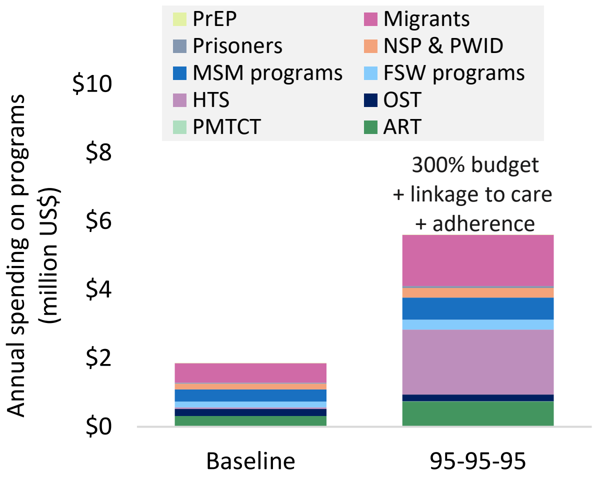
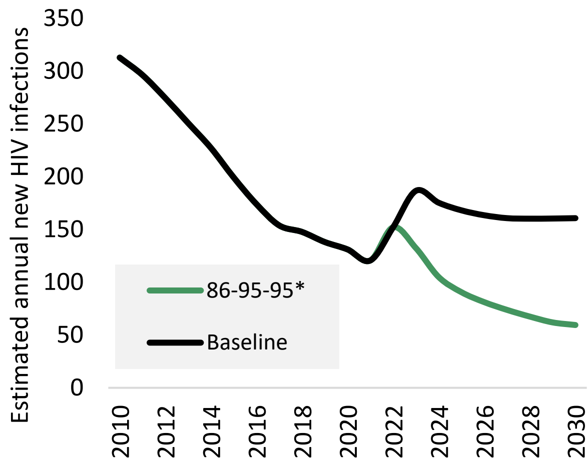
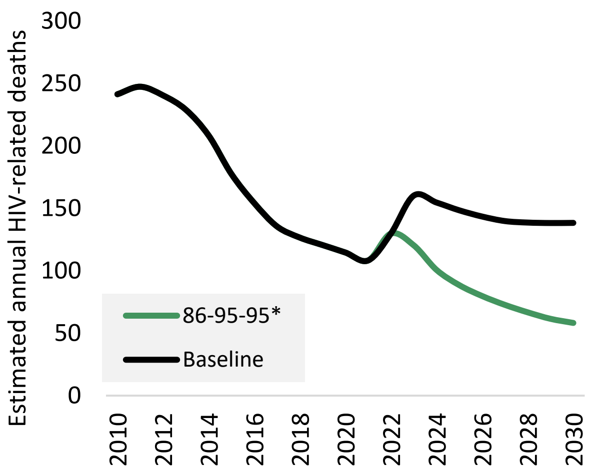
(a) Armenia: optimized budget to reach 95-95-95 targets



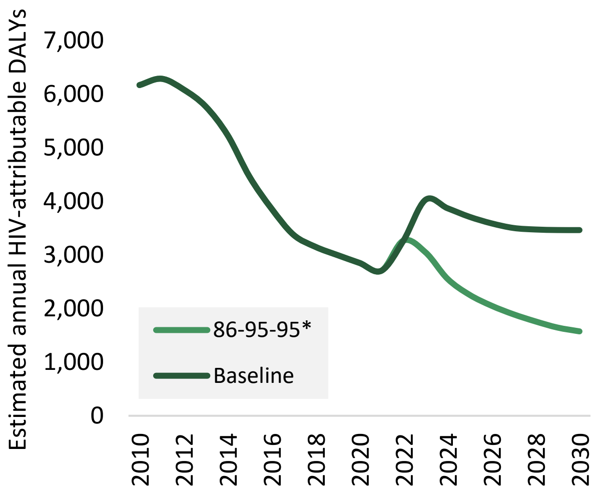
(b) Armenia: annual new HIV infections in 95-95-95 scenario



(c) Armenia: annual HIV deaths in 95-95-95 scenario



(d) Armenia: annual HIV-attributable DALYs in 95-95-95 scenario



(e) Armenia: projected care cascade

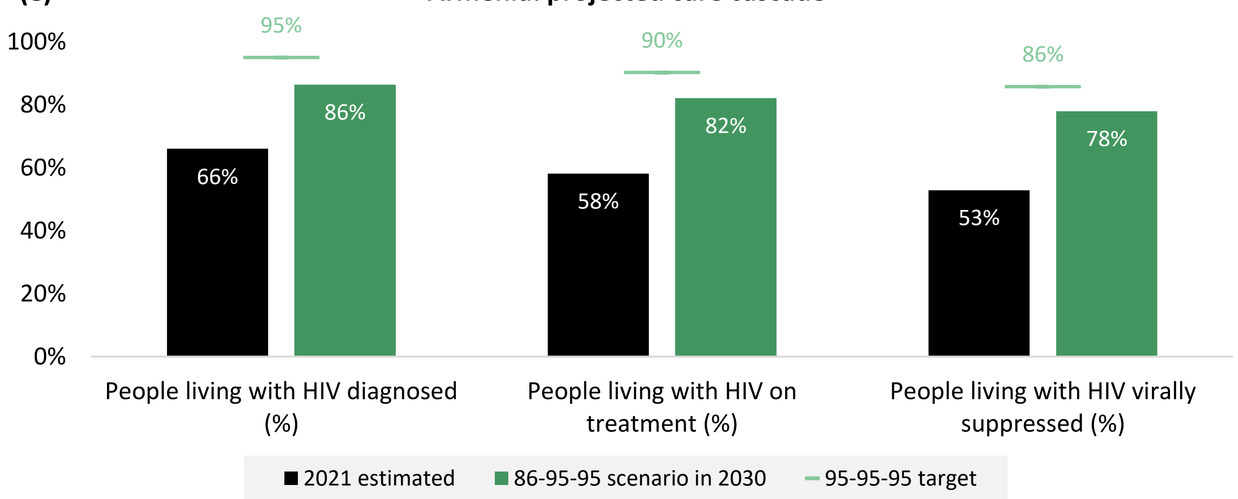


Figure 4. Optimized HIV budget level and allocation to achieve 95-95-95 targets by 2030. *The 95% diagnosis target could not be reached with 300% spending optimized, and impact is shown for the achieved cascade. Panels show (a) optimal budget allocations; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) estimated care cascade in baseline year 2021 and projected for the year 2030 as a proportion of all people living with HIV. ART, antiretroviral therapy; DALY, disability-adjusted life year; HTS, HIV testing program targeting general population; PMTCT, prevention of mother to child transmission; FSW, female sex worker; MSM, men who have sex with men; NSP & PWID, programs for people who inject drugs, including needle-syringe programs; PrEP, pre-exposure prophylaxis; OST, opioid substitution therapy.

5 Comparison with past spending

Spending on targeted HIV programs has decreased over time, from US$2.5M in 2013 to US$1.9M in the 2021. Since 2013, treatment has been successful scaled up in Armenia more than four-fold despite a decrease in both the absolute value and relative proportion of spending on ART between 2013 and 2021 (Figure 5). This was achievable due to reduction in estimated ART program unit cost from US$1,127 in 2013 to US$120 in 2021. Armenia has been able to reduce ART costs through simplified procurement mechanisms, access to cheaper generic antiretrovirals and access to low-cost dolutegravir (18, 19). Consistent with recommendations from the 2019 analysis, since 2021 Armenia has successfully scaled up HIV testing and prevention programs for migrants through incentive-based testing through primary health care and informational campaigns (16). There has also been a shift in the allocation of funding across other key population programs, with reduced spending on prevention and testing programs for PWID relative to total budget and increased relative spending among MSM. Relative spending on FSW programs has fluctuated.

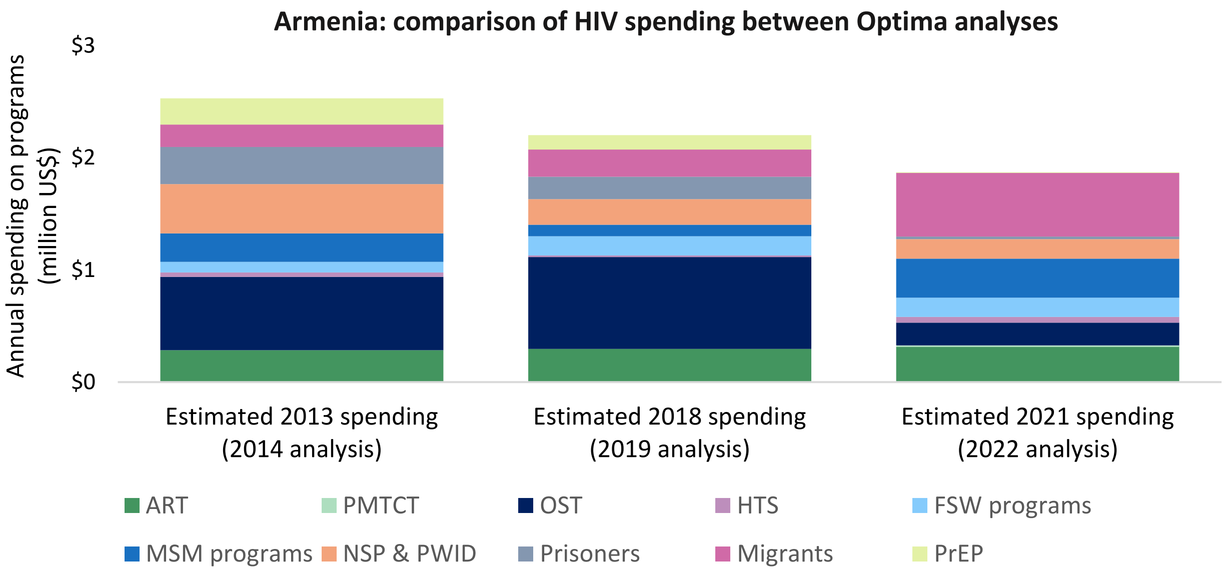


Figure 5. Estimated budget allocations from 2016, 2019 and 2022 Optima analyses. ART, antiretroviral therapy; HTS, HIV testing program targeting general population; PMTCT, prevention of mother to child

transmission; FSW, female sex worker; MSM, men who have sex with men; NSP & PWID, programs for people who inject drugs, including needle-syringe programs; PrEP, pre-exposure prophylaxis; OST, opioid substitution therapy.

6 Study limitations

As with any modeling study, there are limitations that should be considered when interpreting results and recommendations from this analysis.

- **Population sizes:** There is uncertainty in population size estimates; for key populations stigma may lead to underestimation of population size, and for total populations there is instability in migration patterns due to the war in Ukraine. Armenia is currently seeing a large influx of migrants from Russia and Ukraine (estimated 100,000 arrivals in 2022 (9) which would have affected the sharp increase of people living with HIV in 2022 and onwards. It was assumed that Armenia would continue to receive a significant number of migrants from these countries in the coming years. This may influence estimates of people living with HIV and subsequently, service and funding needs for each key population.
- **Epidemiological indicators** come from population surveys or programmatic data that have varying degrees and types of biases. Uncertainty in these indicators combined with uncertainty in population sizes can lead to uncertainty in model calibration and projected baseline outcomes and subsequently, service and funding needs for each key population.
- **Effect (i.e. impact) sizes for interventions** are taken from global literature (e.g. the effectiveness of condom use for preventing infections). Actual program impacts may vary depending on context or quality of implementation.
- **Geographical heterogeneity** is not modeled, and outcomes represent national averages. There may be opportunities for additional efficiency gains through appropriate geographical targeting.
- **Cost functions for each program** are a key driver of model optimizations. Cost functions determine how program coverage will change if funding is reallocated, as well as maximum achievable program coverage. There is uncertainty in the shapes of these cost functions, values which could influence how easily or how high programs could be scaled up.
- **Currency:** The COVID-19 pandemic, war in Ukraine and global economic crises have led to instability in currencies over the past few years. Spending is reported in US$, but what this value represents in local currency may change over time in unknown ways.
- **Retention in care:** This analysis did now consider programs that could improve linkage and retention in care for people diagnosed, or viral suppression for people on treatment. These programs will be essential to achieving the 95-95-95 targets and future analyses should focus on quantifying the spending and impacts of relevant programs.
- **Other efficiency gains** such as improving technical or implementation efficiency were not considered in this analysis.
- **Equity** in program coverage or HIV outcomes was not captured in the model but should be a key consideration in program implementation. Policy makers and funders are encouraged to consider resources required to improve equity, such as through investment

in social enablers to remove human rights-based barriers to health, and technical or implementation efficiency gains. In addition, prevention programs may have benefits outside of HIV, such as for sexually transmitted infections, hepatitis C, and community empowerment. These were not considered in the optimization but should be factored into programmatic and budgeting decisions.

- **Program inclusion**: This analysis is limited to targeted HIV programs with a direct and quantifiable impact on modeled HIV parameters and available program cost and coverage data. Armenia also implements or is considering other non-targeted HIV programs, such as stigma mitigation and professional development for healthcare workers. These programs may enhance HIV epidemic gains by reducing barriers to HIV testing, increasing the saturation values of programs for key populations, and focusing testing on those most at risk. The cost-efficiency of these programs was not assessed in this analysis. In addition, future analyses could consider including the efficiency of decentralized delivery of HIV treatment and alternative testing modalities as relevant data become available.

7 Conclusions

This modeling analysis evaluated the allocative efficiency of direct HIV programs in Armenia, finding that an optimized resource allocation can have an impact on reducing infections and deaths. Program priorities were identified as scale-up of ART and prevention programs targeting migrants. Should additional resources become available, investment for MSM and prisoners programs should be increased, with programs for PWID and FSW maintained. New or scaled-up programs focusing on supporting linkage to care, adherence and retention in treatment are needed to reach care cascade targets by 2030, and the cost of these programs will require future exploration.

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8 Appendices

Appendix 1. Model parameters

Table A1. Model parameters: transmissibility, disease progression and disutility weights

Interaction-related transmissibility (% per act)		
	Insertive penile-vaginal intercourse	0.04%
	Receptive penile-vaginal intercourse	0.08%
	Insertive penile-anal intercourse	0.11%
	Receptive penile-anal intercourse	1.38%
	Intravenous injection	0.80%
	Mother-to-child (breastfeeding)	36.70%
	Mother-to-child (non-breastfeeding)	20.50%
Relative disease-related transmissibility		
	Acute infection	5.60
	CD4 (>500)	1.00
	CD4 (500) to CD4 (350-500)	1.00
	CD4 (200-350)	1.00
	CD4 (50-200)	3.49
	CD4 (<50)	7.17
Disease progression (average years to move)		
	Acute to CD4 (>500)	0.24
	CD4 (500) to CD4 (350-500)	0.95
	CD4 (350-500) to CD4 (200-350)	3.00
	CD4 (200-350) to CD4 (50-200)	3.74
	CD4 (50-200) to CD4 (<50)	1.50
Changes in transmissibility (%)		
	Condom use	95%
	Circumcision	58%
	Diagnosis behavior change	0%
	STI cofactor increase	265%
	Opioid substitution therapy	54%
	PMTCT	90%
	ARV-based pre-exposure prophylaxis	95%
	ARV-based post-exposure prophylaxis	73%
	ART not achieving viral suppression	50%
	ART achieving viral suppression	100%
Disutility weights		
	Untreated HIV, acute	0.08
	Untreated HIV, CD4 (>500)	0.01
	Untreated HIV, CD4 (350-500)	0.02
	Untreated HIV, CD4 (200-350)	0.07
	Untreated HIV, CD4 (50-200)	0.27
	Untreated HIV, CD4 (<50)	0.55
	Treated HIV	0.05

Source: Optima HIV User Guide Volume VI Parameter Data Sources

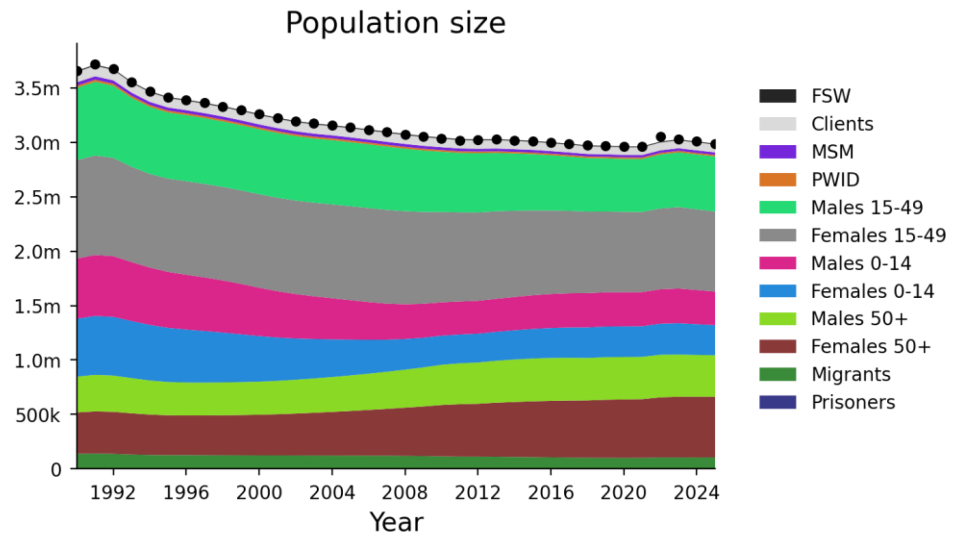
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

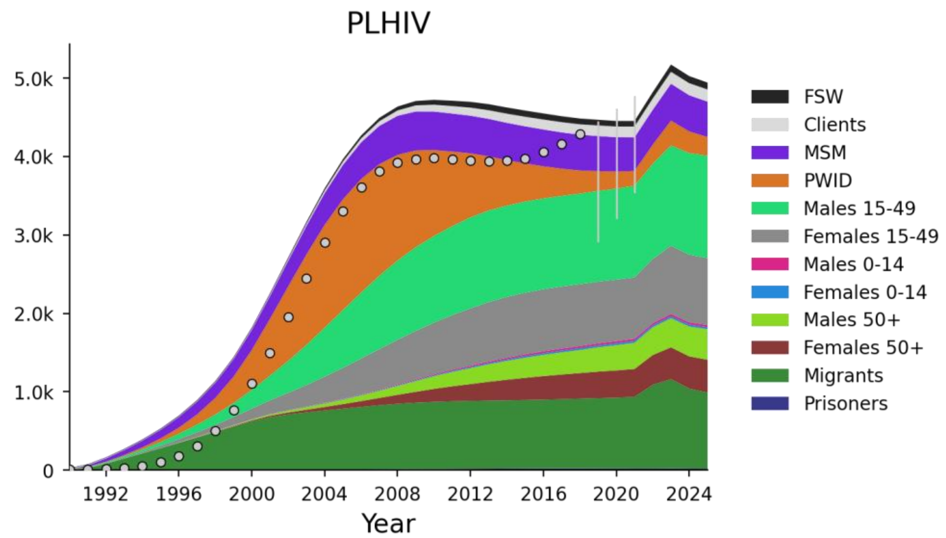
Treatment recovery due to suppressive ART (average years to move)		
	CD4 (350-500) to CD4 (>500)	2.20
	CD4 (200-350) to CD4 (350-500)	1.42
	CD4 (50-200) to CD4 (200-350)	2.14
	CD4 (<50) to CD4 (50-200)	0.66
	Time after initiating ART to achieve viral suppression (years)	0.20
CD4 change due to non-suppressive ART (%/year)		
	CD4 (500) to CD4 (350-500)	3%
	CD4 (350-500) to CD4 (>500)	15%
	CD4 (350-500) to CD4 (200-350)	10%
	CD4 (200-350) to CD4 (350-500)	5%
	CD4 (200-350) to CD4 (50-200)	16%
	CD4 (50-200) to CD4 (200-350)	12%
	CD4 (50-200) to CD4 (<50)	9%
	CD4 (<50) to CD4 (50-200)	11%
Death rate (% HIV-related mortality per year)		
	Acute infection	0%
	CD4 (>500)	0%
	CD4 (350-500)	1%
	CD4 (200-350)	1%
	CD4 (50-200)	6%
	CD4 (<50)	32%
	Relative death rate on ART achieving viral suppression	23%
	Relative death rate on ART not achieving viral suppression	49%
	Tuberculosis cofactor	217%

Source: Optima HIV User Guide Volume VI Parameter Data Sources

Appendix 2. Model calibration

Figure A1. Calibration outputs. Dots represent official country estimates based on Statistical Committee of the Republic of Armenia, Spectrum model, surveillance surveys, program data and UNAIDS.





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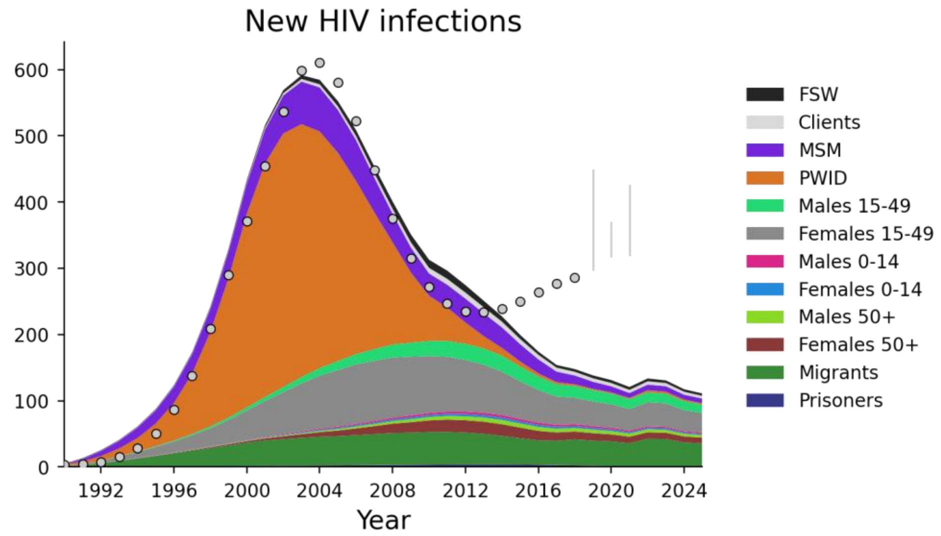

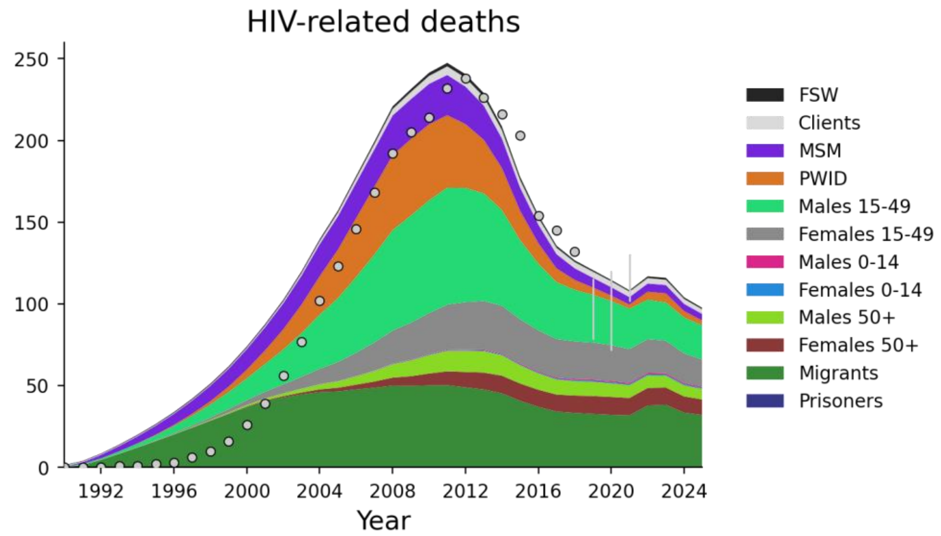

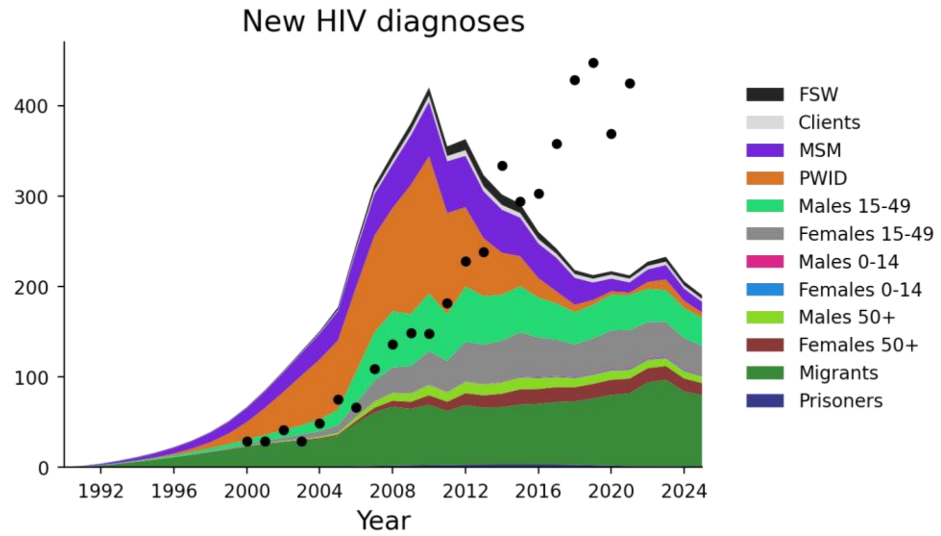

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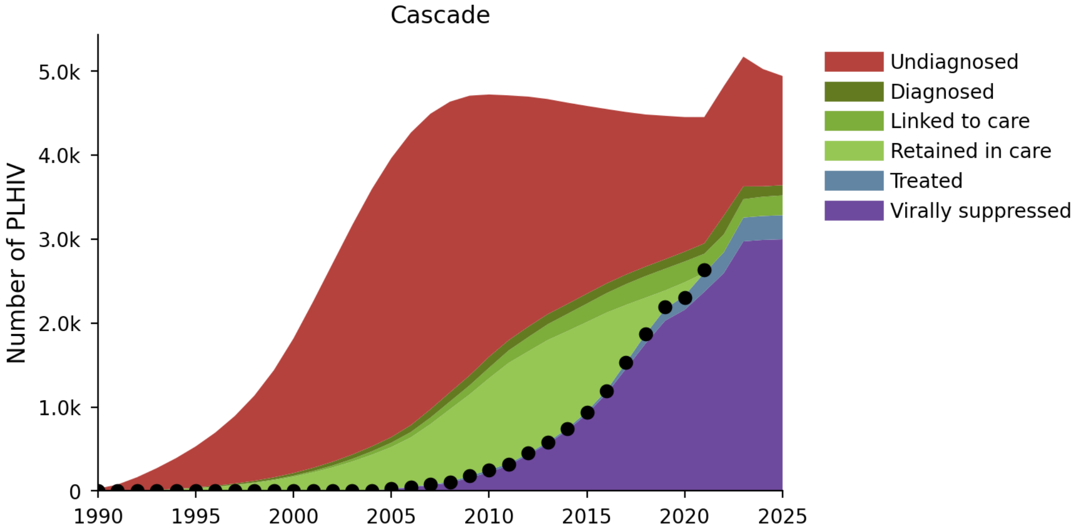

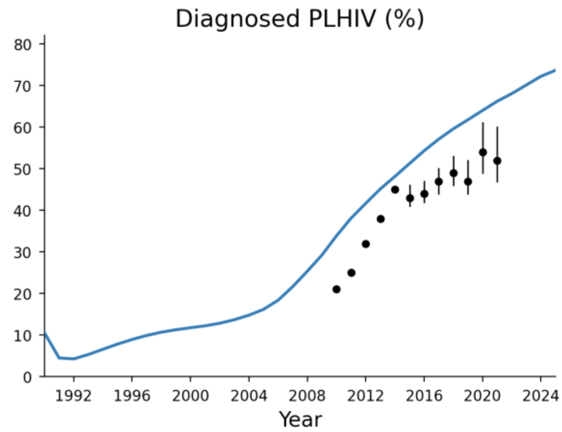

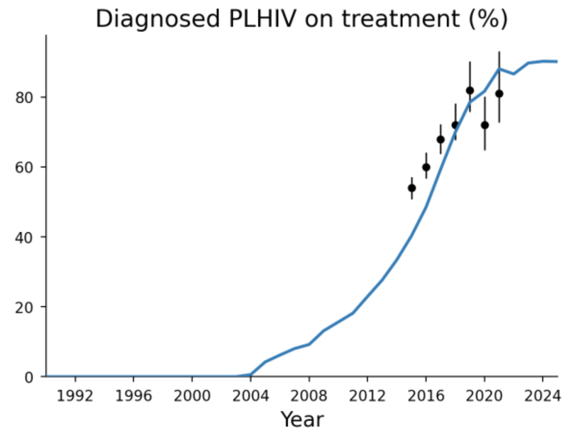

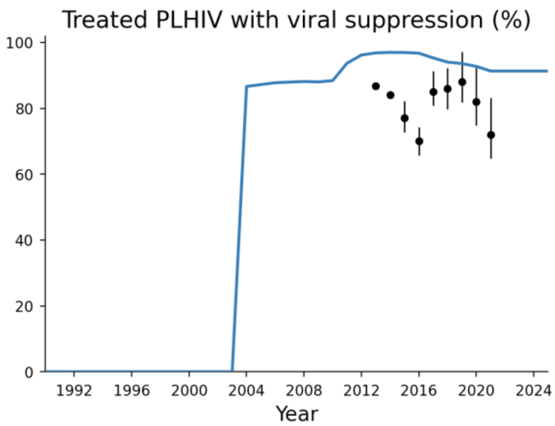

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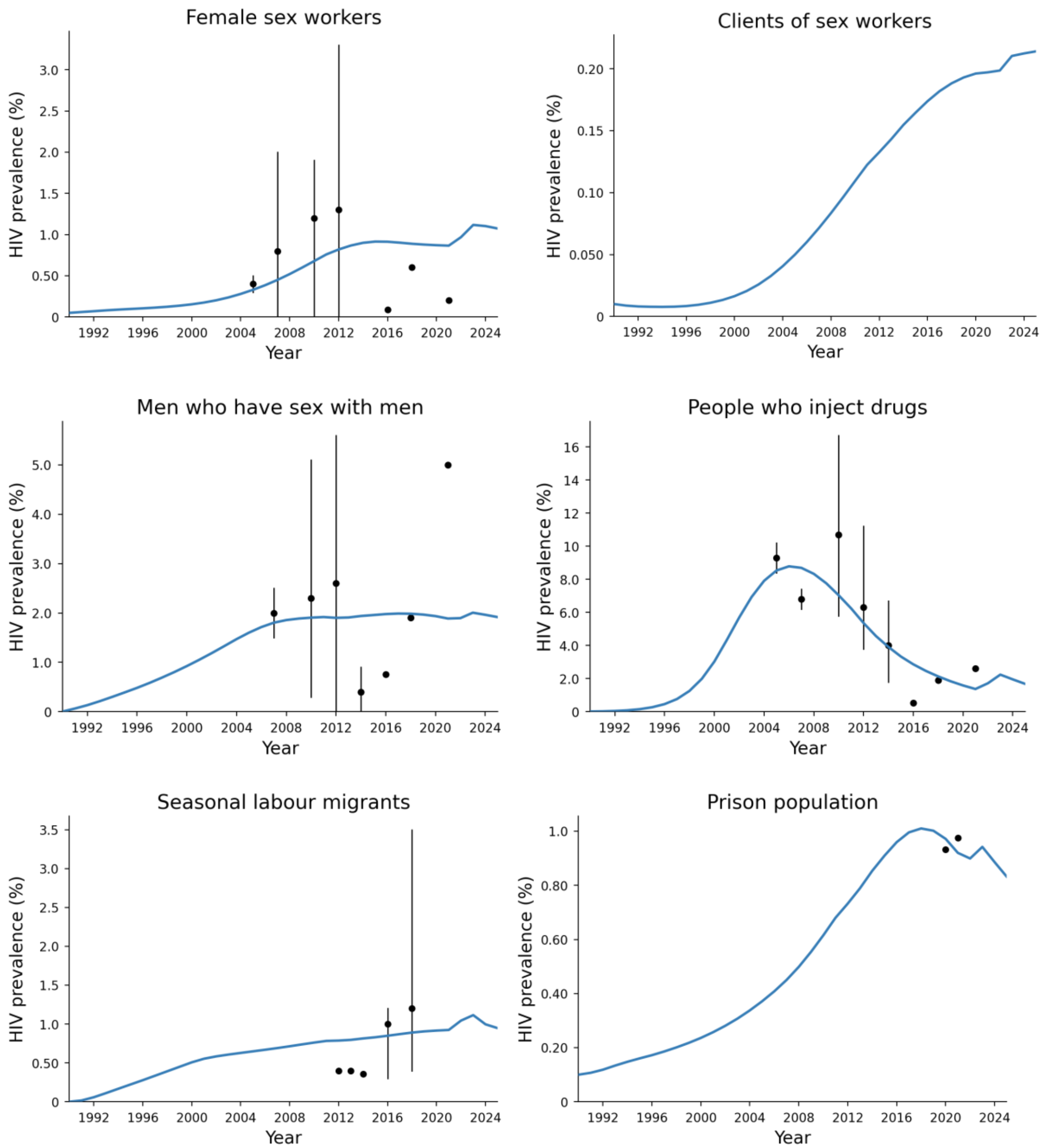

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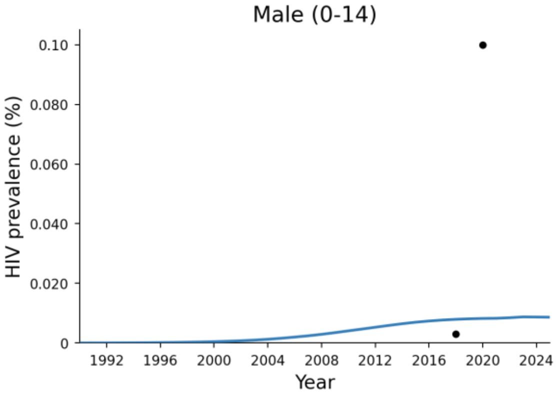
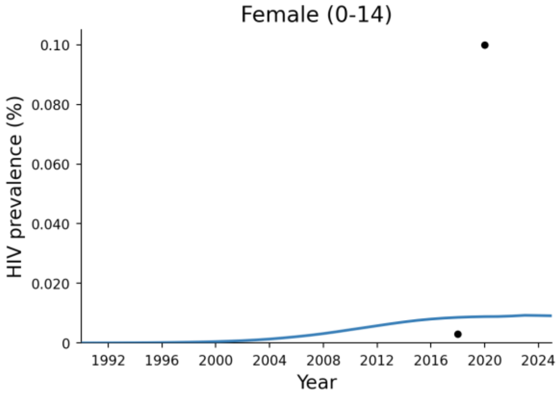
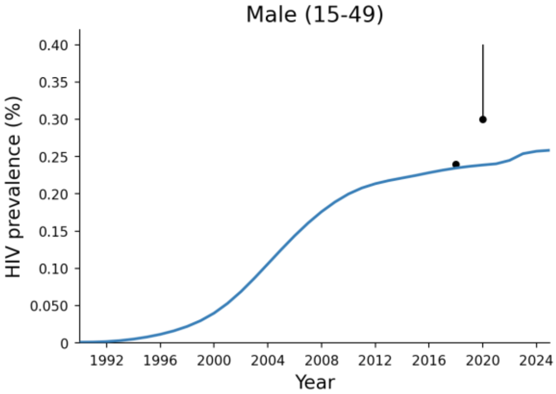
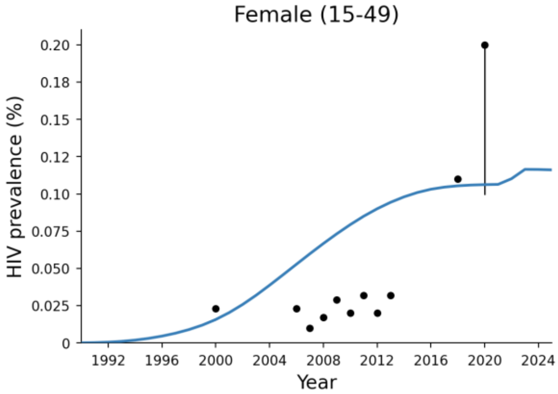
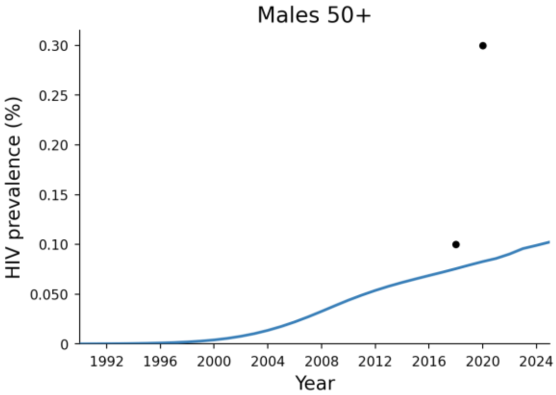
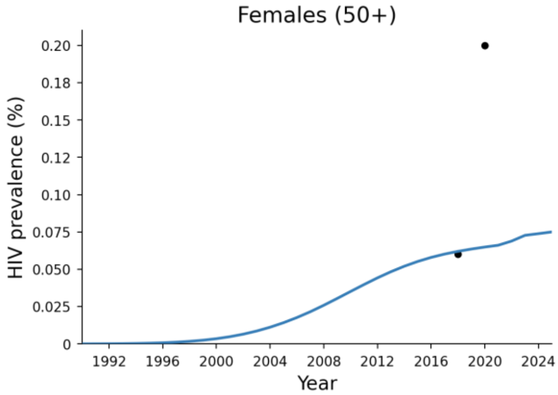












Appendix 3. HIV program costing and impacts

Table A3. HIV program unit costs and saturation values

HIV program	Unit cost (USD)	Saturation (low)	Saturation (high)
Antiretroviral therapy	$120.15	95%	100%
HIV testing services (general population)	$0.70	60%	85%
Prevention of mother-to-child transmission	$253.78	95%	100%
FSW programs	$40.89	75%	75%
MSM programs	$39.26	60%	60%
PWID and NSP programs	$29.17	60%	60%
Migrants programs	$18.04	70%	70%
Prisoners program	$13.12	55%	100%
Pre-exposure prophylaxis	$250.00	5%	5%
Opioid substitution therapy	$343.59	0%	10%

FSW, female sex worker; MSM, men who have sex with men; PWID, people who use inject drugs; NSP, needle-syringe program.

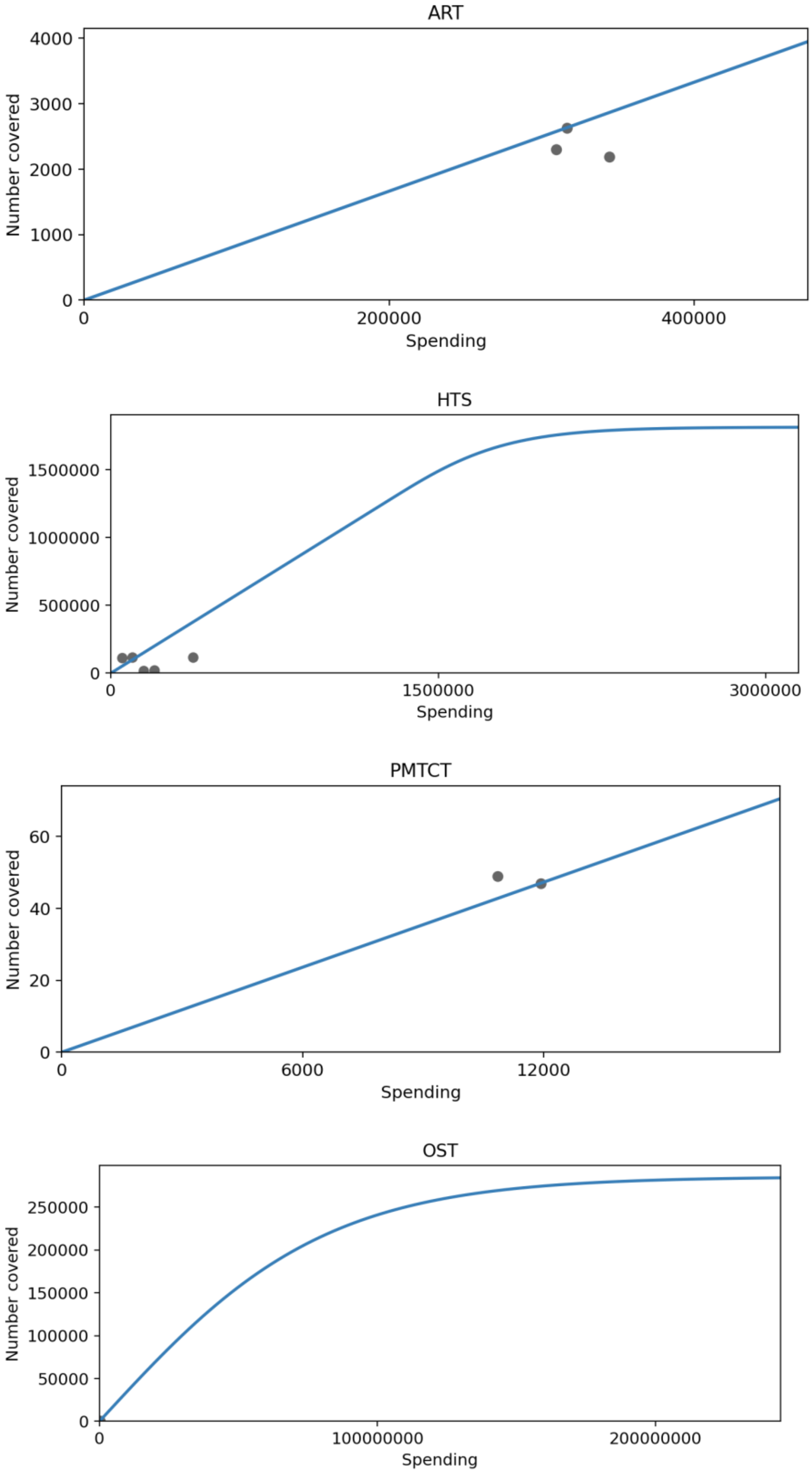
Table A4. Data inputs of impact of programs

HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
Prisoners	Condom use for casual acts	Prisoners, Prisoners	63%	65%	80%	80%
Migrants	Condom use for casual acts	Migrants, Migrants	70%	70%	86%	89%
PWID & NSP	Condom use for casual acts	PWID, PWID	40%	41%	90%	91%
MSM programs	Condom use for casual acts	MSM, MSM	81%	85%	98%	99%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	FSW	0%	0%	2%	2%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	MSM	0%	0%	2%	2%
Migrants	Proportion of people living with HIV who immigrate	Migrants	35%	35%	90%	90%

	who are diagnosed prior to arrival					
Prisoners	HIV testing rate (average tests per year)	Prisoners	0.12	0.14	0.98	1.00
FSW programs	HIV testing rate (average tests per year)	FSW	0.14	0.15	0.69	0.70
Migrants	HIV testing rate (average tests per year)	Migrants	0.05	0.05	0.61	0.61
PWID & NSP	HIV testing rate (average tests per year)	PWID	0.20	0.22	0.30	0.31
MSM programs	HIV testing rate (average tests per year)	MSM	0.05	0.35	1.20	1.29
HTS	HIV testing rate (average tests per year)	Clients	0.00	0.00	0.01	0.01
HTS	HIV testing rate (average tests per year)	Males 15-49	0.04	0.04	0.10	0.11
HTS	HIV testing rate (average tests per year)	Females 15-49	0.05	0.05	0.09	0.11
HTS	HIV testing rate (average tests per year)	Males 50+	0.02	0.02	0.03	0.04
HTS	HIV testing rate (average tests per year)	Females 50+	0.02	0.03	0.05	0.05
FSW programs	Condom use for commercial acts	Clients, FSW	92%	93%	98%	99%
PWID & NSP	Probability of needle sharing (per injection)	PWID	3%	3%	2%	3%
ART	Number of people on treatment	Total	0	0	-	-
OST	Number of PWID on OST	Total	193*	193*	-	-
PMTCT	Number of people on PMTCT	Total	0	0	-	-

ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services for the general population; MSM, men who have sex with men; OST, opioid substitution therapy; PMTCT, prevention of mother-to-child transmission; PrEP, pre-exposure prophylaxis; PWID & NSP, programs for people who inject drugs, including needle-syringe programs.
*Reflects estimated coverage of OST through out-of-pocket spending.
- The number of people modeled as receiving ART, PMTCT and OST is equal to the coverage of the respective programs.

Figure A2. Cost functions. Figures show relationship between total spending and number covered among targeting population of each program.



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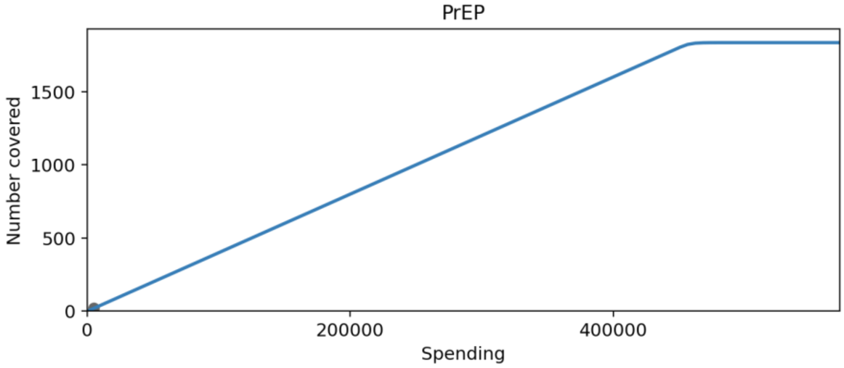

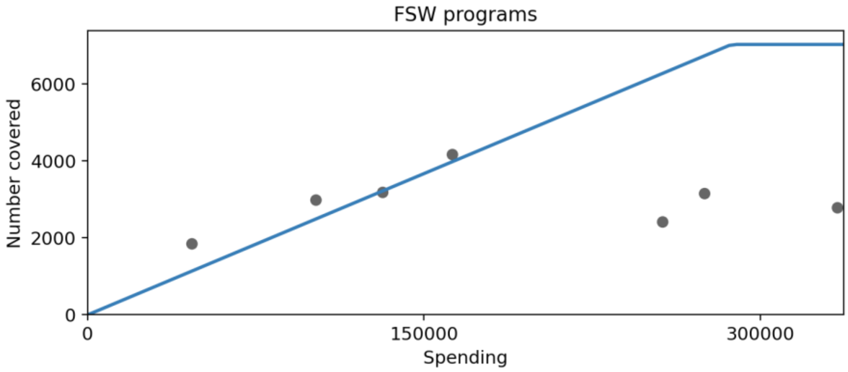

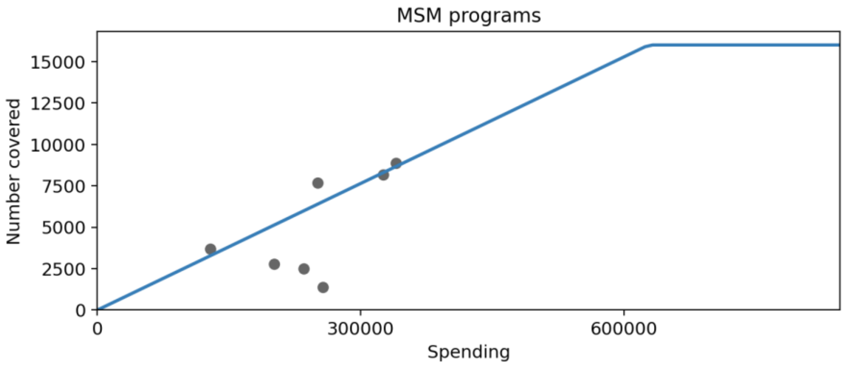

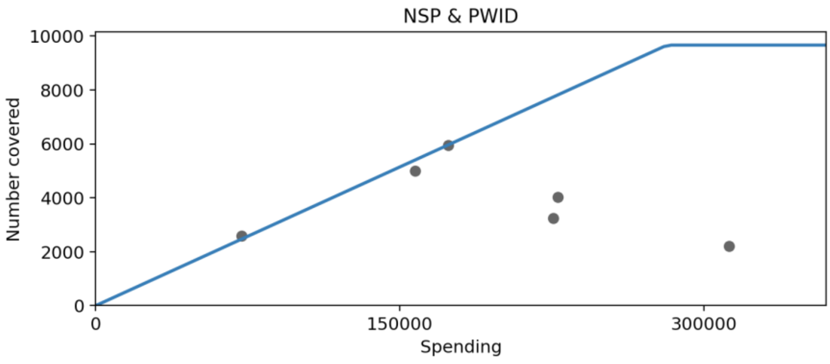

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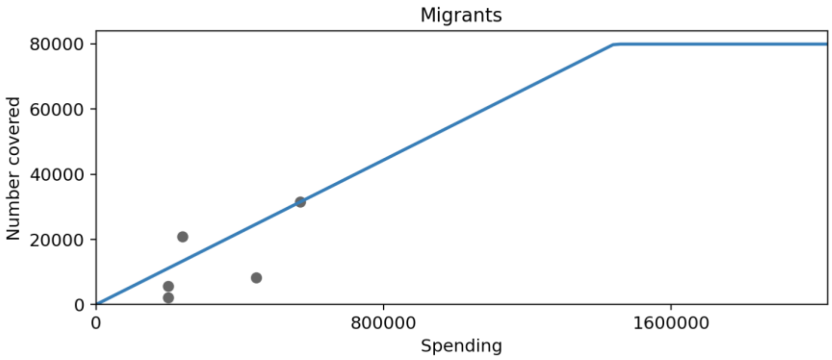

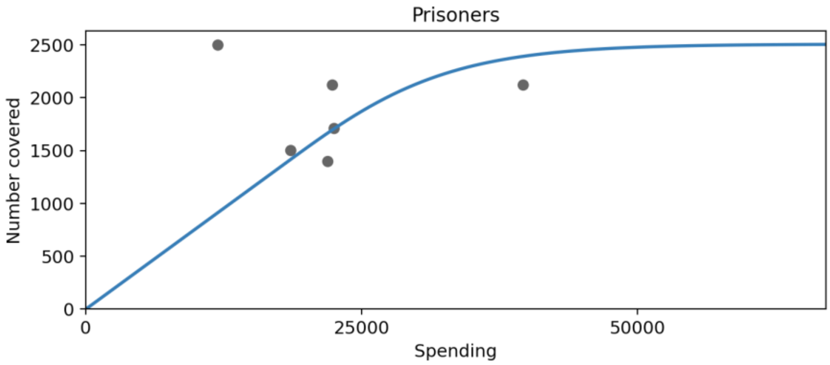

Appendix 4. Annual HIV budget allocations at varying budgets

Table A5. Annual HIV budget (US$) allocations among targeted HIV programs at varying budgets for 2023 to 2030

	100% latest reported (2021)	50% optimized	75% optimized	100% optimized	125% optimized	150% optimized
Antiretroviral therapy (ART)	316,343	429,541	435,868	436,127	436,885	510,385
HIV testing services (general population)	51,130	-	-	25,565	25,565	25,565
Prevention of mother-to-child transmission (PMTCT)	11,928	11,928	11,928	11,928	11,928	11,928
HIV testing and prevention programs for FSW[1]	170,407	-	-	85,204	85,204	85,204
HIV testing and prevention programs for MSM[1]	348,428	-	-	174,214	174,214	355,100
HIV testing and prevention programs for PWID and NSP	173,783	-	-	86,892	86,892	86,892
HIV testing and prevention programs for migrants	567,753	291,120	757,692	839,118	1,305,507	1,491,072
HIV testing and prevention programs for prisoners	22,475	192	-	11,238	11,238	28,852
Pre-prophylaxis (PrEP) for FSW and MSM[2]	5,000	-	-	2,500	2,500	2,500
Opioid substitution therapy (OST)	201,686	201,686	201,686	201,686	201,686	201,686
Total targeted HIV program budget	1,868,933	934,467	1,401,700	1, 868,933	2,336,166	2,803,400

FSW, female sex worker; MSM, men who have sex with men; PWID, people who use inject drugs; NSP, needle-syringe program.

[1] Spending includes a portion of condom procurement costs from 2020

[2] Spending not included in GAM 2021 and was derived from program data

Table A6. Latest reported budget of non-targeted HIV programs, 2021

	Latest reported budget (2021)
Human resources	$18,770
Monitoring and evaluation	$105,679
Management	$668,573
Enabling environment	$10,305
Health systems strengthening	$276,744
Logistics	$260,142
Other HIV care	$199,789
Other HIV costs	$364,846
Total non-targeted HIV program budget	$1,904,848

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