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

AZERBAIJAN

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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 Azerbaijan Republican AIDS Center, Project Implementation Unit, Ministry of Health of Azerbaijan, the Global Fund, UNAIDS, Swiss Tropical and Public Health Institute, and the Burnet Institute.

Summary and key recommendations for HIV resource optimization include:

- Azerbaijan has a concentrated HIV epidemic with a higher but declining prevalence among people who inject drugs (6.1% in 2020 (2)) and a lower but increasing prevalence among female sex workers (3.0% in 2020) and men who have sex with men (2.6% in 2020).
- In 2021 an estimated US$6.0M was spent on targeted HIV interventions, with antiretroviral therapy (ART) accounting for 29% of spending.
- In a baseline scenario with 2021 spending maintained, including a fixed annual spending on ART, there were an estimated 4,370 new HIV infections, 2,665 HIV-related deaths and 69,443 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **Optimizing spending would involve deprioritizing HIV testing for the general population to enable continued scale up of treatment, as well as HIV programs for men who have sex with men and people who inject drugs.** This optimization prioritizes high impact interventions that address the current treatment gap. Prevention programs for men who have sex with men are important to curb the rising prevalence. Even though HIV prevalence among people who inject drugs has been declining, HIV prevention programs were prioritized to prevent epidemic rebound.
- Optimized reallocation of 2021 spending was estimated to avert 2,214 new infections (51%), 986 deaths (37%) and 24,728 DALYs (36%) over 2023-2030 relative to the baseline scenario of continued 2021 spending.
- **With additional resources available, priorities were identified as scale up of HIV testing services for all populations as well as continued expansion of programs for people who inject drugs and female sex workers.**
- Moving from the 73-79-88[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. More focused testing strategies may be needed to better reach undiagnosed people living with HIV. 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 Azerbaijan had an estimated population size of 10.0 million and an estimated 10,000 people living with HIV (3). The HIV epidemic in Azerbaijan is concentrated among key populations, including people who inject drugs (PWID), female sex workers (FSW) and men who have sex with men (MSM). In recent years, the primary mode of transmission has shifted from injecting drug use to sexual transmission, predominantly from high-risk populations living with HIV to their female sexual partners and between men who have sex with men (4). HIV prevalence among PWID decreased from 8.6% in 2015 to 6.1% in 2020, while HIV prevalence increased from 2.2% in 2015 to 2.6% in 2020 among MSM and from 2.3% in 2015 to 3.0% in 2020 among FSW (2, 5).

In Azerbaijan the HIV response is guided by an Action Plan to Combat HIV/AIDS, renewed every five-years. The provision of ART began in 2006 in Azerbaijan and has been steadily scaled up since, increasing from 2,803 people on ART in 2016 to 6,218 people on ART in 2021. A major barrier to treatment is a relatively low diagnosis rate, with less than three-quarters of people living with HIV diagnosed in 2021 (3). The HIV response in Azerbaijan is predominantly funded through the Government of Azerbaijan, and the domestic share of HIV spending increased from 72% to 78% between 2013 and 2021 (6).

A previous HIV allocative efficiency analysis was conducted in 2019 using the Optima HIV model, with support from the World Bank, UNAIDS, the Global Fund, and other partners (8). This is the second Optima HIV analysis in Azerbaijan, 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 HIV program of Azerbaijan. 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 UNAIDS Global AIDS Monitoring and National AIDS Spending Assessment reports, integrated bio-behavioral surveillance surveys, national reports and systems were collated. In Azerbaijan, baseline spending was derived from national program data. 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$6.0M 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 (9).

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)
  - People who inject drugs (PWID)
  - Men who have sex with men (MSM)
- 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)
- Prevention programs for FSW (FSW programs)
- Prevention programs for MSM (MSM programs)
- Prevention programs for PWID (PWID programs)
- HIV testing services (HTS), all populations

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 for a given budget were weighted as 1 to 5 for infections to deaths. Objective 3 weightings were to reach 95% diagnosis by 2030 with the minimal possible total spending.

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, 150 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?*

2021 HIV spending. In Azerbaijan total spending on HIV from domestic and international sources was US$6.6M in 2021, incorporating US$6.0M targeted HIV spending for the programs considered above and US$0.6M non-targeted spending. The majority of targeted spending was for HTS (46%), followed by 29% for ART and 10% for programs for PWID (Figure 2; Table A5). Non-targeted spending, which was not included in the optimization analysis, encompassed human resources, management and infrastructure costs, monitoring and evaluation, programs supporting an enabling environment and some HIV care costs (Table A6).

Resource needs to maintain 2021 ART coverage. In 2021, ART coverage among diagnosed people living with HIV was 80%. If ART unit costs (US$282 in 2021) and current coverage of other HIV programs remained constant, ART spending would need to increase by US$0.5M (29% of 2021 ART spending) by 2030 to maintain a constant proportion of people who are diagnosed on treatment.

Maintaining the "status quo" proportion of diagnosed people living with HIV on treatment will 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 adherence were not modeled or costed in this analysis. Although treatment is available to all diagnosed people living with HIV in Azerbaijan, 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).

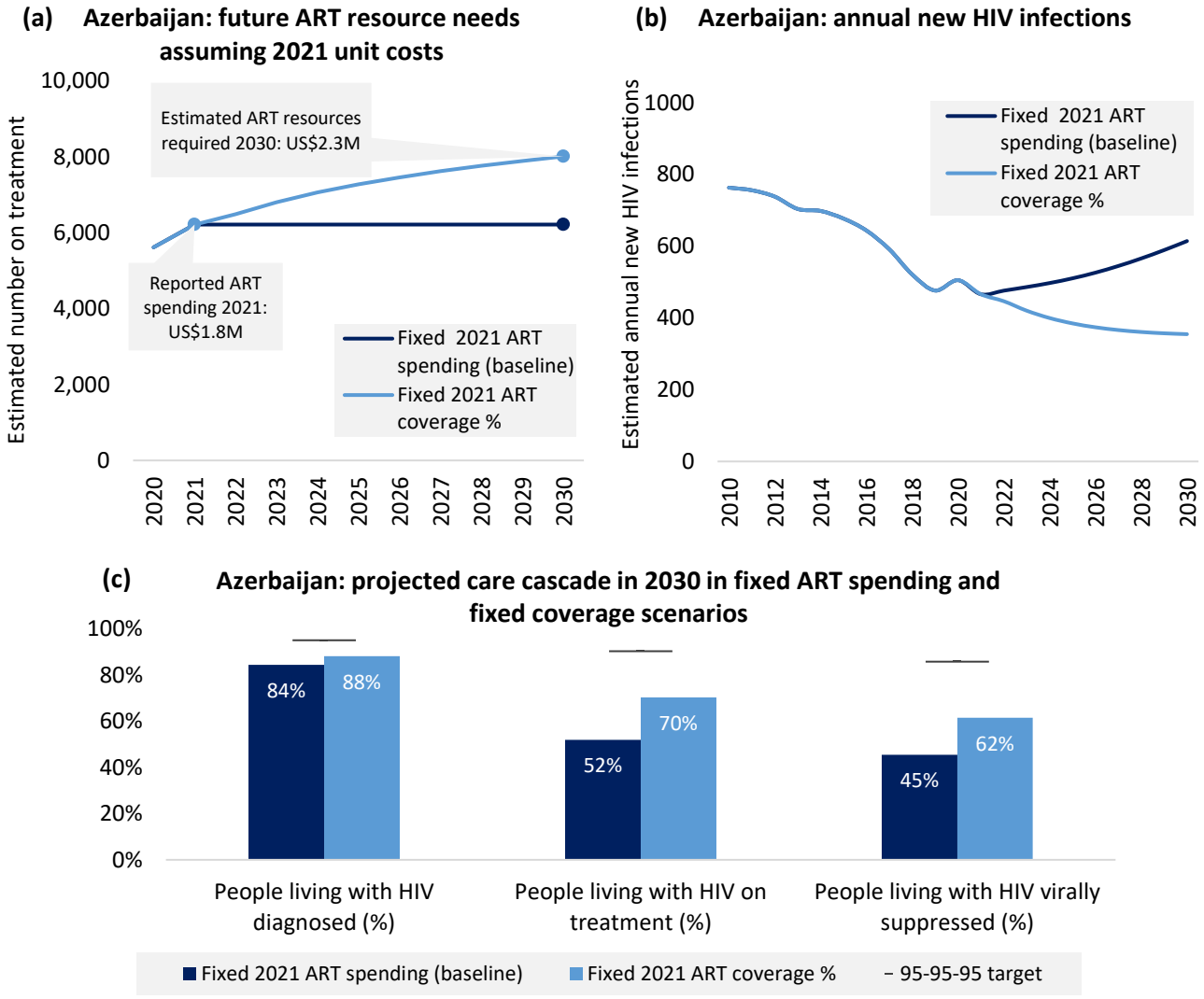

Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021 proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant; (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 4,370 new HIV infections, 2,665 HIV-related deaths and 69,443 HIV-attributable DALYs over 2023-2030 (Table 1). Without additional spending on ART, the HIV care cascade in this scenario was projected to be "84-61-88" in the year 2030 (i.e. 84% people diagnosed, 61% people diagnosed on treatment and 88% people on treatment virally suppressed). The low proportion of people on treatment in

2030 reflects that ART spending will actually need to increase over time just to maintain a constant percentage coverage, since more people will continue to be diagnosed (Figure 1).

Optimized resource allocation of 2021 spending. Optimization of 2021 spending identified that additional impact may be possible by reallocating HTS spending to enable further scale-up of ART and programs for MSM and PWID. Assuming that more people could be accessed for treatment through enhanced linkage to care and adherence programs, then this could reduce mortality as well as new infections through treatment-as-prevention. Scaling up levels of prevention programs for MSM was necessary to control the increasing prevalence, and even though prevalence among PWID is in decline, maintaining prevention programs for PWID was critical in the model to prevent an epidemic resurgence. The model deprioritized HIV testing to enable greater investment into these higher impact programs.

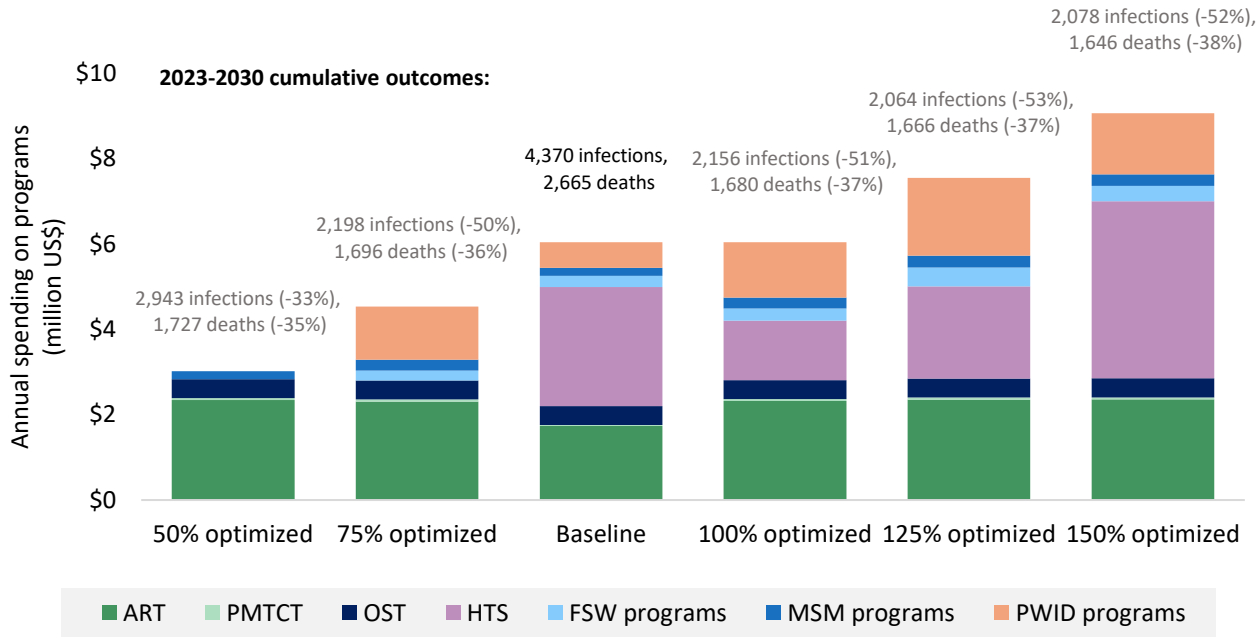

Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030 Percentage optimized refers to the percentage of baseline HIV spending (i.e. 2021 spending). ART, antiretroviral therapy; FSW, female sex worker; HTS,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

Optimized resource allocation at different budget levels. As the total budget envelope increased, the priorities were identified as scale-up of HTS and further expansion of prevention programs for PWID and FSW. The scale-up of these key population programs is prioritized to continue the decreasing prevalence trend and prevent epidemic rebound. Beyond about 125% budget most of the modeled key population programs had reached their saturation levels, with

increased investment going to expansion of HTS which was less efficient and therefore had diminishing returns. At this level of spending, the main gap in reaching 95-95-95 targets is the loss to follow-up of people who are diagnosed, and hence missed opportunities to receive treatment. Approaches to reach those not accessible by current services, for example interventions to support diagnosed people to receive treatment and stay in care, as well as to reduce treatment failure rate, would be needed.

If funding were reduced, priorities were identified as maintaining as many people on treatment as possible, followed by OST, programs for MSM, and then programs for PWID. Prevention programs for MSM are prioritized before PWID due to lower relative unit cost coupled with ongoing risk behavior, increasing HIV incidence and prevalence among MSM, whereas HIV incidence and prevalence has declined among PWID, largely due to behavioral changes and treatment uptake in this group. However even with 75% optimized budget the PWID program is important and heavily funded.

Impact of optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending averted 2,214 (51%) new infections, 986 (37%) deaths and 24,728 (36%) of DALYs over 2023-2030 (Figure 2, Table 1). This benefit was similar at optimized higher budgets due to relatively low impact and diminishing returns of added resources primarily allocated to HTS, with an estimated 52% infections, 38% of deaths and 37% of DALYs averted with an optimized 150% budget (Table 1).

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 35%. This highlights the importance of increasing treatment coverage though whatever mechanisms are available.

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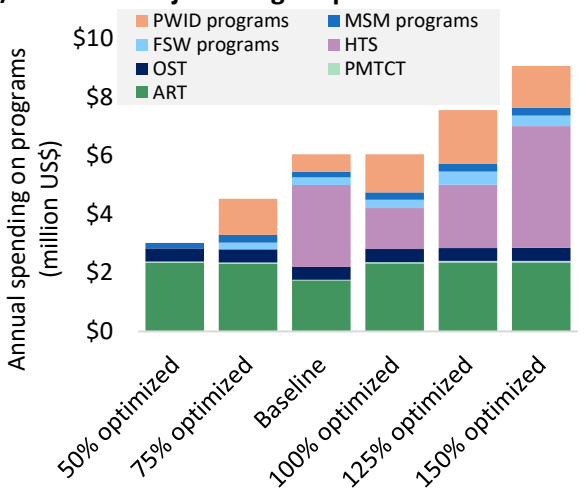
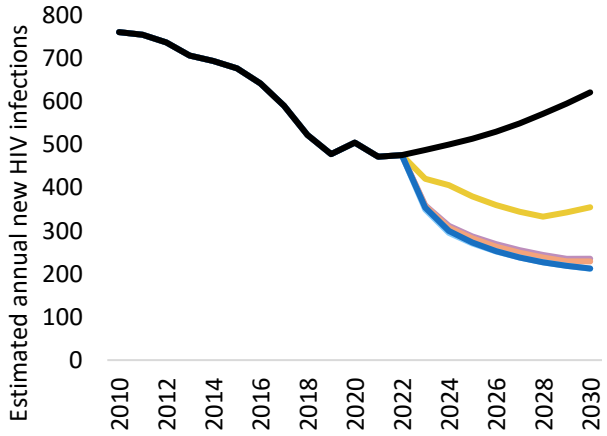
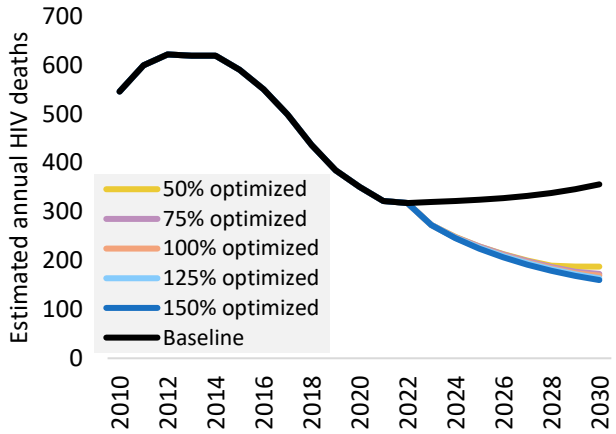
(a) **Azerbaijan: budget optimizations**



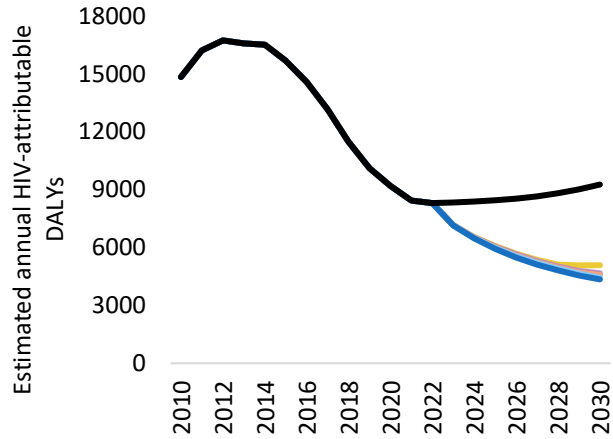
(b) **Azerbaijan: annual new HIV infections in budget optimizations**



(c) **Azerbaijan: annual HIV deaths in budget optimizations**



(d) **Azerbaijan: annual HIV-attributable DALYs in budget optimizations**



(e) **Azerbaijan: projected care cascade in 2030**

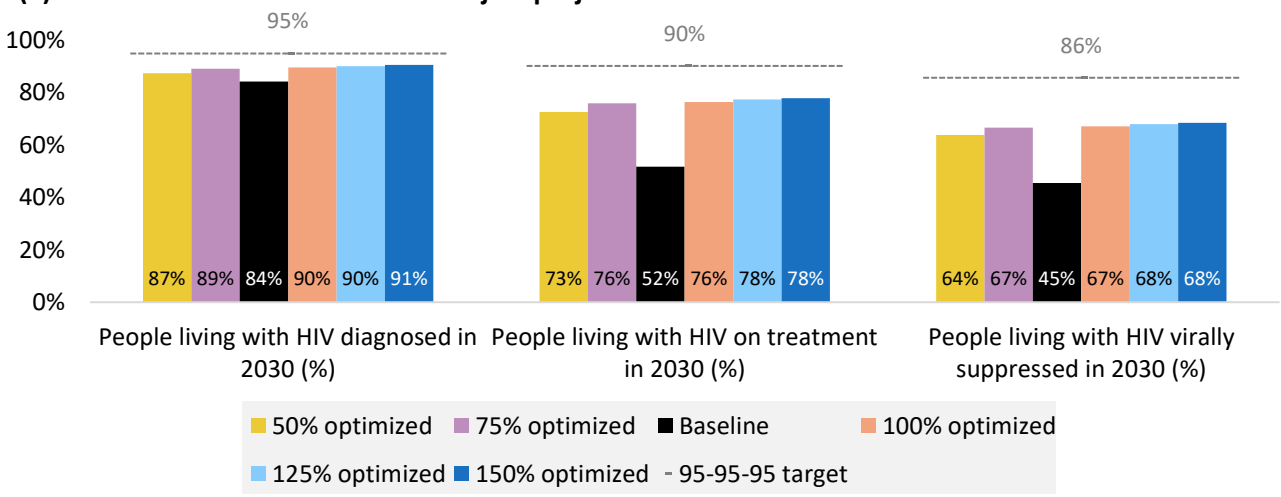


Figure 3. Model outcomes from budget optimization scenarios aiming to minimize infections and deaths. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of estimated 2021 spending; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) projected care cascade for the year 2030 among all people living with HIV. ART, antiretroviral therapy; DALY, disability-adjusted life year; FSW, female sex worker; HTS, HIV testing services; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission.

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 8,949 (+205%) more new infections, 2,749 (+103%) more deaths and 68,898 (+99%) 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	13,319	5,415	138,341	205%	103%	99%
50% optimized	2,943	1,727	46,089	-33%	-35%	-34%
75% optimized	2,198	1,696	45,140	-50%	-36%	-35%
Baseline	4,370	2,665	69,443			
100% optimized	2,156	1,680	44,715	-51%	-37%	-36%
125% optimized	2,064	1,666	44,352	-53%	-37%	-36%
150% optimized	2,078	1,646	43,867	-52%	-38%	-37%
*95-95-95**	1,611	1,300	35,502	-63%	-51%	-49%

*Optimization was only able to reach 94-95-95; 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, Azerbaijan'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$12.1M per annum, or a total 300% of targeted HIV spending, will increase diagnosis of people living with HIV to 94% by 2030, which is just short of the target. Additional programs that focus prevention and testing services to people at high past (e.g. former sex workers or people with a history of injecting drug use) or present risk may make it possible to reach the 95% diagnosis target more cost-efficiently. Although not modeled, delivery approaches and modalities for the testing program could be strategically utilized to better reach undiagnosed people living with HIV with existing or expanded HTS resources. This could incorporate index testing and social network testing strategies, tailored demand creation, task shifting and HIV self-testing, and focused provider-initiated testing (10).

No programs were modeled 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 Azerbaijan to improve linkage to care, treatment adherence and retention to achieve 95% treatment coverage and 95% viral suppression.

Achieving "94-95-95" in this optimized scenario could avert 2,759 new infections (63%), 1,365 deaths (51%) and 33,941 DALYs (49%) 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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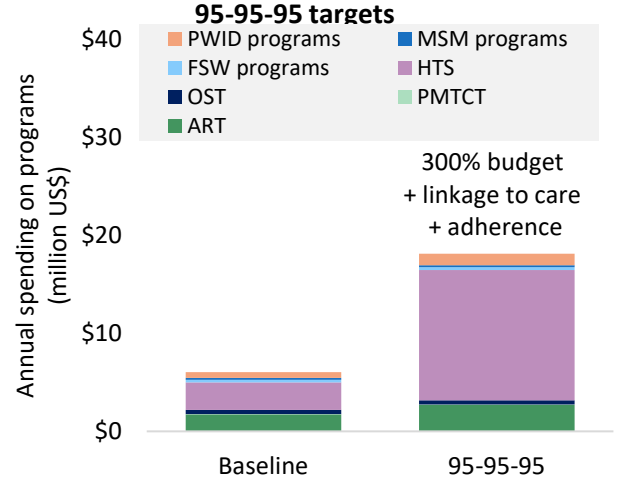
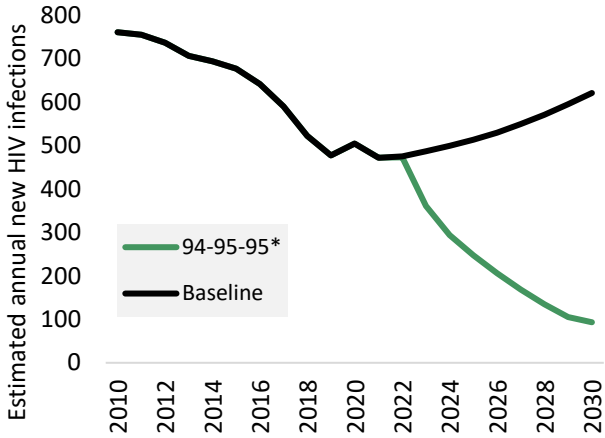
Allocation of HIV resources towards maximizing the impact of funding

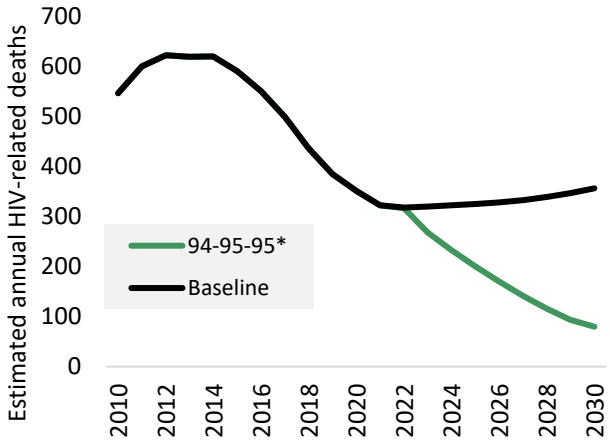
(a) Azerbaijan: optimized budget to reach 95-95-95 targets



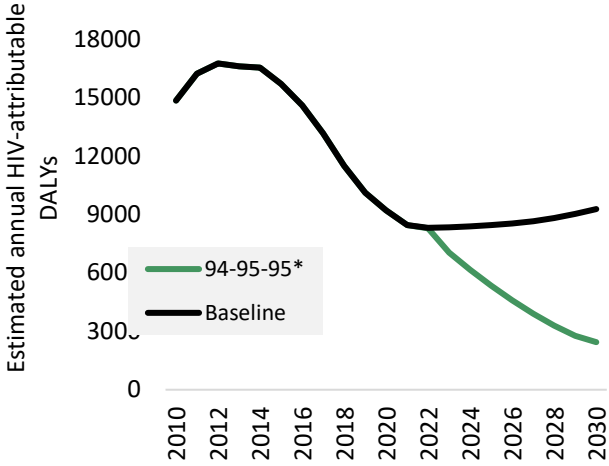
(b) Azerbaijan: annual new HIV infections in 95-95-95 scenario



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



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



(e) Azerbaijan: projected care cascade

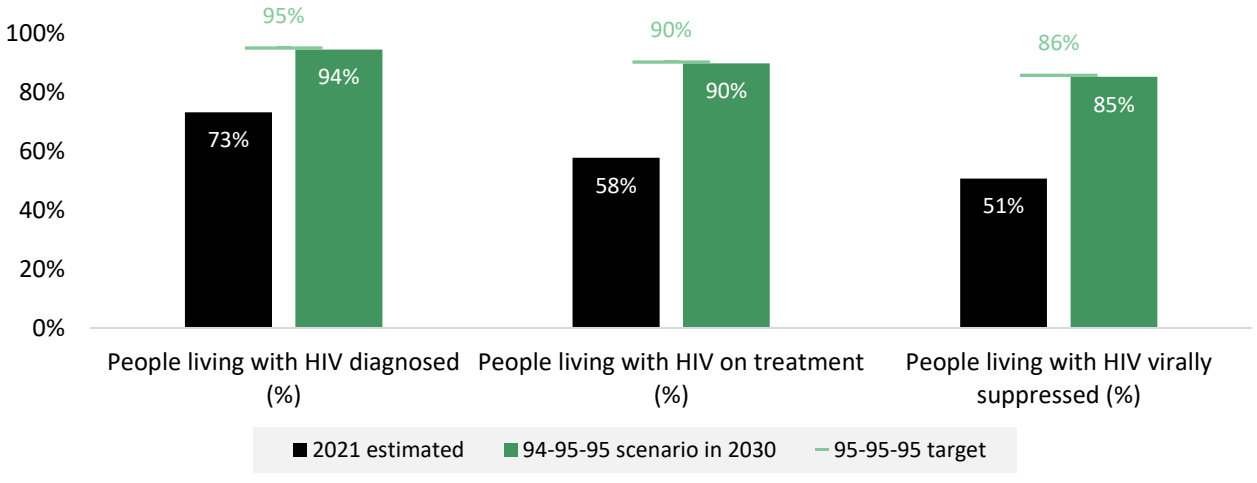


Figure 4. Optimized HIV budget level and allocation to aim for 95-95-95 targets by 2030. Panels show (a) optimal budget allocations; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) estimated care cascade in baseline year 2021 and projected for the year 2030 as a proportion of all people living with HIV. ART, antiretroviral therapy; DALY, disability-adjusted life year; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission.

5 Comparison with past spending

Spending on targeted HIV programs has decreased over time, from US$8.3M in 2018 to US$6.0M in 2021 (Figure 5), largely due to a decrease in spending on ART. Despite this, there has been an increase in treatment coverage over time attributed to a reduction in the unit cost of ART, which was US$716 in 2018 and US$282 in 2021. New licensing agreements and adoption of international procurement platforms since 2020 has enabled access to more affordable generic treatment regimens, thus supporting these cost reductions (11). The subsequent expansion of treatment coverage has likely played an important role in reducing both new infections and deaths. Similarly, the unit cost of programs for PWID decreased between 2018 and 2021, but the number covered has stayed relatively constant, meaning that the total spending on PWID programs has decreased. The decreased total spending on ART and PWID programs has allowed for an increase in spending on other prevention programs, particularly programs for FSW and MSM, as well as more spending on OST.

Key recommendations from the previous allocative efficiency analysis were to increase treatment and programs for PWID, and the reductions in ART unit costs that Azerbaijan has achieved has enabled treatment coverage to increase and the coverage of PWID programs to be maintained, despite a smaller total spending.

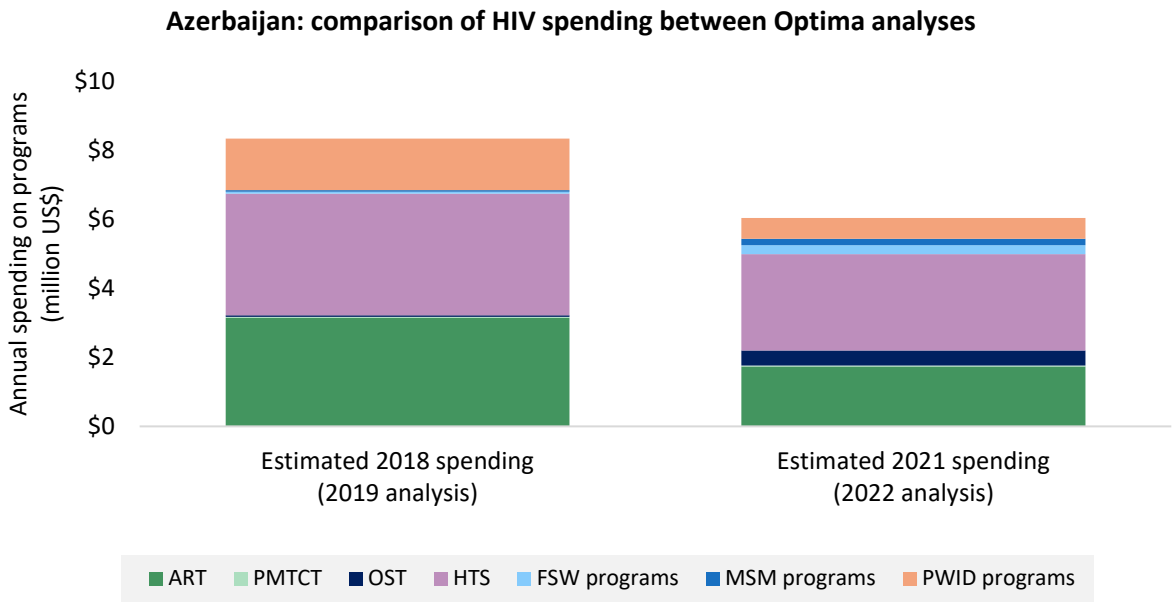


Figure 5. Estimated budget allocations from 2019 and 2022 Optima analyses. ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission.

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. 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, as well as changes in unit costs over time, 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:** Programs were not considered that could improve 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.

7 Conclusions

This modeling analysis evaluated the allocative efficiency of direct HIV programs in Azerbaijan, finding that an optimized resource allocation can have an impact on reducing infections and deaths. Program priorities were identified as increased treatment scale-up where possible and prevention program coverage among PWID and MSM. Azerbaijan is projected to have challenges in reaching 95% diagnosis, and opportunities to enhance strategies to better focus HIV testing on individuals at past or current risk, including current key populations, their sexual partners and those with a history of injecting drug use or sex work, could help to reach targets more cost-efficiently. Additionally, 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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University College London: Tom Palmer

UNAIDS: Eleanora Hvazdziova

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	0.18
	Untreated HIV, CD4 (>500)	0.01
	Untreated HIV, CD4 (350-500)	0.03
	Untreated HIV, CD4 (200-350)	0.08
	Untreated HIV, CD4 (50-200)	0.29
	Untreated HIV, CD4 (<50)	0.58
	Treated HIV	0.08

Source: Optima HIV User Guide Volume VI Parameter Data Sources

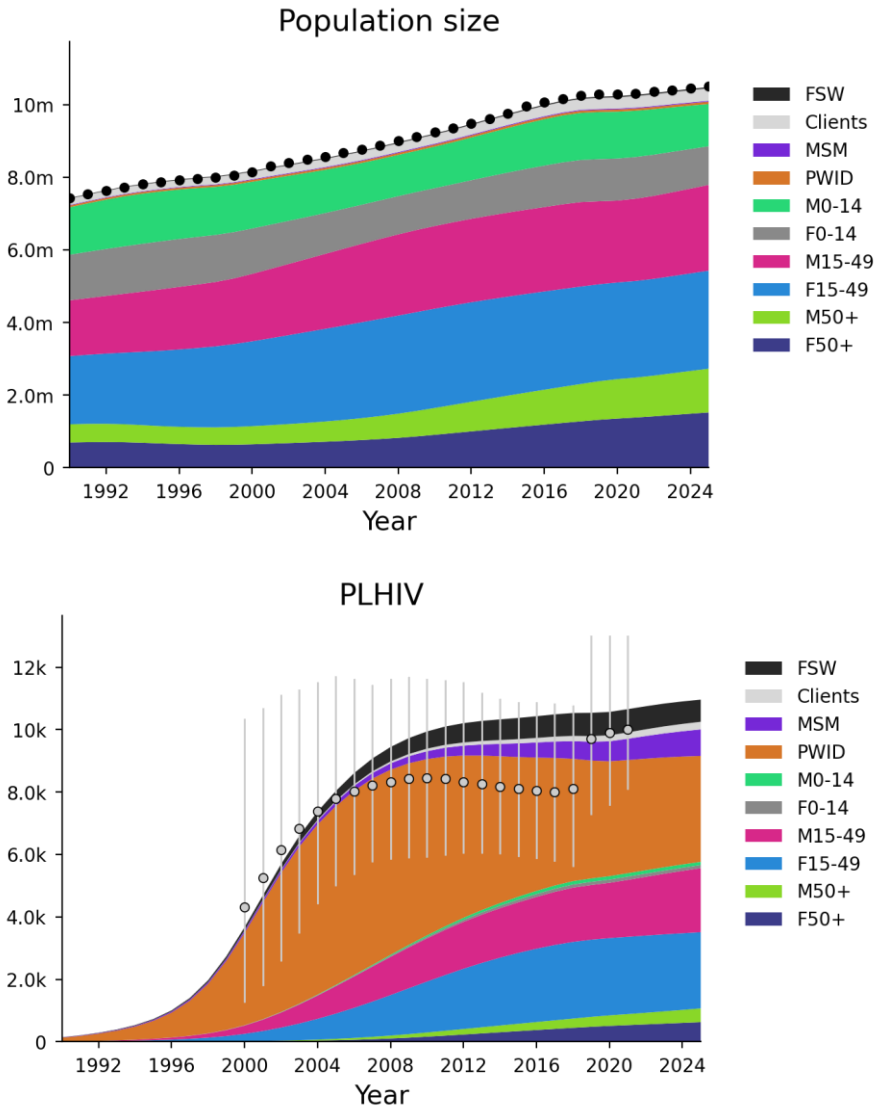
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

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	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 World Population Prospects, Spectrum model, surveillance surveys, program data and UNAIDS.



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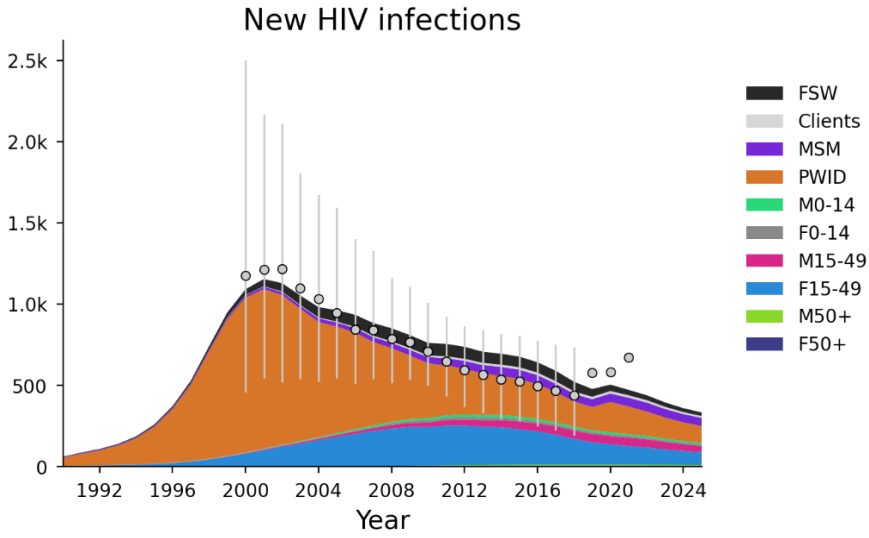
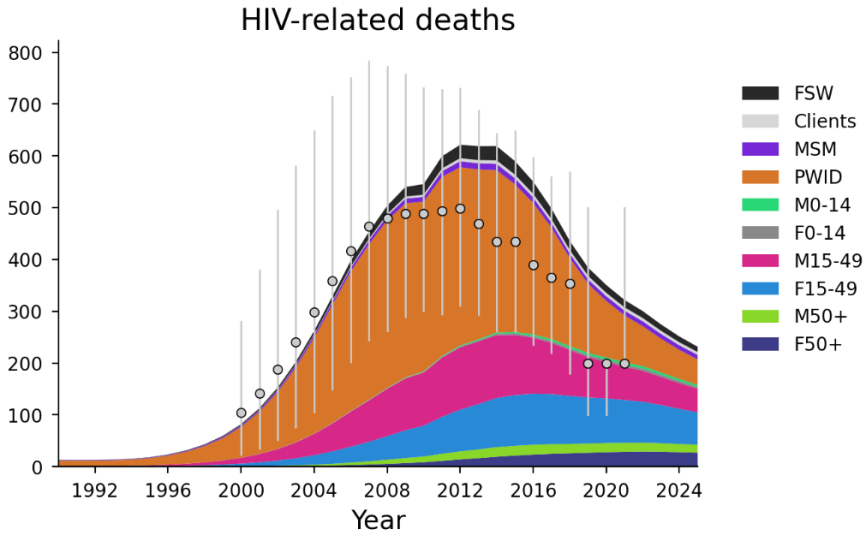
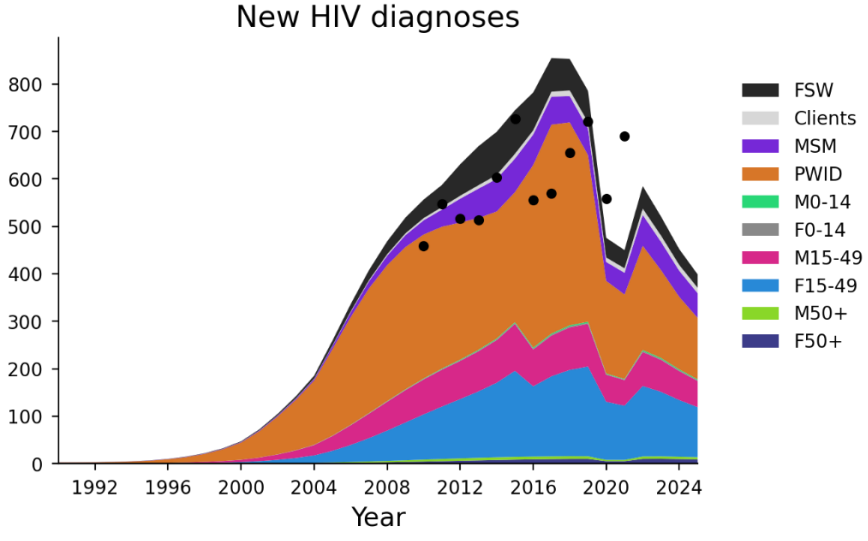
Allocation of HIV resources towards maximizing the impact of funding







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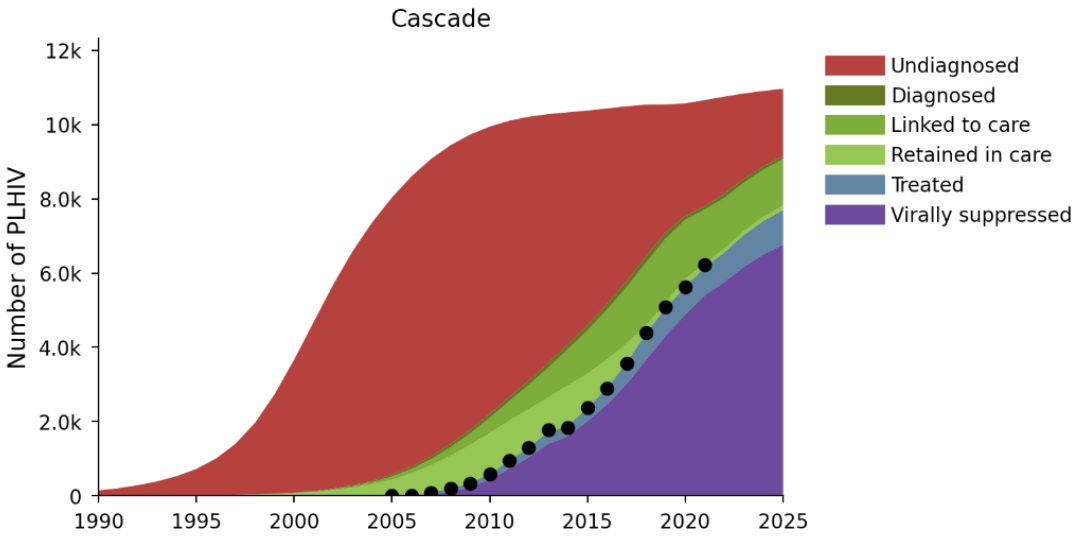
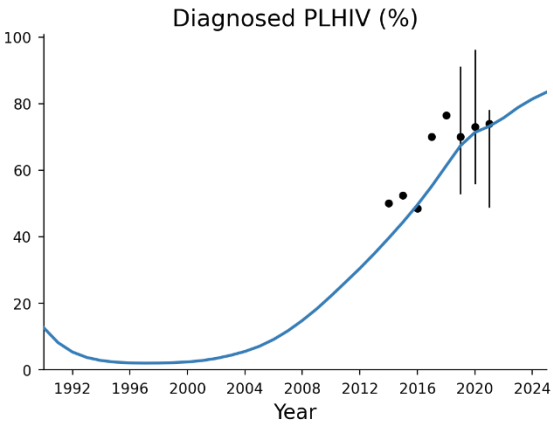
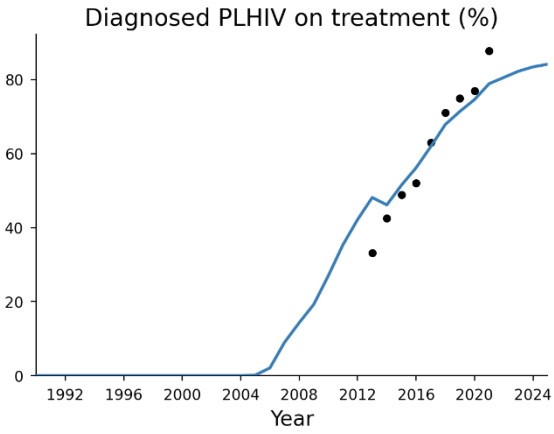
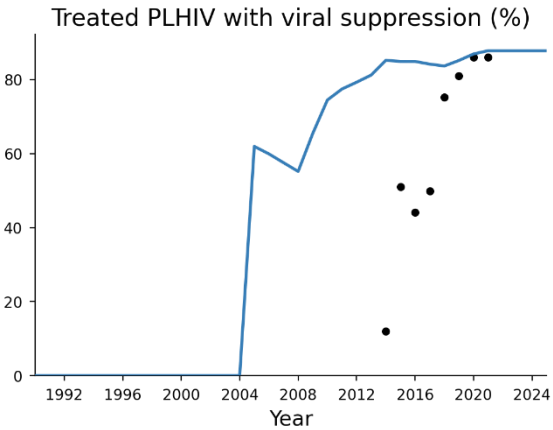
Allocation of HIV resources towards maximizing the impact of funding









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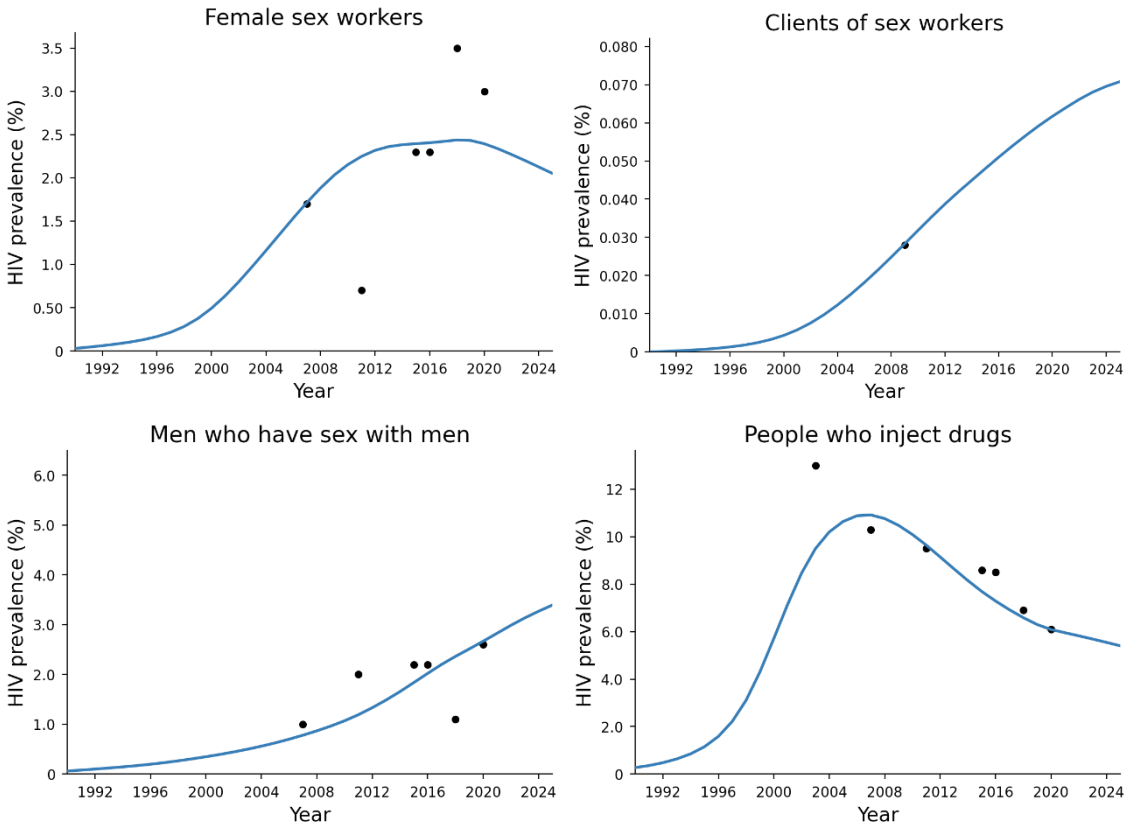
Allocation of HIV resources towards maximizing the impact of funding



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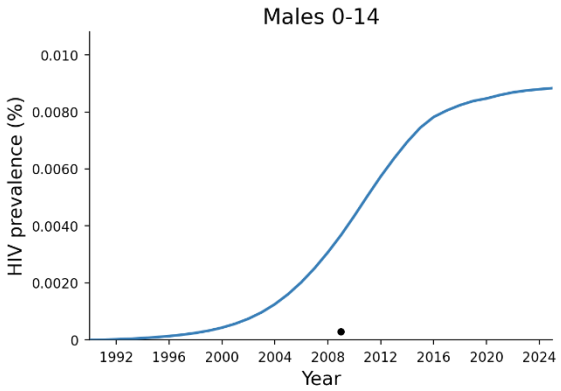
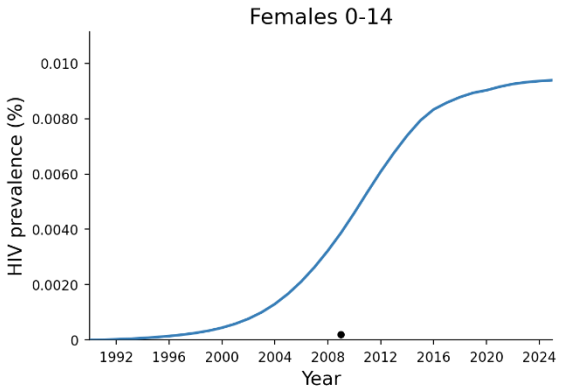
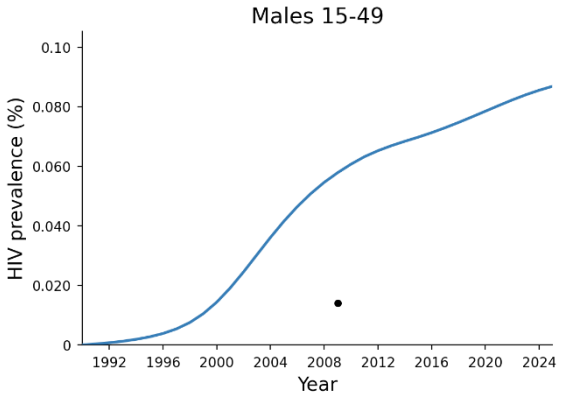
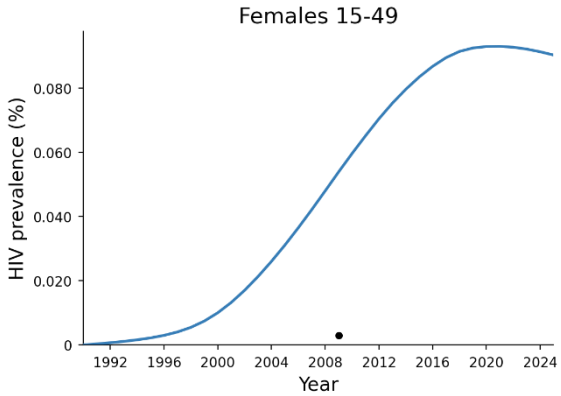
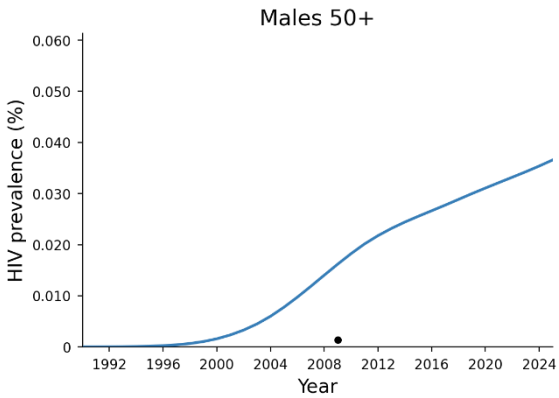
Allocation of HIV resources towards maximizing the impact of funding

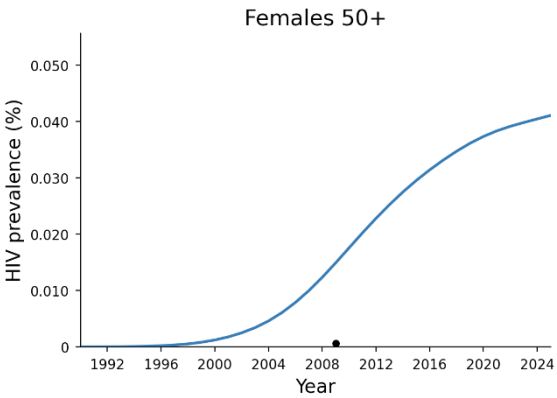












Appendix 3. HIV program costing and impacts

Table A3. HIV program unit costs and saturation values

HIV program	Unit cost (USD)	Saturation (low)	Saturation (high)
Antiretroviral therapy	$282.18	95%	100%
HIV testing services	$4.20	80%	90%
Opioid substitution therapy	$469.43	15%	15%
Prevention of mother-to-child transmission	$386.05	95%	100%
Programs for female sex workers	$14.24	0%*	70%
Programs for men who have sex with men	$12.37	70%	90%
Programs for people who inject drugs	$23.99	0%*	70%

ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission.

* Low saturation value of 0% implies non-linear increases in cost up to high saturation value. Else, the cost-coverage curve is assumed to increase linearly until the low saturation point and non-linearly between the low saturation and the high saturation value.

Table A4. Data inputs of impact of programs

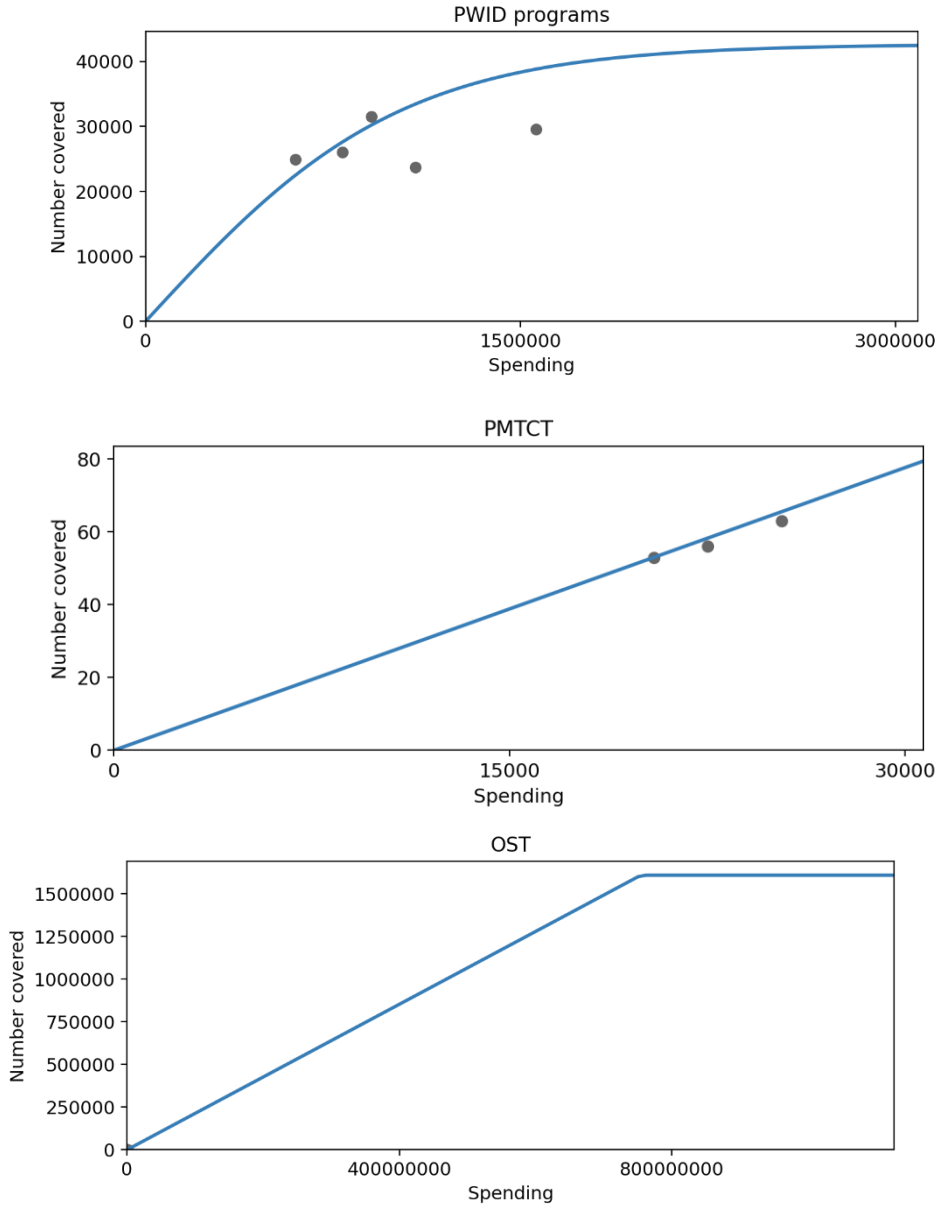
HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
HTS	HIV testing rate (average tests per year)	FSW	0.39	0.40	1.50	1.50
HTS	HIV testing rate (average tests per year)	Clients	0.19	0.20	0.45	0.45
HTS	HIV testing rate (average tests per year)	MSM	0.77	0.85	2.40	2.50
HTS	HIV testing rate (average tests per year)	PWID	0.43	0.46	1.30	1.40
HTS	HIV testing rate (average tests per year)	M0-14	0.02	0.02	0.10	0.10
HTS	HIV testing rate (average tests per year)	F0-14	0.02	0.02	0.10	0.10
HTS	HIV testing rate (average tests per year)	M15-49	0.19	0.19	0.55	0.55
HTS	HIV testing rate (average tests per year)	F15-49	0.19	0.19	0.55	0.55
HTS	HIV testing rate (average tests per year)	M50+	0.02	0.02	0.10	0.10
HTS	HIV testing rate (average tests per year)	F50+	0.02	0.02	0.10	0.10
FSW programs	Condom use for commercial acts	Clients, FSW	50%	50%	83%	83%

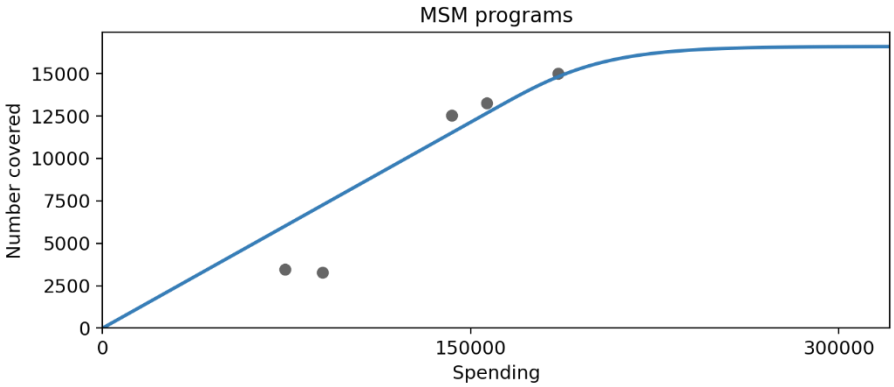
FSW programs	Condom use for commercial acts	PWID, FSW	10%	10%	40%	41%
MSM programs	Condom use for casual acts	MSM, MSM	45%	45%	76%	76%
PWID programs	Condom use for casual acts	PWID, FSW	34%	35%	50%	53%
PWID programs	Condom use for casual acts	PWID, F15-49	14%	15%	30%	30%
FSW programs	Condom use for casual acts	Clients, FSW	45%	45%	60%	62%
FSW programs	Condom use for casual acts	PWID, FSW	34%	35%	53%	53%
FSW programs	Condom use for casual acts	M15-49, FSW	35%	35%	53%	53%
FSW programs	Condom use for casual acts	M50+, FSW	40%	40%	60%	60%
PWID programs	Probability of needle sharing (per injection)	PWID	60%	65%	13%	20%
PMTCT	Number of people on PMTCT	Total	0	0	-	-
OST	Number of PWID on OST	Total	0	0	-	-
PMTCT	Number of people on treatment	Total	0	0	-	-
ART	Number of people on treatment	Total	0	0	-	-

ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission.

- 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 the target populations of each program.




MSM programs
Number covered
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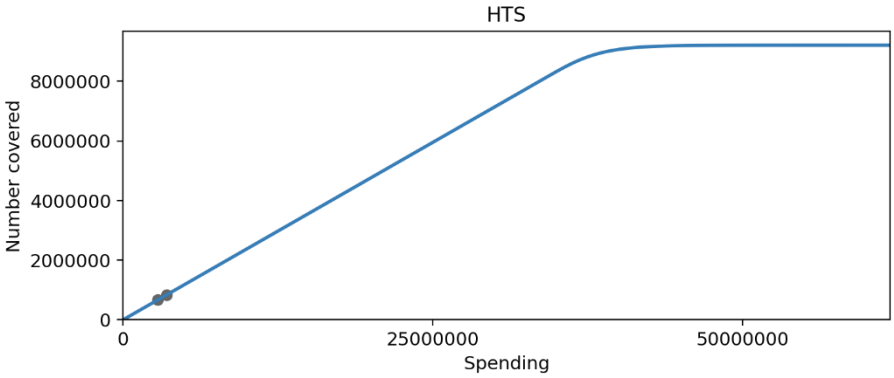
12500
10000
7500
5000
2500
0
0
150000
300000
Spending


HTS
Number covered
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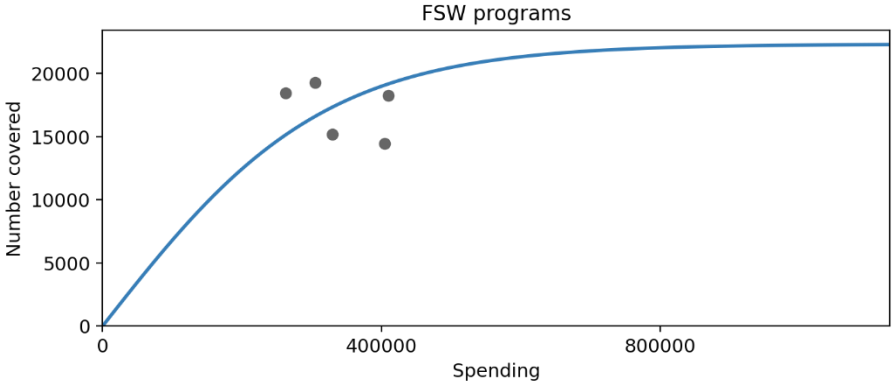
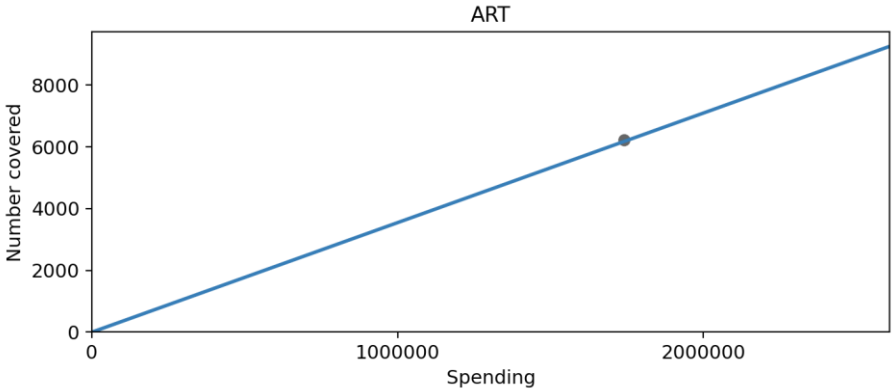
6000000
4000000
2000000
0
0
25000000
50000000
Spending


FSW programs
Number covered
20000
15000
10000
5000
0
0
400000
800000
Spending


ART
Number covered
8000
6000
4000
2000
0
0
1000000
2000000
Spending

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)	1,739,633	2,345,666	2,307,094	2,317,826	2,354,884	2,356,304
HIV prevention programs for FSW	262,615	-	232,340	284,293	444,367	358,304
HIV prevention programs for MSM	185,646	189,548	257,565	253,532	275,984	267,973
HIV prevention programs for PWID	598,707	-	1,239,947	1,296,257	1,823,513	1,432,461
HIV testing services, all populations	2,791,248	-	-	1,395,624	2,159,098	4,153,250
Opioid substitution therapy (OST)	443,616	443,616	443,616	443,616	443,616	443,616
Prevention of mother-to-child transmission (PMTCT)	20,463	42,133	50,884	50,780	50,948	50,983
Total targeted HIV program budget	6,041,928	3,020,964	4,531,446	6,041,928	7,552,410	9,062,892

FSW, female sex worker; MSM, men who have sex with men; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission

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

	Latest reported budget (2021)
Enabling environment	$199,375
Human resources	$234,538
Monitoring and evaluation	$12,406
Management	$112,456
Other HIV care (2020)	$23,468
Other HIV costs (2020)	$32,094
Total non-targeted HIV program budget (incl 2020 Other HIV care and Other HIV costs)	$614,337

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