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

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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 National Center for Disease and Public Health of Georgia, the Infectious Diseases, AIDS and Clinical Immunology Research Center, the Global Fund, UNAIDS, Swiss Tropical and Public Health Institute, and the Burnet Institute.

Summary and key recommendations for HIV resource optimization include:

- Optima modeled estimates of declining new HIV infections diverge from UNAIDS future projections of rising new infections due to different considerations of reported behavioral changes (2). Caution should be taken in interpreting future HIV resource needs from these results until additional epidemiological data can confirm the current underlying trend.
- Georgia has a concentrated HIV epidemic with a high prevalence among men who have sex with men and a lower but still high prevalence among people who inject drugs and female sex workers.
- In 2021 an estimated US$10.9M was spent on targeted HIV interventions, with opioid substitute therapy (OST) accounting for 32% of this, followed by antiretroviral therapy (ART) accounting for 28%.
- In a baseline scenario where 2021 spending was maintained, including a fixed annual spending on ART, there were estimated to be 1,329 new HIV infections, 628 HIV-related deaths and 18,426 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **HIV spending allocations in Georgia are estimated to be close to optimized already, with prioritization of effective key population programs. With additional focus to increase treatment for people who are diagnosed, and ongoing prioritization adjustments to reflect changing risks in the country and the region, Georgia may be well placed to bring the 95-95-95 targets within reach by 2030.**
- Further optimizing 2021 spending would involve scaling up HIV programs for men who have sex with men as well as improving coverage of ART and testing of pregnant women to prevent mother-to-child transmission, ahead of programs for female sex workers, pre-exposure prophylaxis (PrEP), and needle-syringe programs.
- Optimized reallocation of 2021 spending can advance epidemic gains without additional resources and was estimated to avert 656 new infections (49%), 282 deaths (45%) and 6,503 of DALYs (35%) over 2023-2030 relative to the baseline scenario of continued 2021 spending.
- With additional resources, priorities were identified as scaling up PrEP and further increasing coverage of HIV programs for men who have sex with men, followed by needle-syringe programs, then HIV programs for female sex workers and OST. Planned budgets for 2022 and future years already include additional funding to scale-up coverage of HIV programs for men who have sex with men and ART.
- With optimized allocation of 2021 spending, Georgia could be within reach of 95% diagnosis by 2030. Achieving the 95% treatment coverage target by 2030 was estimated to require additional novel programs to improve linkage and retention to care, which were not costed in this analysis.

1 Background

In 2021 Georgia had an estimated population of 3.8 million and an estimated 8,081 people living with HIV (3). Following the first detected HIV case in 1989, Georgia has remained a low HIV prevalence country with an estimated 0.4% prevalence in the adult population (4). The HIV epidemic began primarily through injecting drug use and migration to/from neighboring countries with higher HIV prevalence, but HIV prevalence among people who inject drugs (PWID) has remained under 5% in most cities (5). This is largely attributed to high coverage of harm reduction interventions such as needle-syringe programs (NSP), the introduction of syringe vending machines since 2019, and opioid substitution therapy (OST). The epidemic is now growing mostly among men who have sex with men (MSM), with estimated HIV prevalence among MSM in Tbilisi increasing from 6% in 2010 to 13% in 2012 to 21.5% in 2018 (6, 7). Due to stigma, some MSM do not disclose their sexual orientation and register as heterosexual when receiving HIV services (8), and population size estimates for MSM are likely underestimated. Non-disclosing or heterosexual-identifying MSM are less likely to be reached by MSM programs and many may have regular female sexual partners who may also be at high risk of contracting HIV (7).

The national response to the HIV epidemic is currently guided by the Georgia HIV/AIDS National Strategic Plan 2019-2022. Antiretroviral therapy (ART) was first introduced in Georgia in 2004, and coverage has steadily increased since then. Harm reduction interventions have been implemented since 2005, and early in the epidemic when infections were primarily occurring through needle sharing, national spending on prevention was primarily on NSP and OST. Since 2017 the government has taken over OST funding, making the program more accessible to PWID (8). A larger share of new infections are now estimated to occur through male-male sexual partnerships and spending on MSM programs has increased (9). Overall, the domestic share of HIV spending increased from 43% to 85% between 2013 and 2021 (10).

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 (11, 12). This is the third Optima HIV analysis in Georgia, 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 efficiency modeling analysis was undertaken in collaboration with the National HIV program of Georgia. 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, as well as from other sources were collated. In Georgia, 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$10.9M of the total annual spending. This 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 (13).

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 and women (MSMW)
    - People who inject drugs (PWID), male
- General populations

  - Male 0-14 years old (M0-14)
  - Female 0-14 years old (F0-14)
  - Male 15-49 years old (M15-49)
  - Female 15-49 years old (F15-49)
  - Male 50+ years old (M50+)
  - Female 50+ years old (F50+)
- Targeted HIV programs
  - Antiretroviral therapy (ART)
  - Prevention of mother-to-child transmission (PMTCT)
  - Opioid substitution therapy (OST)
  - Pre-exposure prophylaxis (PrEP)
  - HIV prevention programs for FSW (FSW programs)
  - HIV prevention programs for MSMW (MSM programs)
  - Needle-syringe programs (NSP)
  - HIV testing services (HTS), all populations

Unidentified MSM have been modelled as part of the M15-49 population in the Georgia analysis to account for MSM who do not disclose their behavior and are not reached or reachable by key population programs. The true size of this population is not known, and thus to model HIV transmission pathways in this population it was assumed that there are some casual partnerships between MSMW and men aged 15-49.

HTS in Georgia are focused primarily on reaching key populations, and the unit cost reflects the cost per key population reached with testing. However, the overall testing includes spending on all testing conducted in Georgia for all populations, and the impact of the program includes these additional tests outside of key populations.

In Georgia PrEP is available to anyone eligible but is prioritized among populations with high prevalence, particularly MSM. In the model, a target population of MSMW was defined for PrEP program to reflect this prioritization and maximize the potential epidemic impact of PrEP.

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 Interpreting the care cascade

For the baseline year of 2021, UNAIDS care cascade estimates are that 83% of people living with HIV were diagnosed, 86% of diagnosed people were on treatment and 93% of those on treatment were virally suppressed (“83-86-93”).

To conduct this analysis, the Optima HIV model must be calibrated to the HIV epidemic in Georgia. This involves fitting to all available data simultaneously, including estimates of population sizes, HIV prevalence, sexual behavior, and testing among each key population, as well as the coverage and impact of various HIV programs (Appendix). Calibrations should be understood holistically, because data limitations can mean that achieving a better model fit for one indicator can lead to a worse fit for another indicator. Following calibration across all indicators and sources, the resulting model-fitted estimates the care cascade for 2021 were 85% of people living with HIV diagnosed, 89% of diagnosed people living with HIV are on treatment and 95% of those on treatment are virally suppressed ("85-89-95"), within a few percentage points of the UNAIDS cascade estimates. The purpose of these calibrated estimates is so that the model can assess how the cascade may change over time and for different spending scenarios.

In addition, throughout this report results about the care cascade are often reported as projected values for the year 2030 (rather than the baseline year 2021), and values shown in figures use a denominator of all people living with HIV (e.g. percentage of people living with HIV on treatment, rather than the percentage of people diagnosed on treatment). To assist with clarity, the value being reported has been specified on each use.

3.4 Treatment retention

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.

3.5 Model weightings

Objective 1 aimed to minimize new HIV infections and HIV-related deaths by 2030 for a given budget, with a weighting of 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, 150 and 200 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?*

2021 HIV spending. In Georgia total spending on HIV from domestic and international sources was US$15.9M in 2021, incorporating US$10.9M targeted HIV spending for the programs considered above and US$5.0M non-targeted spending. The majority of targeted spending was for OST (32%), followed by 28% on ART and 19% for HTS (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 the 2021 model calibration, ART coverage among all people living with HIV was 76%. If ART unit costs remain constant (US$528 in 2021), ART spending would need to increase by US$0.3M (9% of 2021 ART spending) from 2021 to 2030 to maintain a constant proportion of diagnosed people living with HIV on treatment given current epidemic trends, including current coverage of other HIV programs. 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 treatment, and specific programs to improve linkage to care or adherence were not modelled or costed in this analysis. Although treatment is available to all diagnosed people living with HIV in Georgia, 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).

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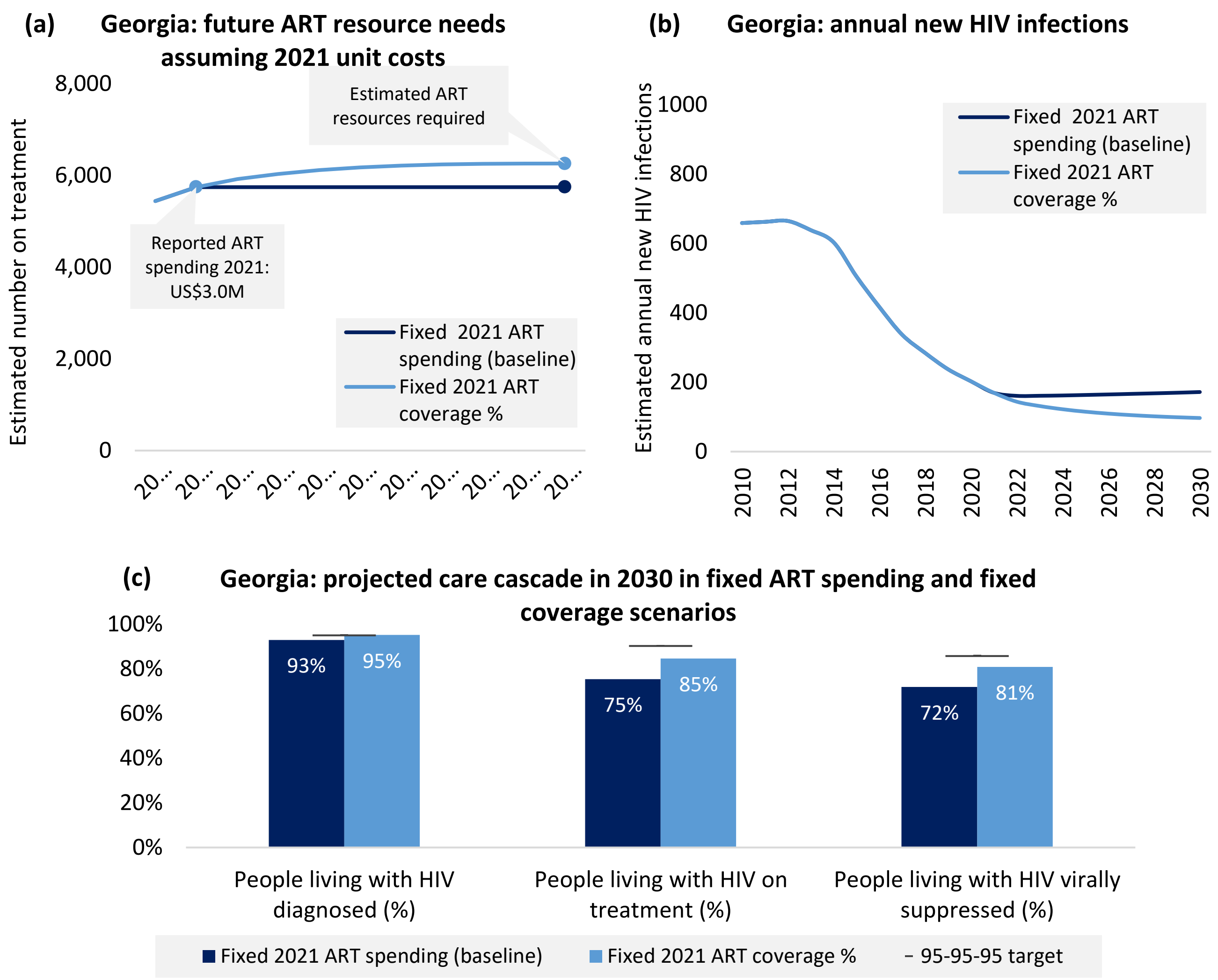

Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021 proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant; (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 1,329 new HIV infections, 628 HIV-related deaths and 18,426 HIV-attributable DALYs over 2023-2030 (Table 1). Without additional spending on ART, the HIV care cascade in this scenario was projected to be "93-81-95" in the year 2030 (i.e. 93% of people diagnosed, 81% of diagnosed people on treatment and 95% of people on treatment virally suppressed) (Figure 1). The lower proportion of people on treatment in 2030 reflects that ART spending will need to increase over time just to maintain constant percentage treatment coverage, since more people will continue to be diagnosed.

Optimized resource allocation of 2021 spending. Optimization of 2021 spending identified that additional impact may be possible by prioritizing further scale-up of HIV programs for MSM, as well as ART and PMTCT (including testing for pregnant women), over programs for FSW, PrEP and NSP (Figure 2). Scaling up HIV programs for MSM, who are a high-risk population in Georgia, would help reduce new infections and curb a rising prevalence. Assuming that more people could be accessed for treatment through enhanced linkage to care and adherence programs, then scaling up ART could reduce mortality as well as new infections through treatment-as-prevention. If there are practical limitations on expanding the proportion of people retained in care including migration of people living with HIV, then prioritization of remaining resources would be in line with increased budget levels.

In Georgia, 57% of homosexual HIV transmission in 2021 was estimated to be among males who are non-disclosing as MSM, and these men are difficult to directly reach through MSM-focused programs, including PrEP. While PrEP is likely to only reach identified MSM, outreach prevention programs for MSM may have indirect benefits to non-disclosing MSM through their partners, detection and treatment of HIV among reachable MSM, and changes in condom use social norms. In this context, prevention programs for MSM incorporating condom distribution and behavior change communication are prioritized before PrEP given their indirect benefits in a broader group of both disclosing and non-disclosing MSM.

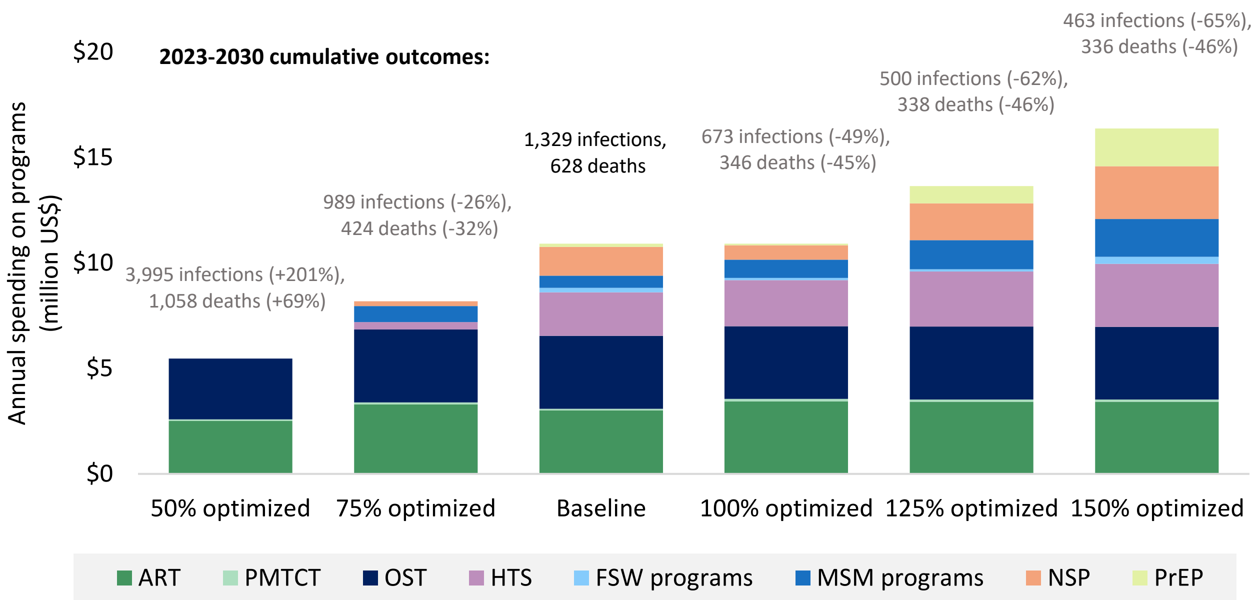

Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030. Percentage optimized refers to the percentage of

baseline HIV funding at a given budget level. ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; NSP, needle-syringe programs; OST, opioid substitution therapy; 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 the scale up of PrEP as well as other HIV programs for MSM, followed by NSP and HIV programs for FSW. While new infections among identified MSM make up a relatively small proportion of total new infections (an estimated 13% in 2021 in the model calibration), the epidemic among MSM is rising within the country as well as the region and so prevention programs are critical. Furthermore, many new infections between men are estimated to occur outside of identified MSM, hence outreach programs that focus on behavioral change are critical for reaching both identified and unidentified populations at high risk.

If funding were reduced, priorities were identified as maintaining as many people on treatment as possible, followed by MSM programs, then HTS.

Impact of optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending could avert 656 new infections (49%), 282 deaths (45%) and 6,503 of DALYs (35%) over 2023-2030. This benefit increases to 65% infections, 46% deaths and 37% DALYs averted with an optimized 150% budget (Figure 3, Table 1).

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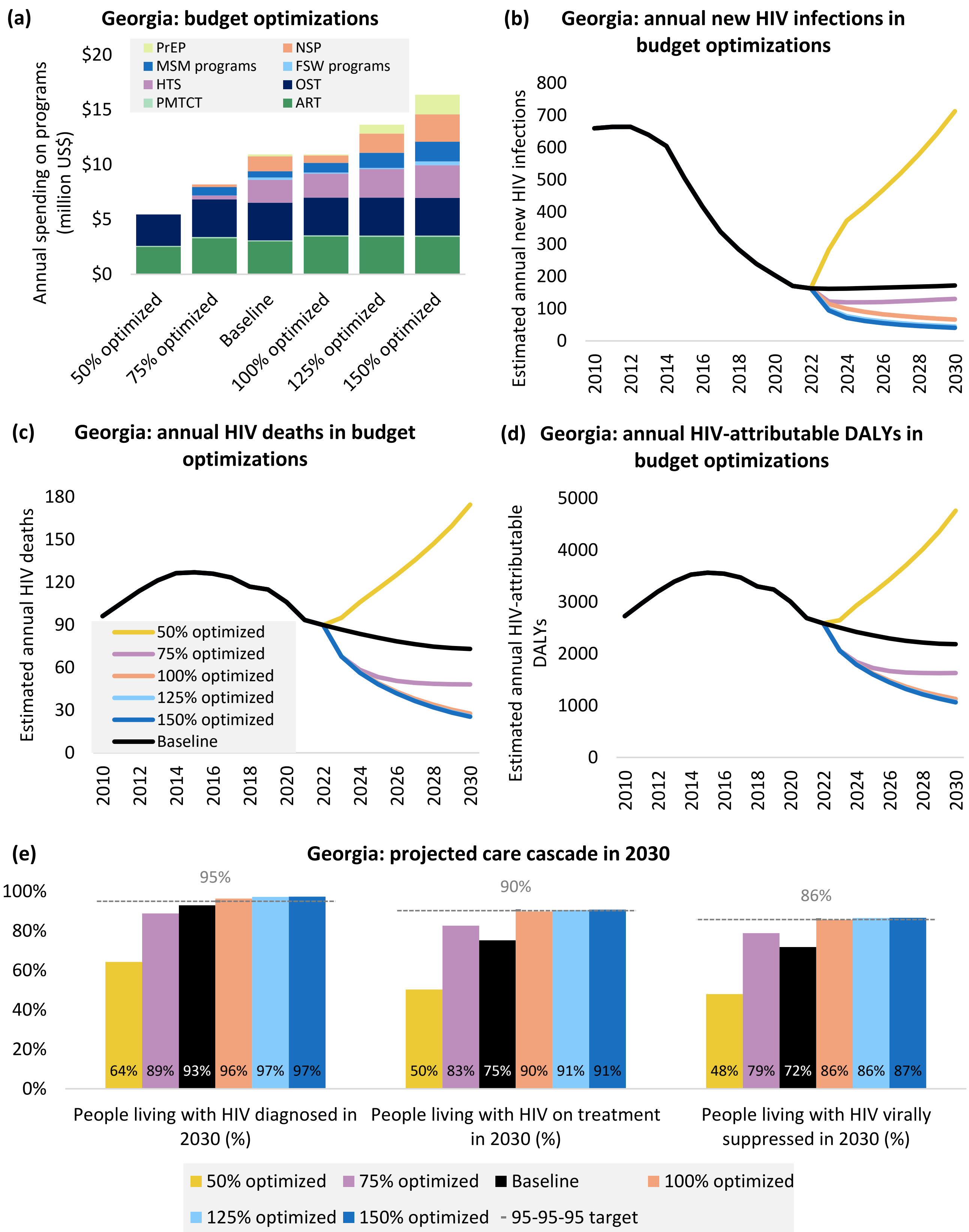

Figure 3. Model outcomes from budget optimization scenarios aiming to minimize infections and deaths. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of current HIV funding; (b) estimated annual new HIV infections; (c) HIV-related deaths; (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; DALY, disability-adjusted life year; FSW, female sex worker; HTS, HIV testing services; NSP, needle-syringe programs; OST, opioid substitution therapy; PMTCT, prevention of mother to child transmission.

Increased impact was possible in the model even with 75% optimized spending compared to the baseline (Figure 3), since the reallocation of reduced funds heavily prioritized ART, still achieving a 10% increase in ART spending. This highlights the importance of increasing treatment coverage though all available mechanisms.

Beyond 150% budget the modeled programs all reached close to their saturation levels, and increased investment had diminishing returns. At this level of spending, the main gap in the care cascade 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.

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. With no HIV spending, the model estimates that there would be 12,561 (+945%) more new infections, 2,565 (+409%) more deaths and 61,904 (+336%) 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	13890	3192	80329	945%	409%	336%
50% optimized	3995	1058	29014	201%	69%	57%
75% optimized	989	424	13819	-26%	-32%	-25%
Baseline	1329	628	18426			
100% optimized	673	346	11923	-49%	-45%	-35%
125% optimized	500	338	11678	-62%	-46%	-37%
150% optimized	463	336	11632	-65%	-46%	-37%

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?*

With 100% optimized spending, Georgia is on track to be within reach of the 95-95-95 targets by 2030 (equivalent to 95-90-86 of all people living with HIV).

No programs were modeled to improve linkage and retention in treatment, adherence, and viral suppression, and there is some uncertainty whether treatment coverage targets will be met, with the model projecting that 93% of diagnosed people living with HIV will be on treatment in 2030. In addition to ART spending, novel programs may be necessary in Georgia to improve linkage to care, treatment adherence and retention to achieve 95% treatment coverage and 95% viral suppression. However, the cost of these supporting programs is not known.

Achieving 97-95-96 by 2030 through the 100% optimized scenario plus assumed realization of the treatment target could avert an additional 62 (9%) new HIV infections, 17 (5%) deaths and 404 (3%) DALYs compared to 100% spending optimized scenario (Figure 4).

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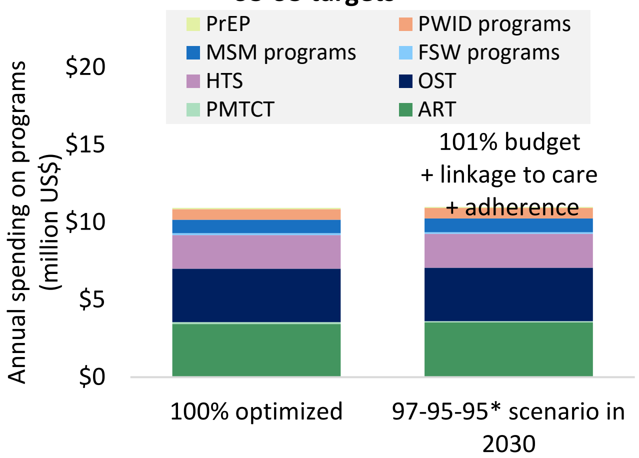
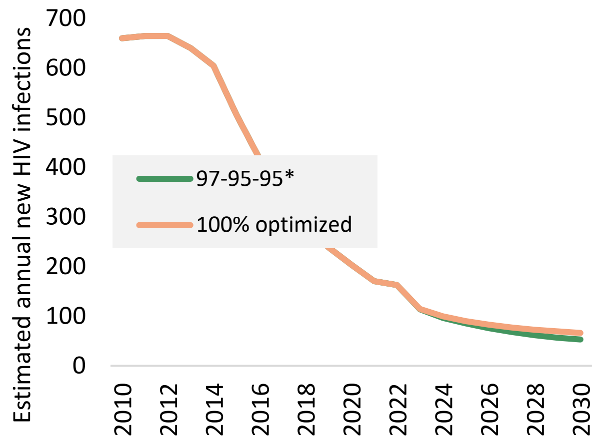
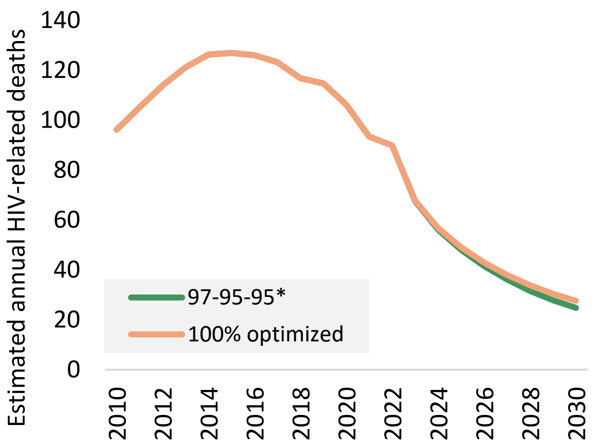
(a) Georgia: optimized budget to reach 95-95-95 targets



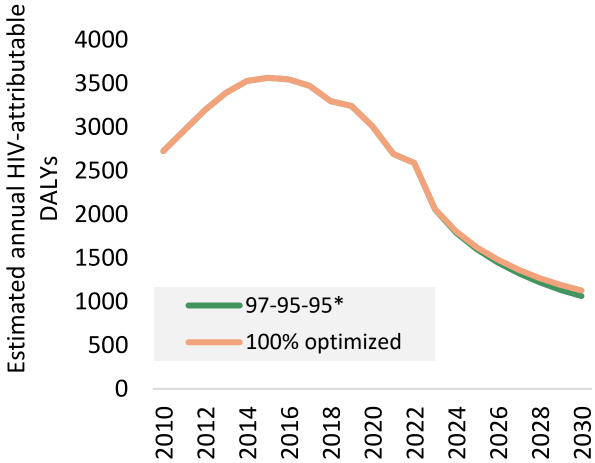
(b) Georgia: annual new HIV infections in 95-95-95 scenario



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



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



(e) Georgia: projected care cascade

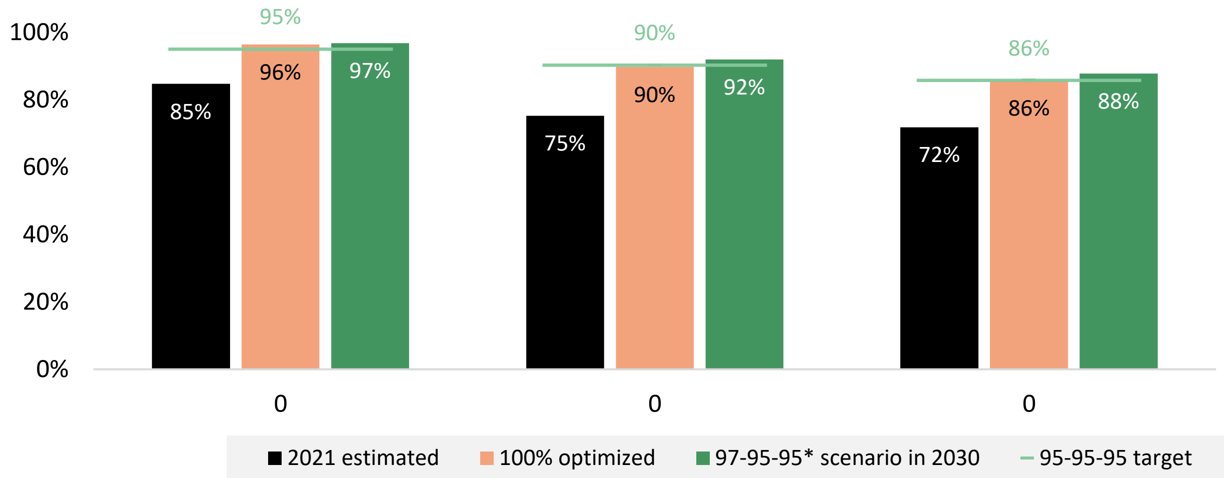


Figure 4. Optimized HIV budget level and allocation to achieve 95-95-95 targets by 2030. *Georgia is projected to reach 97-95-96 by 2030 with 100% optimized budget allocation plus assumed achievements reaching treatment target. Panels show (a) optimal budget allocations; (b) estimated annual new HIV 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 targeting general population; 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

Since 2014, total spending on targeted HIV programs has remained relatively constant, with US$11.2M spending in 2014 (12), US$12.1M in 2018 (11) and US$10.9M in 2021. There has however been a shift in the allocation of funding across programs, with increased spending on HTS and MSM programs, including the introduction of a PrEP program, and decreased spending on OST and NSP programs. The unit cost of antiretroviral therapy (ART) has been steadily decreasing (US$1,465 in 2013, US$782 in 2018, US$523 in 2021), which has allowed for the scale-up of treatment coverage while slightly reducing total spending on ART. The previous allocative efficiency analysis recommended a reallocation of funding from HTS and programs for NSP and FSW to enable further scale-up of ART and HIV programs for MSM as a priority. Since the previous analysis, reduced unit costs for ART and programs for MSM have allowed for an increased coverage to be achieved with slightly less spending.

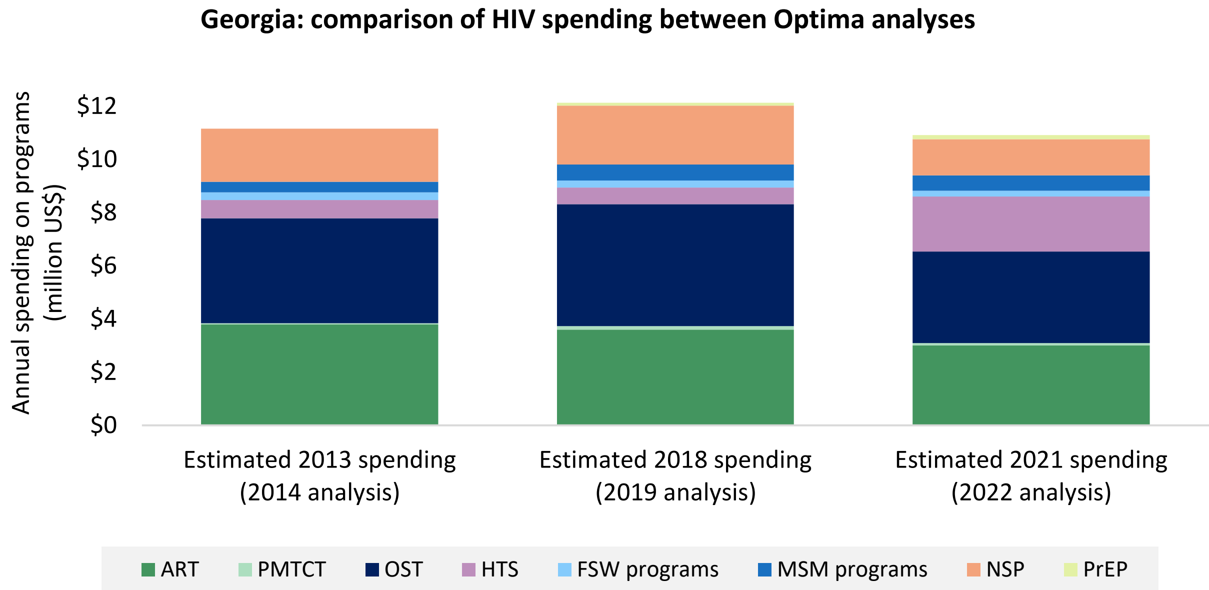


Figure 5. Estimated budget allocations from 2014, 2019 and 2022 Optima analyses. ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; OST, opioid substitution therapy; NSP, needle-syringe program; PMTCT, prevention of mother to child transmission.

6 Study limitations

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

- **Divergence from UNAIDS estimates:** The model calibration is sensitive to behavioral changes including the reduced number of people who inject drugs, the reduced frequency of injecting, and reduced sharing of needles. If these reported data are not fully representative, it is possible that the size of the epidemic is under-estimated. Optima modeled estimates diverge from UNAIDS future projections (see Appendix 2), which do not factor in behavioral change and project continuing rises in new HIV infections. Subsequently, caution should be taken in interpreting these results until additional epidemiological data can confirm the current trend, as additional resources may be necessary to achieve epidemic outcomes.
- **Population sizes:** There is uncertainty in population size estimates; for key populations stigma may lead to underestimation of population size. In Georgia, uncertainty in the population size of non-disclosing men who have sex men is especially important to the HIV epidemic. For total populations there is instability in migration patterns due to the war in Ukraine. These 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, the service and funding need for each key population.
- **Effect sizes (i.e. impact) 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. Given epidemic heterogeneity in Georgia (5, 7), 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. Although treatment is available to all diagnosed people living with HIV in Georgia, 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).
- **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.

7 Conclusions

This modeling analysis evaluated the allocative efficiency of direct HIV programs in Georgia, finding that an optimized resource allocation can have an impact on reducing infections and deaths as well as achieving 95-95-95 targets. Confirmation of future resource needs are subject to additional epidemiological data to validate the current underlying trends in new infections, but program priorities were identified as increased coverage of ART, PMTCT and programs for MSM, followed by increased PrEP, NSP and HIV programs for FSW. New or scaled-up programs focusing on supporting linkage to care, adherence and retention in treatment may support reaching 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	0.18
	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

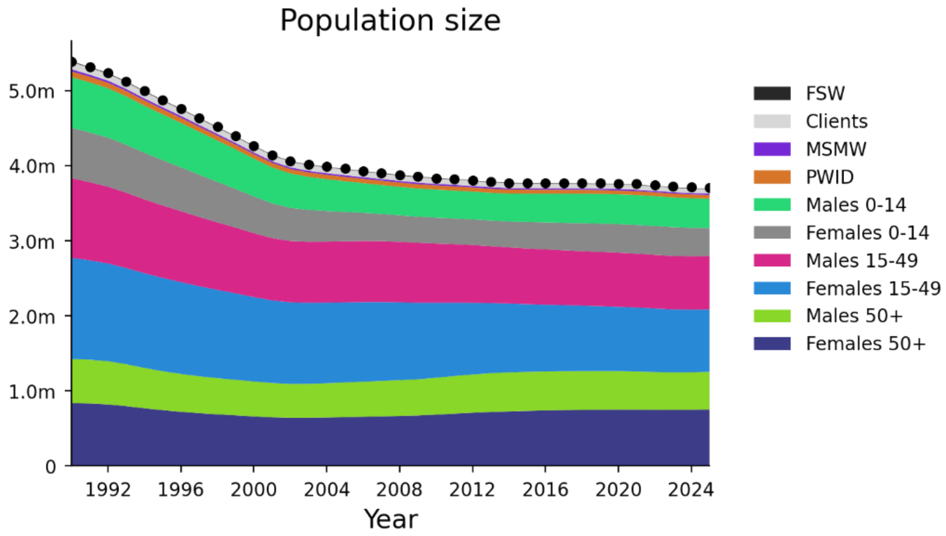
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

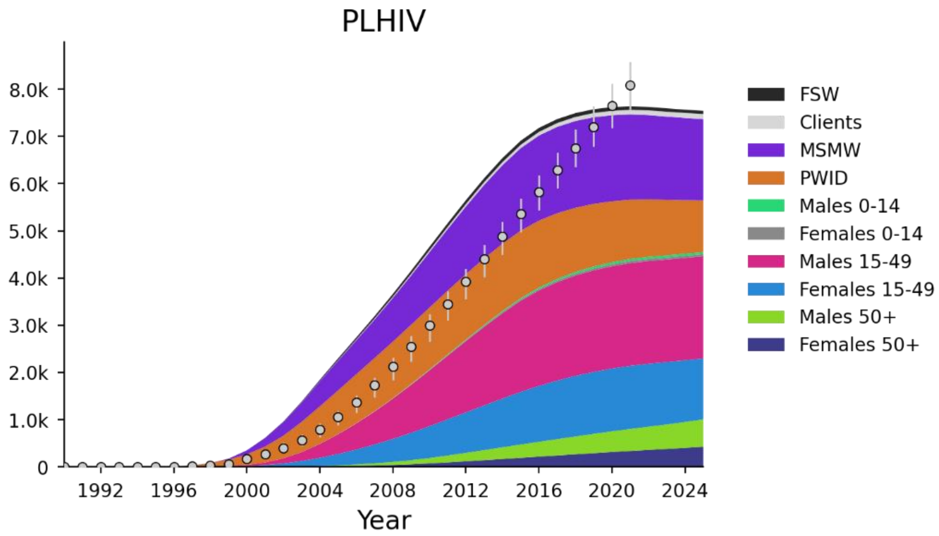
Treatment recovery due to suppressive ART (average years to move)		
	CD4 (350-500) to CD4 (>500)	2.20
	CD4 (200-350) to CD4 (350-500)	1.42
	CD4 (50-200) to CD4 (200-350)	2.14
	CD4 (<50) to CD4 (50-200)	0.66
	Time after initiating ART to achieve viral suppression (years)	0.20
CD4 change due to non-suppressive 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 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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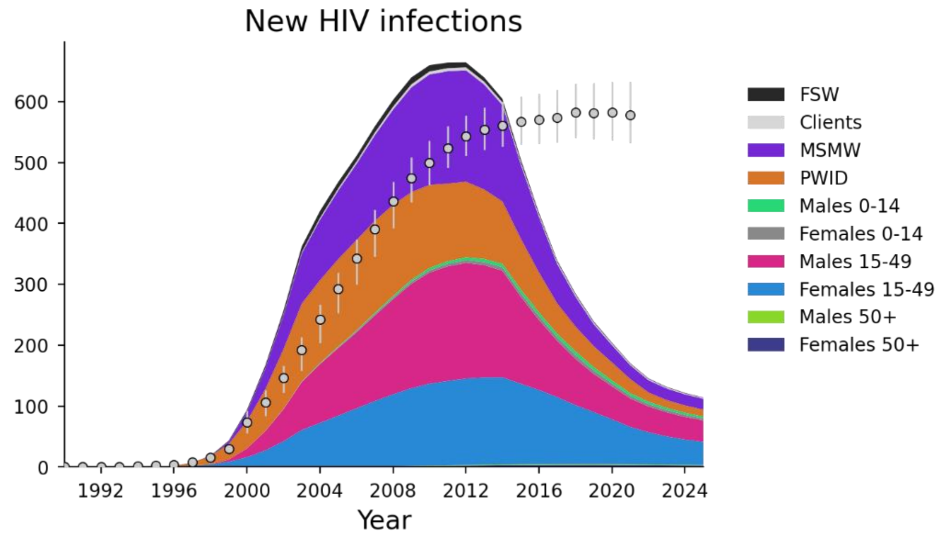
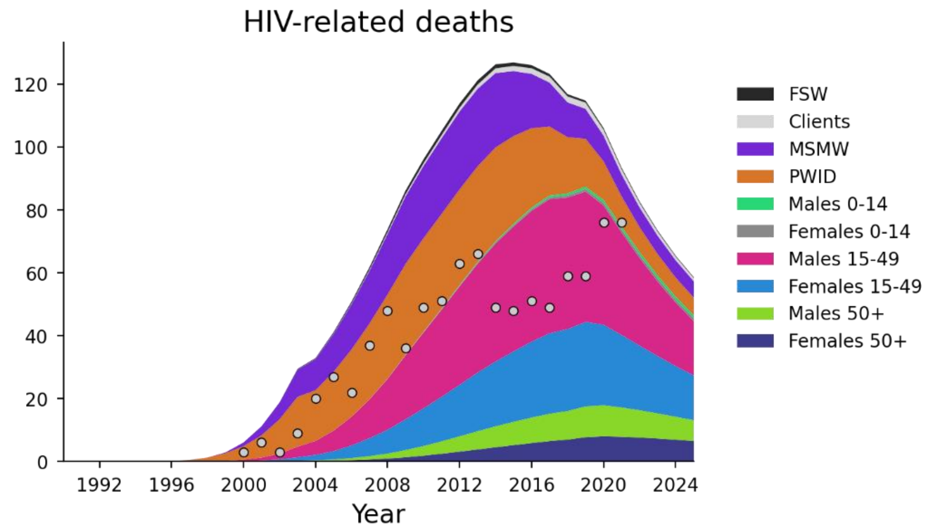
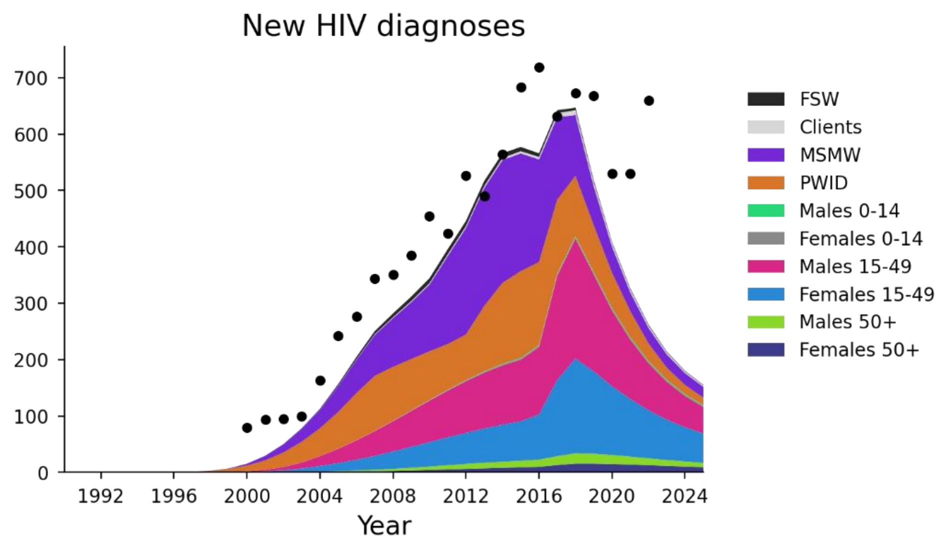
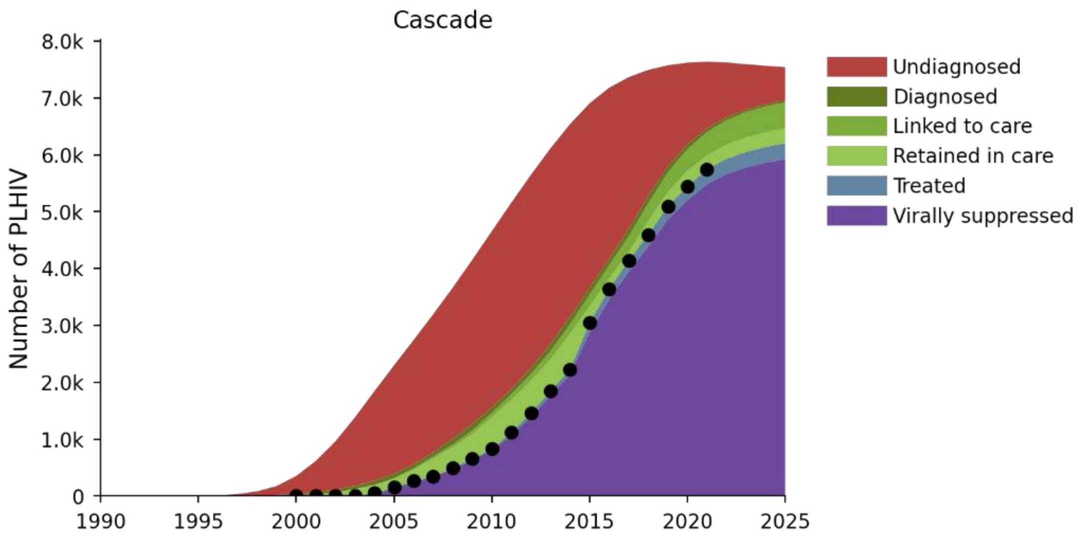
Allocation of HIV resources towards maximizing the impact of funding

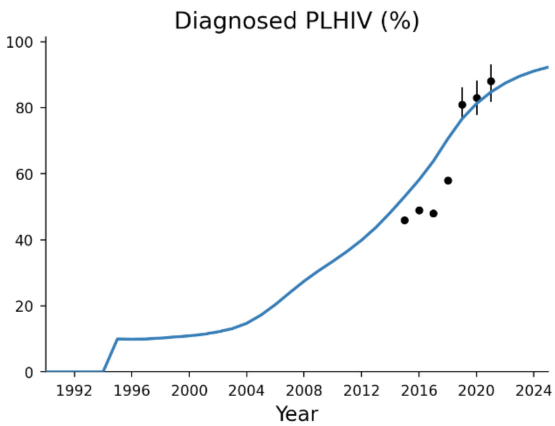


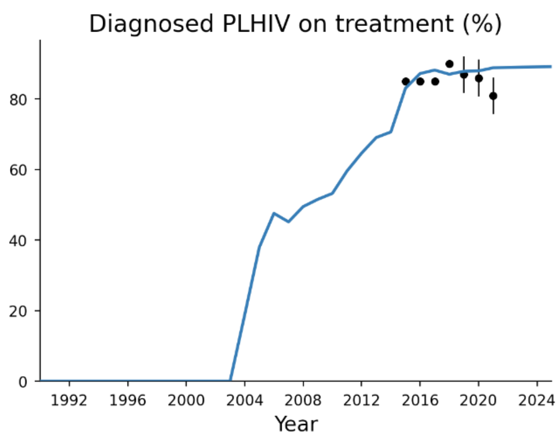


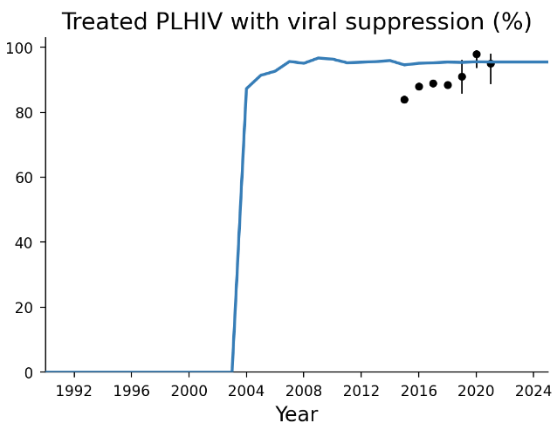


Allocation of HIV resources towards maximizing the impact of funding









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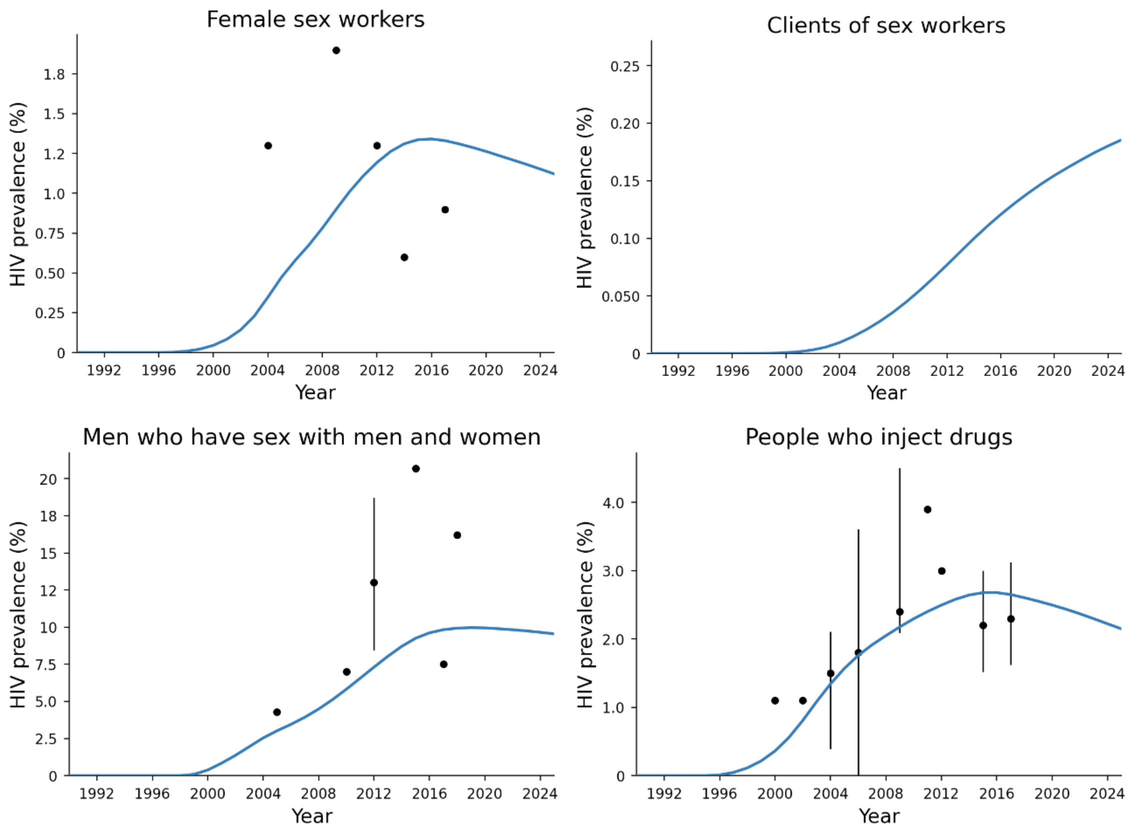
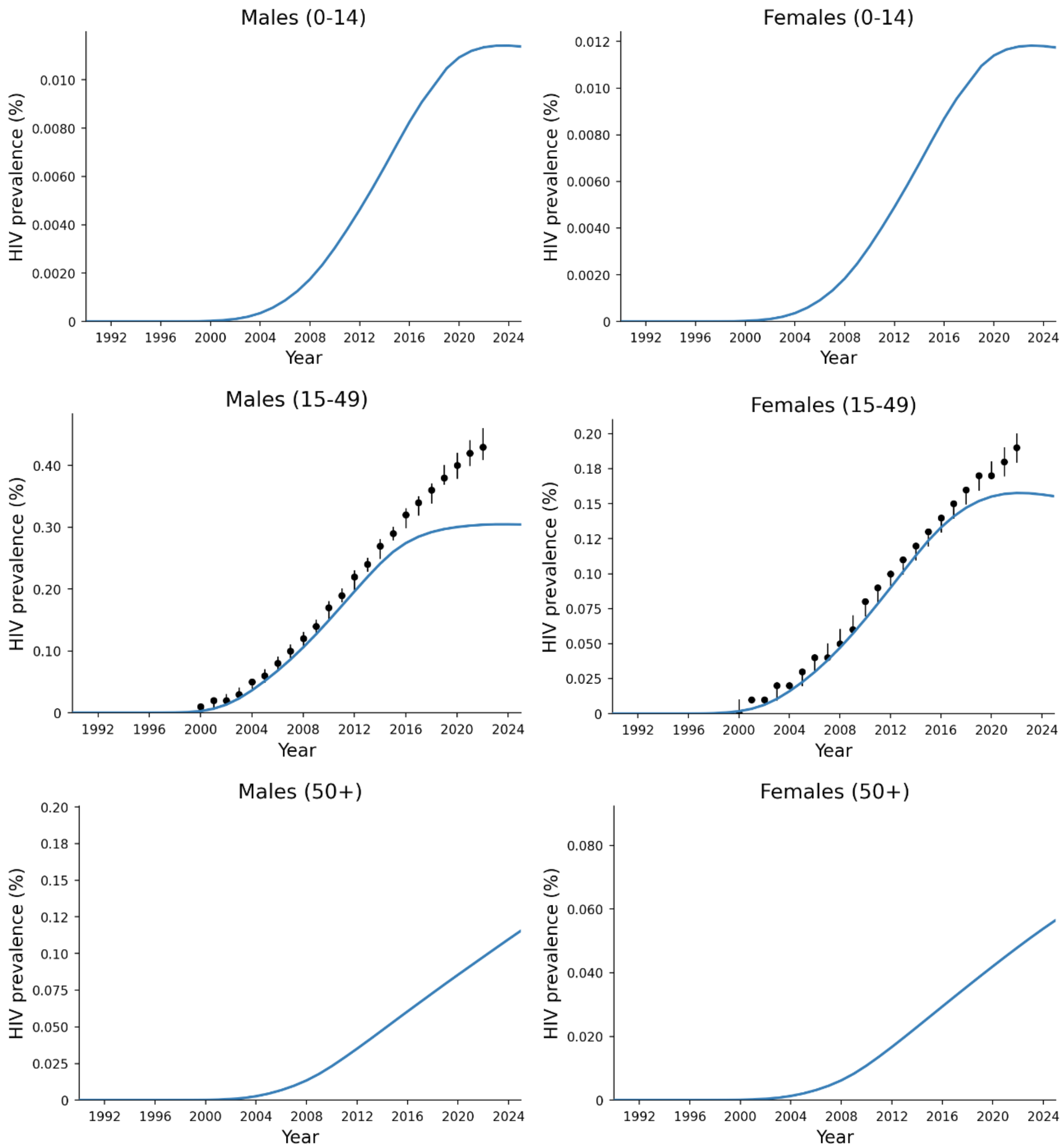
Allocation of HIV resources towards maximizing the impact of funding





Males (0-14)
Females (0-14)
Males (15-49)
Females (15-49)
Males (50+)
Females (50+)
HIV prevalence (%)
Year
1992
1996
2000
2004
2008
2012
2016
2020
2024

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	$528.08	95%	100%
HIV testing services	$34.37	80%	95%
Needle-syringe programs	$38.19	50%	90%
Opioid substitution therapy	$211.55	30%	60%
Pre-exposure prophylaxis	$198.31	0%	60%
Prevention of mother-to-child transmission	$1,611.11	95%	100%
Programs for female sex workers	$71.09	30%	80%
Programs for men who have sex with men	$72.21	40%	80%

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; PrEP, pre-exposure prophylaxis.
* High saturation value represents the maximum achievable coverage considering social and structural constraints on program access and uptake.

Table A4. Data inputs of impact of programs

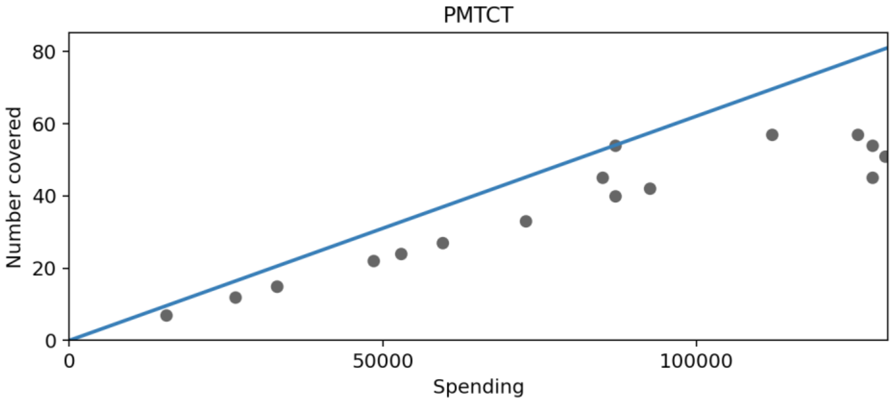
HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
FSW programs	Condom use for commercial acts	Clients, FSW	85%	85%	98%	99%
FSW programs	Condom use for commercial acts	PWID, FSW	81%	82%	98%	99%
FSW programs	Condom use for casual acts	Clients, FSW	40%	53%	84%	90%
FSW programs	Condom use for casual acts	PWID, FSW	50%	58%	80%	85%
FSW programs	Condom use for casual acts	Males 15-49, FSW	50%	50%	76%	76%
FSW programs	Condom use for casual acts	Males 50+, FSW	50%	50%	76%	76%
HTS	HIV testing rate (average tests per year)	FSW	0.00	0.00	0.47	0.56
HTS	HIV testing rate (average tests per year)	Clients	0.00	0.00	0.26	0.31

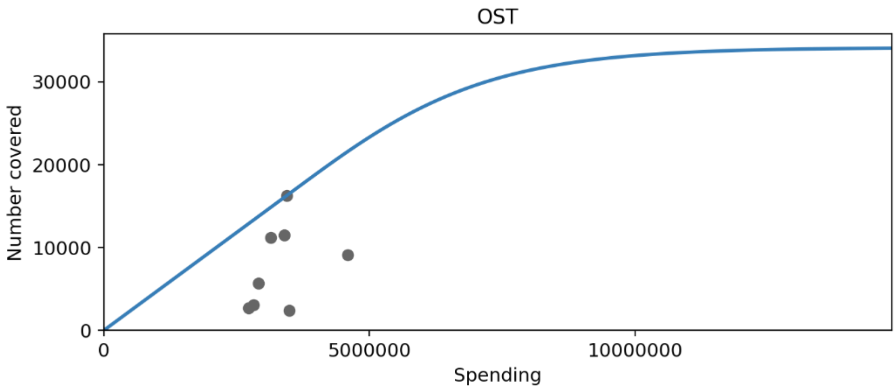
HTS	HIV testing rate (average tests per year)	MSMW	0.00	0.00	0.51	0.52
HTS	HIV testing rate (average tests per year)	PWID	0.00	0.00	0.70	0.83
HTS	HIV testing rate (average tests per year)	Males 0-14	0.00	0.00	0.07	0.07
HTS	HIV testing rate (average tests per year)	Females 0-14	0.00	0.00	0.07	0.07
HTS	HIV testing rate (average tests per year)	Males 15-49	0.00	0.00	0.31	0.31
HTS	HIV testing rate (average tests per year)	Females 15-49	0.00	0.00	0.31	0.31
HTS	HIV testing rate (average tests per year)	Males 50+	0.00	0.00	0.09	0.09
HTS	HIV testing rate (average tests per year)	Females 50+	0.00	0.00	0.09	0.09
MSM programs	Condom use for commercial acts	MSMW, MSMW	30%	35%	70%	80%
MSM programs	Condom use for casual acts	MSMW, MSMW	70%	70%	98%	99%
MSM programs	Condom use for casual acts	MSMW, Males 15-49	39%	39%	80%	80%
NSP	Probability of needle sharing (per injection)	PWID	16%	20%	1%	1%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	MSMW	0%	0%	100%	100%
OST	Number of PWID on OST	Total	0	0	-	-
PMTCT	Number of people on PMTCT	Total	0	0	-	-
ART	Number of people on treatment	Total	0	0	-	-
PMTCT	Number of people on treatment	Total	0	0	-	-

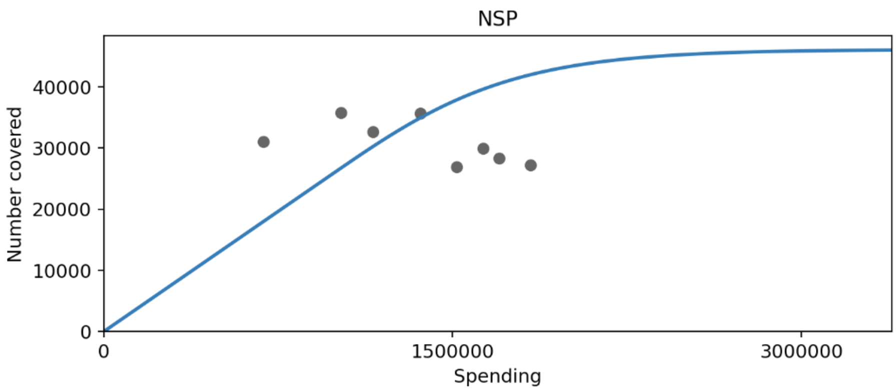
ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services targeting; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission; PrEP, pre-exposure prophylaxis.

- 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. Dots represent cost and coverage data from previous years for Georgia. Data sources include program data and GAM.







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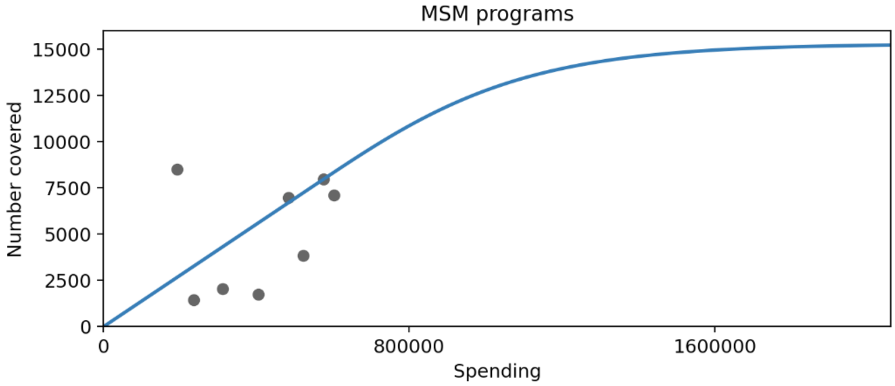
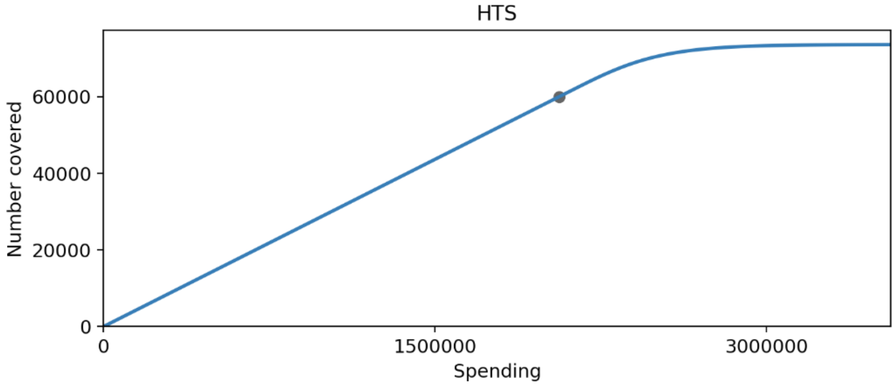
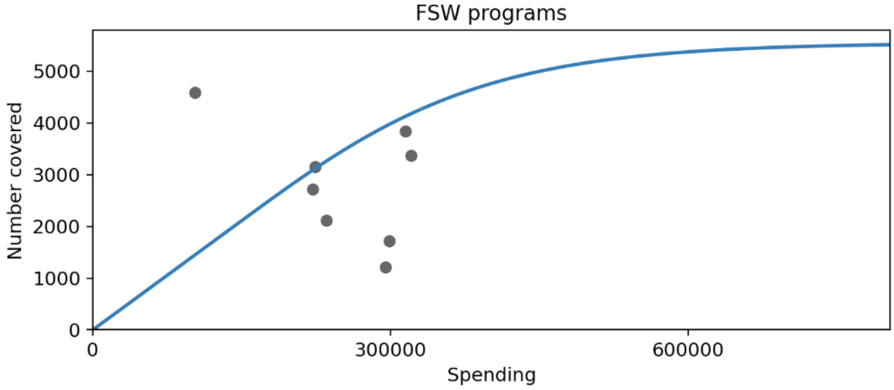
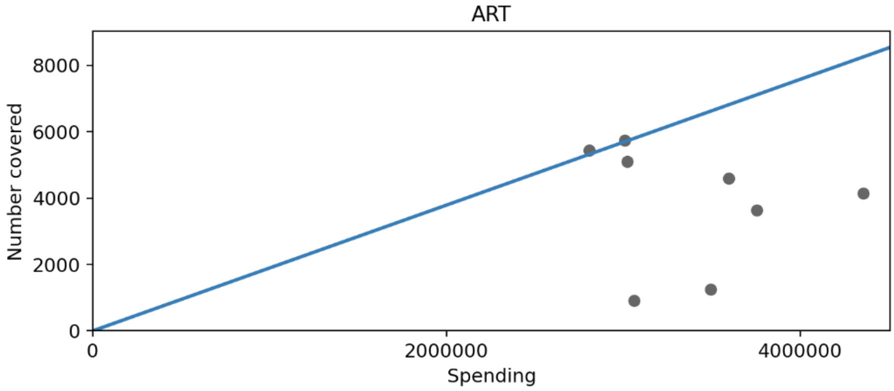
Allocation of HIV resources towards maximizing the impact of funding

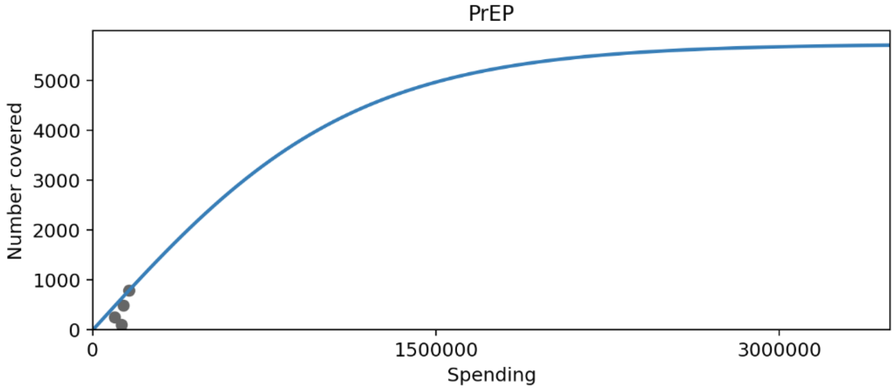








ART
Number covered
8000
6000
4000
2000
0
0
2000000
4000000
Spending



PrEP
Number covered
5000
4000
3000
2000
1000
0
0
1500000
3000000
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)	3,005,900	2,509,706	3,297,985	3,438,115	3,421,756	3,418,809
FSW programs	224,287	-	-	112,144	112,144	338,493
HIV testing services	2,062,056	-	352,194	2,181,665	2,608,149	2,976,743
MSM programs	575,188	-	756,930	871,709	1,382,278	1,786,467
Needle and syringe program	1,361,503	-	237,960	680,752	1,743,595	2,501,467
Opioid substitution therapy (OST)	3,445,990	2,877,149	3,445,990	3,445,990	3,445,990	3,445,990
Prevention of mother-to-child transmission (PMTCT)	87,000	72,639	98,182	110,083	110,384	110,368
PrEP	157,065	-	-	78,533	824,441	1,800,146
Total targeted HIV program budget	10,918,989	5,459,495	8,189,242	10,918,989	13,648,736	16,378,484

ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis.

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

	Latest reported budget (2021)
Enabling environment	$347,335
Human resources	$945,000
Infrastructure	$135,000
Monitoring and evaluation	$30,000
Management	$422,000
Other HIV care	$312,000
Other HIV costs	$2,834,033
Total non-targeted HIV program budget	$5,025,368

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