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

TAJIKISTAN

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Allocation of HIV resources towards maximizing the impact of funding

Executive Summary

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

Summary and key recommendations for HIV resource optimization include:

- Tajikistan has a concentrated HIV epidemic with a high prevalence among people who inject drugs (estimated 11-24% in 2021 (2)) and other key populations, including female sex workers, men who have sex with men, labor migrants and prisoners (latest estimated HIV prevalence 2.9%, 2.3%, 0.4% and 3.1%, respectively (2, 3)).
- In this analysis, we considered the baseline spending of US$3.9M on targeted HIV interventions in 2021, of which 32% was allocated to antiretroviral therapy (ART).
- In a baseline scenario with 2021 spending allocations maintained, including fixed annual spending on ART, there were estimated to be 3,187 new domestic HIV infections (i.e. not including migrants arriving with HIV), 1,977 HIV-related deaths and 53,532 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **Optimizing spending would involve continued scale up of ART and a shift in emphasis toward HIV programs for female sex workers and migrants while maintaining substantial investment in PWID programs.**
- This optimization prioritizes high impact interventions that address the current treatment gap, the high HIV incidence among female sex workers, as well as the large number of migrants living with HIV. Scaling up these programs could reduce mortality and new infections among all populations and prevent the epidemic expanding among female sex workers.
- Optimized reallocation of 2021 spending was estimated to avert 918 new infections (29%), 419 deaths (21%) and 9,670 DALYs (18%) over 2023-2030 relative to the baseline scenario of continued 2021 spending.
- **With additional resources, priorities were identified as investment in programs for people who inject drugs, continued scale up of programs for female sex workers and migrants.**
- Moving from the 73-83-84 care cascade modeled in 2021[1] to reach the 95-95-95 targets by 2030 will require progress particularly in increasing diagnoses and linking and retaining people on treatment. The optimized expansion of current programs at 300% of 2021 targeted spending is projected to be insufficient to reach the 95% diagnosis target by 2030, and novel programs may be needed to 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, strategies to reach people with historic risks, 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 Tajikistan had an estimated population size of 9.7 million and an estimated 13,000 people living with HIV (2, 4). Tajikistan has an HIV epidemic concentrated primarily among people who inject drugs (PWID), with an estimated prevalence of 11% and 24% among males and females who inject drugs in 2018 (2). Men who have sex with men (MSM) and female sex workers (FSW) are also disproportionately impacted by HIV, with estimated prevalence of 2.3% and 2.9% respectively in the 2018 (2). Recent data in this region suggests that HIV prevalence is increasing among these groups (5).

Labor migrants have been identified as an at-risk group for HIV infection in Tajikistan. It is estimated half a million people temporarily migrate every year for overseas employment, over 85% of whom are male (6). HIV prevalence among migrants was estimated to be 0.4% in 2018, however HIV test positivity rate in national program data is 1.3% (3). Given the large number of migrants and increased HIV vulnerability among mobile individuals, this key population is an important consideration for Tajikistan.

Prisoners are another key population in Tajikistan. There are approximately 10,000 prisoners in the country, and while HIV prevalence among prisoners has decreased from an estimated 8.4% in 2013 to an estimated 3.1% in 2020 (3), it still remains high. Prisoners are also a unique key population, as there is substantial overlap with other groups including PWID, FSW and MSM, and so prison may be a setting where existing programs could reach these groups.

National program data suggested that sexual transmission has become the predominant mode of transmission: during the period of 2002-2011, the percentage of new infections attributed to injection and sexual transmission was 60% and 36%, respectively; in the period of 2012-2021, the percentage of infections due to injection and sexual transmission was 18% and 70%, respectively (3).

The national response to the HIV epidemic is currently guided by the National Program to Counter the HIV and AIDS Epidemic in the Republic of Tajikistan (2021-2025). According to the global AIDS monitoring program, the total annual spending on HIV programs in Tajikistan in 2020 was approximately US$11.97 million from all funding sources (7). The majority of this funding was from international donors, with only around 29% coming from domestic sources in 2020 (7). Coverage of the government-funded antiretroviral therapy (ART) program has more than doubled over the past five years, from 3,890 people on ART in 2016 to 8,740 people on ART in 2021 (2, 3), and to enhance the HIV response Tajikistan intends to further increase treatment coverage, as well as coverage of services for key populations.

Previous HIV allocative efficiency analyses were conducted in 2014 and 2019 using the Optima HIV model (8, 9), with support from the World Bank, UNAIDS, the Global Fund, and other partners. This is the third Optima HIV analysis in Tajikistan, 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 Tajikistan Ministry of Health, Republican AIDS Center, and UNDP Tajikistan country office. 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, IBBS surveys, national reports and systems were collated.

The baseline HIV spending used in this analysis was derived from national program data and does not represent all spending; in 2021 this was US$4.8 million, which is only about 40% of the total reported in the 2020 global AIDS monitoring program. The analysis does not include other donor programs, for example United States Agency for International Development (USAID) spent an estimated US$1.4 million on projects, however, this spending could not be included in due to the lack of coverage data disaggregated by programs. The analysis was also based on only targeted HIV spending for programs with a direct and quantifiable impact on HIV parameters included in the model, which amounted to US$3.9M of the total US$4.8M.

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. A detailed description of the Optima HIV model is available in Kerr et al (10).

3.1 Populations and HIV programs

Populations and HIV programs considered in this analysis were:

- Key populations
  - Female sex workers (FSW)
  - Clients of female sex workers (Clients)
  - Men who have sex with men (MSM)
  - Males who inject drugs (MWID)
  - Females who inject drugs (FWID)
  - Labor migrants (migrants)
- General populations
  - Males 0-14 (M0-14)
  - Females 0-14 (F0-14)
  - Males 15-49 (M15-49)
  - Females 15-49 (F15-49)
  - Males 50+ (M50+)
  - Females 50+ (F50+)
- Targeted HIV programs
  - Antiretroviral therapy (ART)
  - Prevention of mother to child transmission (PMTCT)
  - HIV testing and prevention for PWID, including needle-syringe program (NSP; PWID programs)
  - HIV testing and prevention for FSW (FSW programs)
  - HIV testing and prevention for MSM (MSM programs)
  - HIV testing and prevention programs for migrants (Migrant programs)
  - HIV testing services (HTS) for the general population (includes HIV testing services for pregnant women and newly married couples)

Of note, prisoners are considered a key population in Tajikistan, however limited risk behavior data in prisons as well as significant overlap with other key population groups, including PWID, FSW and MSM, poses a challenge to estimate program effectiveness and coverage in prisons. Therefore, while prisoners were not included as an explicit key population in the model, they should be a key part of the HIV response.

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. Additionally, HTS for the general population program was set to not increase by more than 100% due to practical considerations of expanding the program given that testing is provided on a needs basis to pregnant women and newly married couples.

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, 150 and 200 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?*

2021 HIV spending. In Tajikistan total spending on HIV included in current analysis was US$4.8 in 2021, incorporating US$3.9M targeted HIV spending for the programs considered above and US$0.7M non-targeted spending. The majority of targeted spending was for ART (32%), followed by 30% and 14% for HIV testing and prevention programs for PWID and FSW, respectively (Figure 2; Table A5). Non-targeted spending, which was not included in the optimization analysis, encompassed human resources, management, and infrastructure costs as well as programs supporting an enabling environment and some HIV care costs (Table A6).

Resource needs to maintain 2021 ART coverage. In 2021, estimated ART coverage among diagnosed people living with HIV was 87%. If ART unit costs (estimated US$143 in

2021) and current coverage of other HIV programs remained constant, annual ART spending would need to increase by US$1.6M (30% 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 treatment adherence were not modeled or costed in this analysis. Although treatment is available to all diagnosed people living with HIV in Tajikistan, 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).

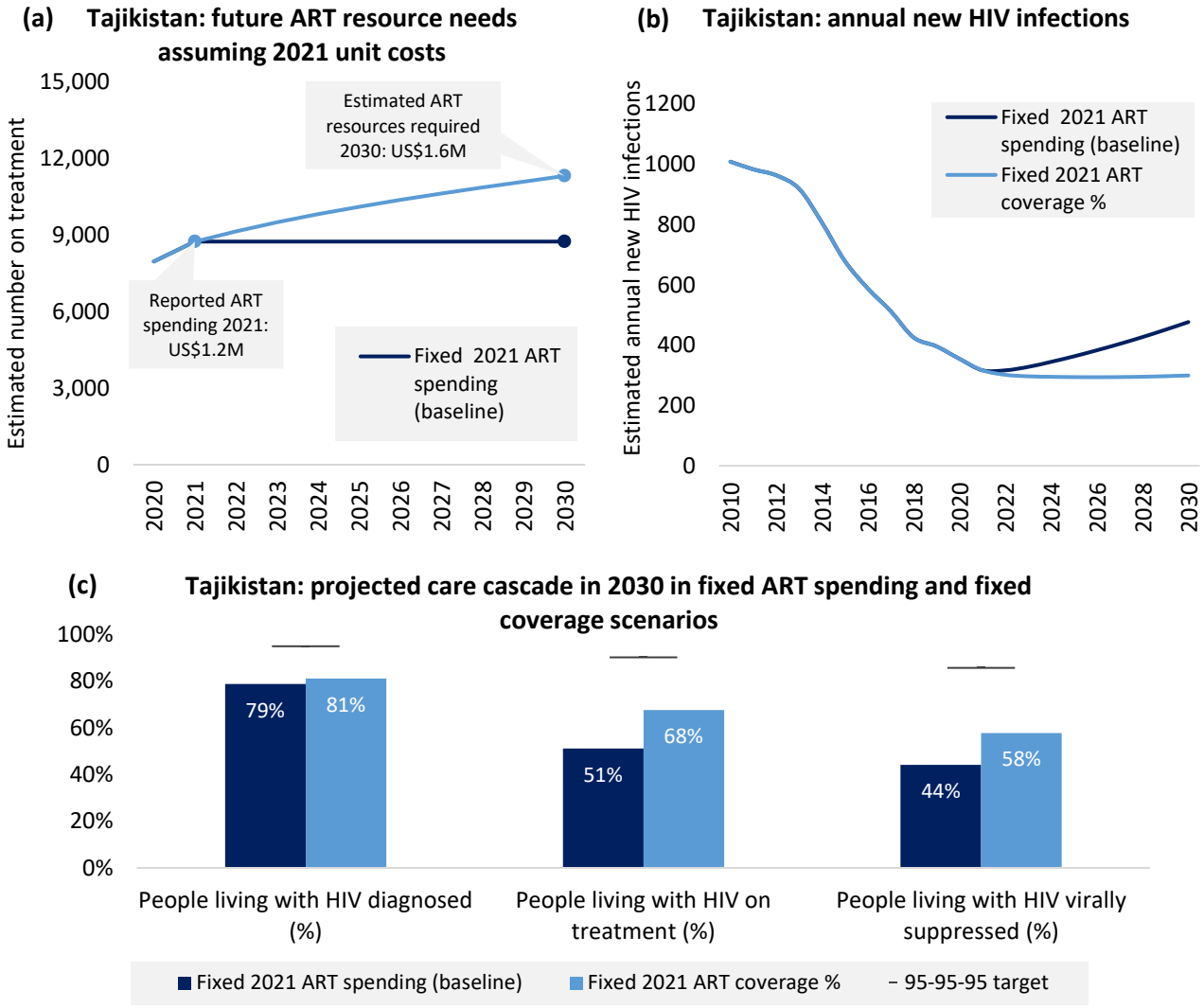

Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021 proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant; (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 3,187 new HIV infections, 1,977 HIV-related deaths and 53,532 HIV-attributable DALYs over 2023-2030. The HIV care cascade in this scenario was "79-65-86" in the year 2030 (i.e. 79% people diagnosed, 65% people diagnosed on treatment and 86% people on treatment virally suppressed) (Figure 1c). The low 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 reallocating some spending from HTS (for general population), and prevention programs for PWID and MSM to enable further scale-up of ART, testing and prevention programs for FSW, as well as testing and prevention programs for migrants. This is because in the calibrated model up to 17% of diagnosed people living with HIV are not yet on treatment. If these diagnosed people could be accessed for treatment through enhanced linkage to care and adherence programs, then closing the treatment gap through increased investment in ART could reduce mortality as well as new infections through treatment-as-prevention. Increasing testing and prevention programs for FSW is also critical, since the incidence of HIV among FSW is estimated to be higher than all other population groups; in the model 29% of new infection occurred among FSW and their clients in 2021. The suggested optimized budget allocation prioritizes programs for migrants for several reasons. While the prevalence of HIV among migrants is relatively lower than other key population groups, the large population size of migrants means that they account for a significant proportion of people living with HIV in Tajikistan, an estimated 18% in 2021, and this proportion is expected to increase over time. Migrant programs have a direct impact on reducing new infections among FSW and the general female population through increased use of condoms, as well as reducing HIV-related deaths by ensuring that migrants get tested and treated. Additionally, the estimated cost of migrant programs is much cheaper, at US$8.03 per person, compared to HIV testing and prevention programs for other key population groups, which range from US$43 to US$89 per person.

Programs for PWID were deprioritized in the theoretical optimization not because they are not effective or important, but because of the high impact and cost-effectiveness of ART at preventing mortality and new infections among all populations. However importantly, PWID programs were still allocated 24% of total funding in the budget optimization and still form a major component of the HIV response. While a slight change in focus to programs for FSW and migrants is warranted given the rising prevalence, it is important to note the importance of PWID programs in contributing to the decline in HIV prevalence among PWID and to prevent epidemic rebound.

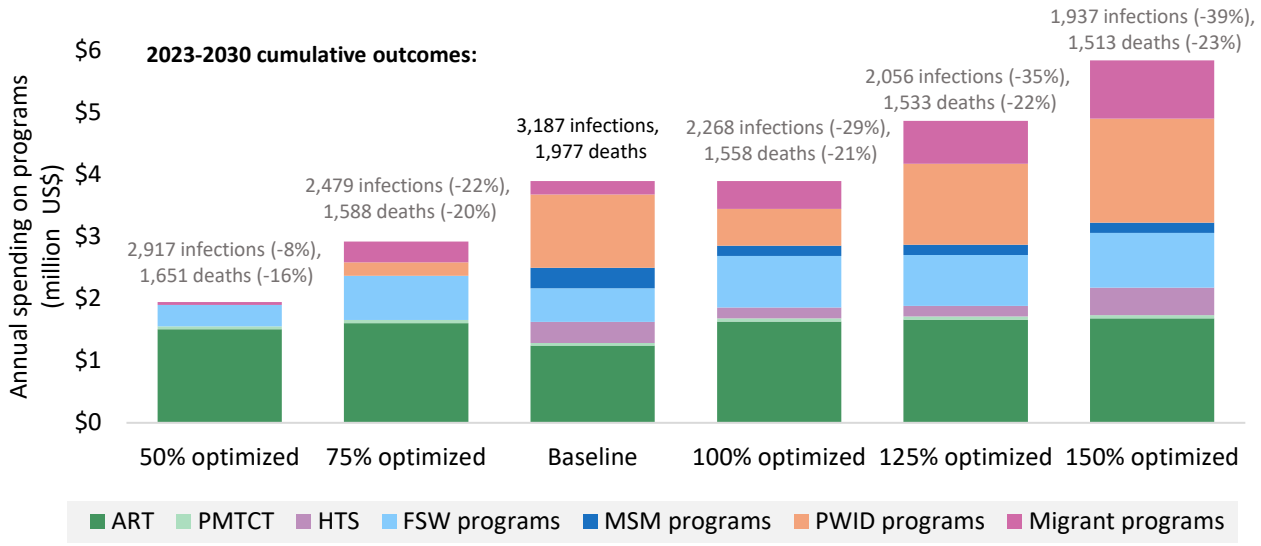

Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030. Percentage optimized refers to the percentage of baseline HIV spending (i.e. 2021 spending). ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs. N.B. HTS gen pop refers to HIV testing program for the general population (specifically for pregnant women and newly married couples) in the current analysis.

Optimized resource allocation at different budget levels. As the total budget envelope increased, the priorities were identified as increasing investment in programs for PWID and continued scale up of programs for FSW and migrants. Beyond 150% budget most modeled programs approach saturation levels where increased investment had diminishing returns. The exception was migrant programs, with potential to increase coverage with higher investment.

If funding were reduced, maintaining as many people on treatment as possible was prioritized, followed by prevention programs for FSW and migrants.

Impact of optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending could avert 918 new infections (29%), 419 deaths (21%) and 9,670 DALYs (18%) over 2023-2030. The benefits increase to 39% of infections, 23% of deaths and 20% of DALYs averted, compared to the baseline scenario with an optimized 150% budget (Figure 3; Table 1).

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.

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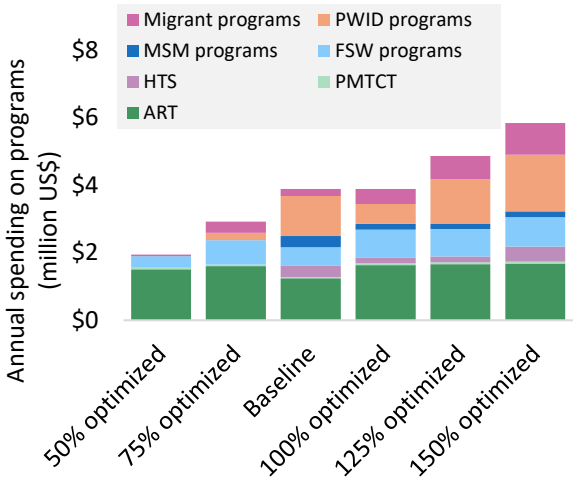
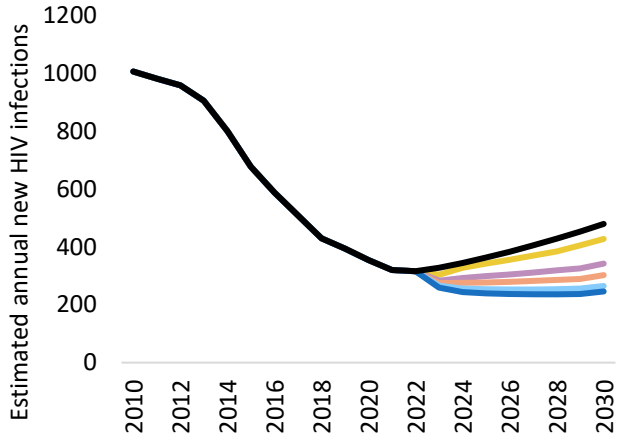
Allocation of HIV resources towards maximizing the impact of funding

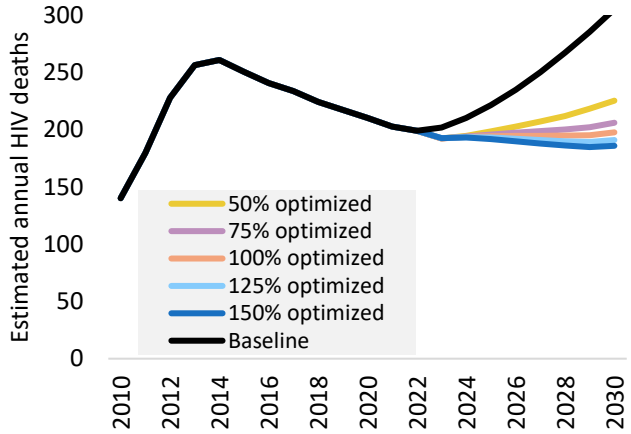
(a) Tajikistan: budget optimizations



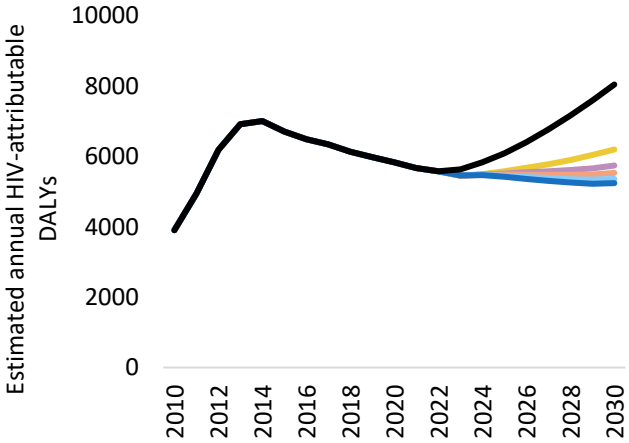
(b) Tajikistan: annual new HIV infections in budget optimizations



(c) Tajikistan: annual HIV deaths in budget optimizations



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



(e) Tajikistan: projected care cascade

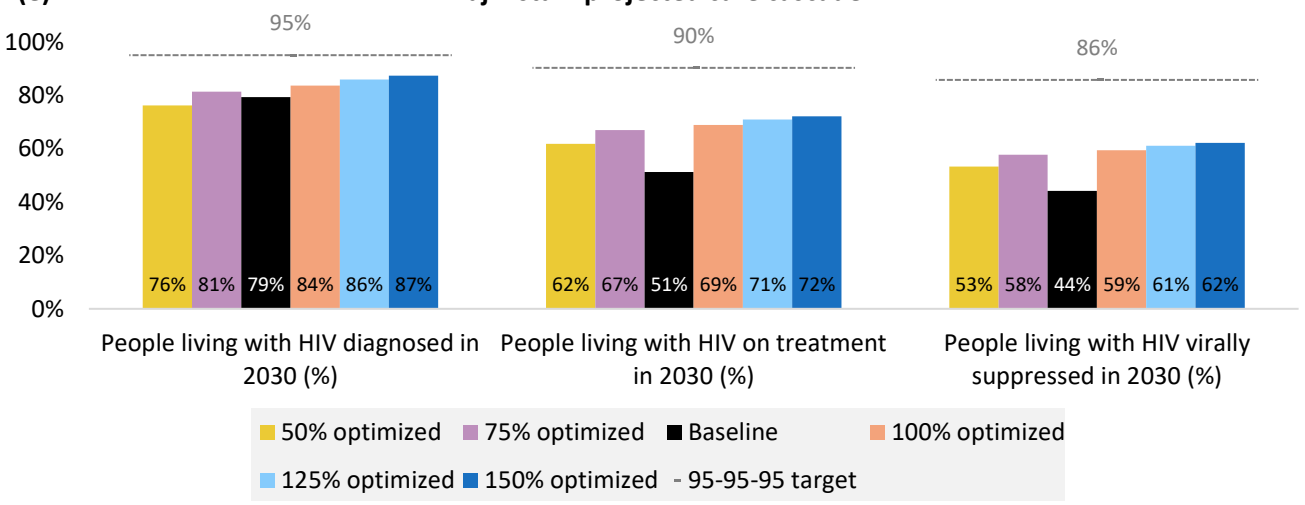


Figure 3. Model outcomes from budget optimization scenarios aiming to minimize infections and deaths. Panels show (a) optimal budget allocations; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) projected care cascade for the year 2030. ART, antiretroviral therapy; DALY, disability-adjusted life years; FSW, female sex worker; GP, general population; HTS, HIV testing services; MSM, men who have sex with men; NSP, Needle-syringe program; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs. N.B. HTS gen pop refers to HIV testing program for the general population (specifically for pregnant women and newly married couples), in current analysis for Tajikistan.

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 9,145 (+287%) more new infections, 5,526 (+279%) more deaths and 128,644 (+240%) more DALYs over 2023-2030 compared to the baseline scenario of fixed annual spending on programs (Table 1).

Table 1. Cumulative new HIV infections, 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	12,332	7,504	182,175	287%	279%	240%
50% optimized	2,917	1,651	46,121	-8%	-16%	-14%
75% optimized	2,479	1,588	44,597	-22%	-20%	-17%
Baseline	3,187	1,977	53,532			
100% optimized	2,268	1,558	43,862	-29%	-21%	-18%
125% optimized	2,056	1,533	43,249	-35%	-22%	-19%
150% optimized	1,937	1,513	42,753	-39%	-23%	-20%
*95-95-95**	1,290	1,122	34,122	-60%	-43%	-36%

Percentage optimized refers to percentage of baseline spending.

* Optimization was only able to reach 92-95-95; refer to section 4.3

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, Tajikistan'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$7.8M per annum, or a total 300% of targeted HIV spending, will only increase diagnosis of people living with HIV to 92% by 2030. In Tajikistan a challenge to reaching the diagnosis target is the ongoing return of labor migrants who have acquired HIV in other countries. Even with high program coverage, early detection among this group is challenging. This also highlights that reaching HIV targets requires a global effort. Another critical gap is that people with historical risks and clients of female sex workers are not reached by current services. Additional programs that focus prevention and testing services to people at high past or present risk (e.g. former sex workers or people with a history of injecting drug use) may make it possible to reach the 95% diagnosis target more cost-efficiently. Although not modeled, delivery approaches and modalities for HTS can also be strategically utilized to better reach undiagnosed people living with HIV even with reduced resources, such as through index testing and social network testing strategies, tailored demand creation, task shifting and HIV self-testing, and focused provider-initiated testing; this approach might lead to better efficiency than current methods which mostly focus on pregnant women and newlyweds.

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 Tajikistan to improve linkage to care, treatment adherence and retention to achieve 95% treatment coverage and 95% viral suppression.

Achieving "92-95-95" in this optimized scenario could avert 1,897 new infections (60%), 855 deaths (43%) and 19,410 DALYs (36%) 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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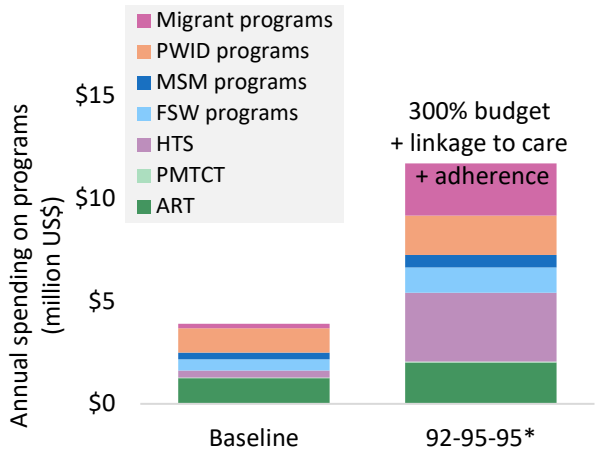
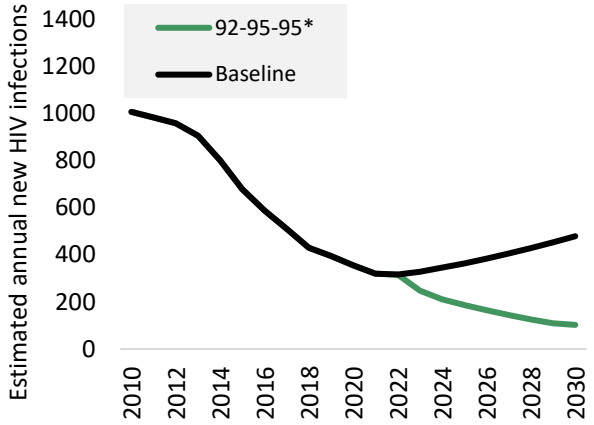
Allocation of HIV resources towards maximizing the impact of funding

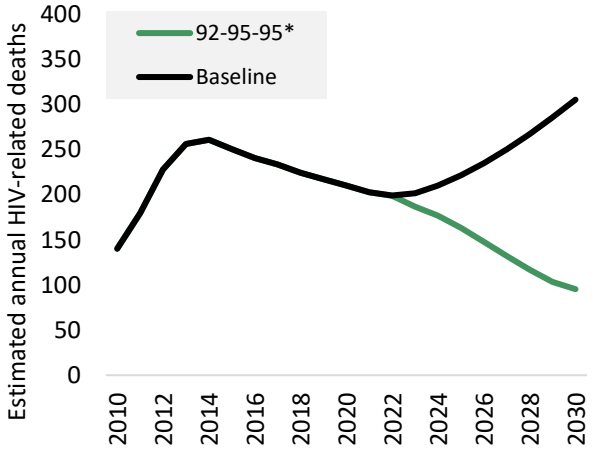
(a) Tajikistan: optimized budget to reach 95-95-95 targets



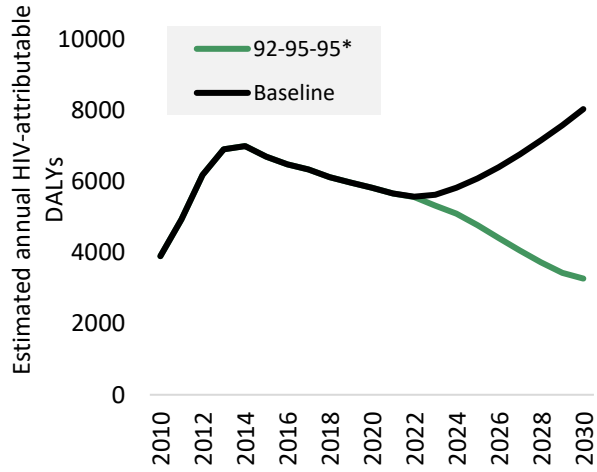
(b) Tajikistan: annual new HIV infections in 95-95-95 scenario



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



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



(e) Tajikistan: projected care cascade

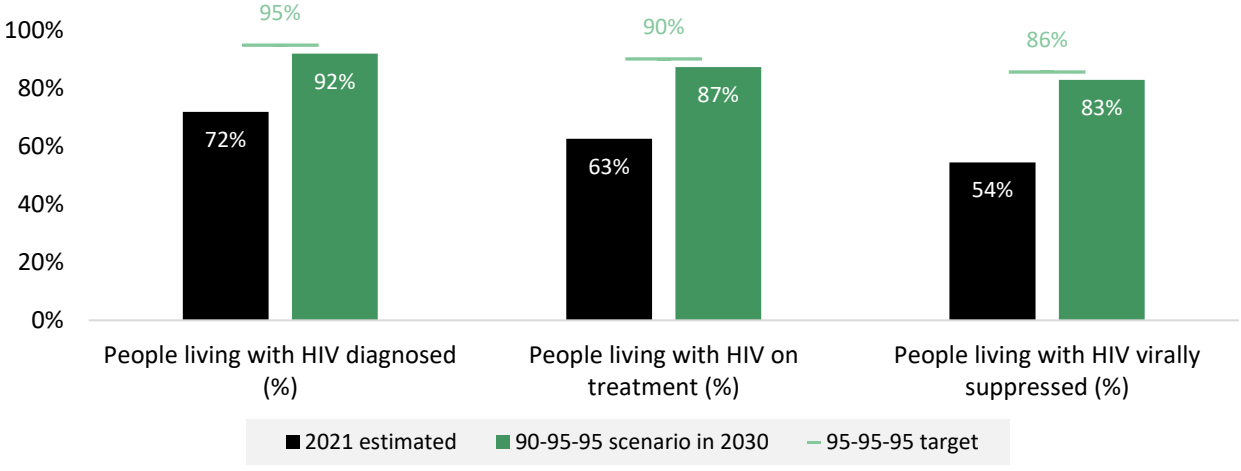


Figure 4. Optimized HIV budget level and allocation to achieve 90-95-95 targets by 2030. Panels show (a) optimal budget allocations; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) estimated care cascade in baseline year 2021 and 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; GP, general population; HTS, HIV testing services; MSM, men who have sex with men; NSP, Needle-syringe program; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs. N.B. HTS gen pop refers to HIV testing program for the general population (specifically for pregnant women and newly married couples), in current analysis for Tajikistan.
* Optimization was only able to reach 92-95-95.

5 Comparison with past spending

Spending on targeted HIV programs has decreased over time, from US$4.2M in 2018 to US$3.9M in 2021 (Figure 5). Despite the total spending on ART decreasing, reductions in unit cost (from US$365 in 2018 to US$143 in 2021) have enabled treatment coverage to increase. This treatment scale-up has likely played an important role in reducing both new infections and deaths, and the reduced total costs have enabled additional resources to be invested in other programs. It is evident that there has been increased emphasis on HIV testing and prevention programs focusing on migrants, PWID, and FSW despite decreased total budget. These changes are consistent with recommendations from previous allocative efficiency analyses and would likely have improved the cost-effectiveness and impact of investment. Note that the costs of condom procurement and HIV testing have been incorporated into the unit costs of program for FSW, MSM and PWID in 2021, meaning that the programs and spending are not directly comparable between analyses.

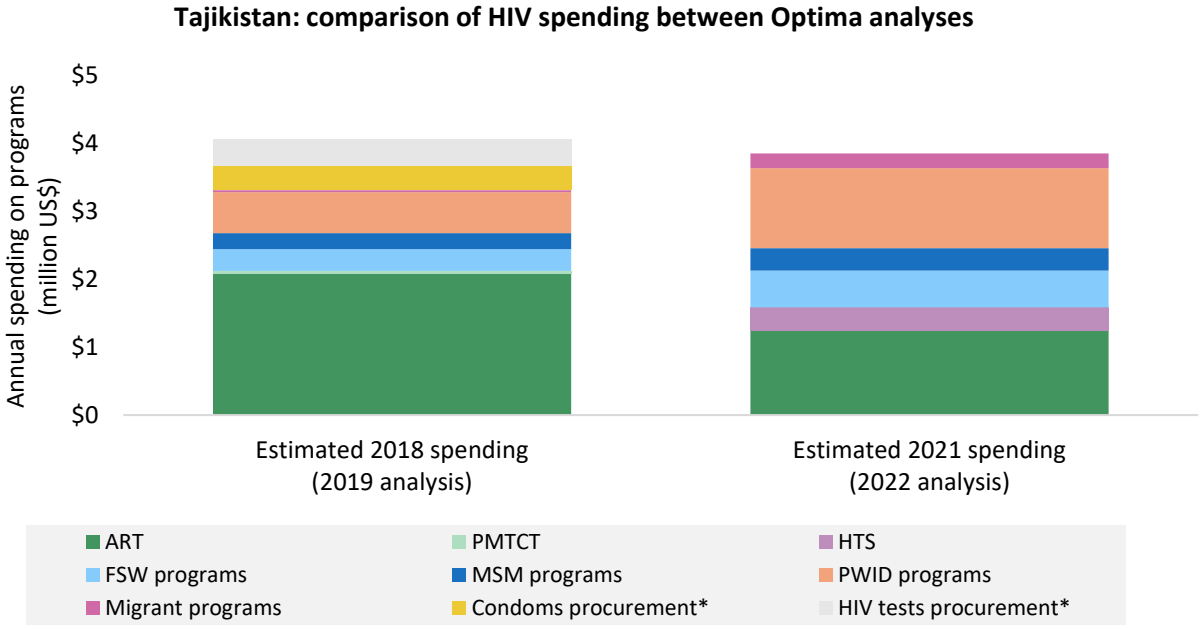


Figure 5. Estimated budget allocations from 2019 and 2022 Optima analyses. Note that in 2021 the costs of condom and HIV test procurement for key population were incorporated into prevention programs for FSW, MSM and PWID, meaning the programs are not directly comparable. HTS gen pop refers to HIV testing program for the

general population (specifically for pregnant women and newly married couples), which is a new program added to 2022 analysis). ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs.

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.
- **Retention in care:** This analysis did not consider programs that could improve linkage and retention in care for people diagnosed, or viral suppression for people on treatment. These programs will be essential to achieving the 95-95-95 targets and future analyses should focus on quantifying the spending and impacts of relevant programs.
- **Other efficiency gains** such as improving technical or implementation efficiency were not considered in this analysis.
- **Equity** in program coverage or HIV outcomes was not captured in the model but should be a key consideration in program implementation. Policy makers and funders are encouraged to consider resources required to improve equity, such as through investment in social enablers to remove human rights-based barriers to health, and technical or implementation efficiency gains. In addition, prevention programs may have benefits outside of HIV, such as for sexually transmitted infections, hepatitis C,

and community empowerment. These were not considered in the optimization but should be factored into programmatic and budgeting decisions.

- **Currency:** The COVID-19 pandemic, war in Ukraine and global economic crises have led to instability in currencies over the past few years. Cost data were provided in US dollars, and when data were reported in Tajikistan Somoni, an exchange rate of 1 US dollar to 11.30 Somoni was applied as suggested by the country team. Spending is reported in US$, but what this value represents in local currency may change over time in unknown ways.

7 Conclusions

This modeling analysis evaluated the allocative efficiency of direct HIV programs in Tajikistan, 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, an increased focus on testing and prevention programs for FSW, and maintaining substantial investment in PWID programs, followed by programs for migrants and MSM. 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.

Acknowledgements

This Optima HIV modeling analysis was conducted as a collaboration between the Tajikistan country team and international partners.

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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

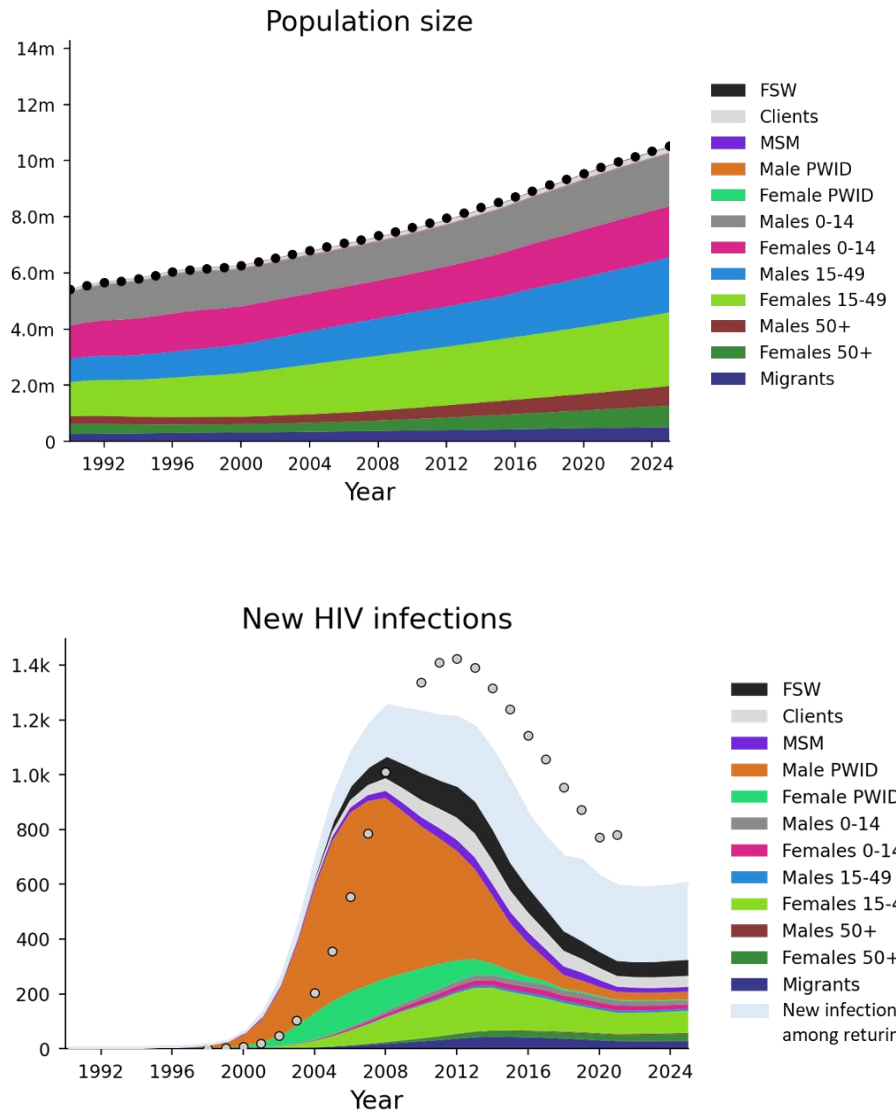
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

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 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.



Note: labor migrants who acquire HIV infections in other countries and return to Tajikistan are included in current new infection plot, on top of new domestic HIV infections.

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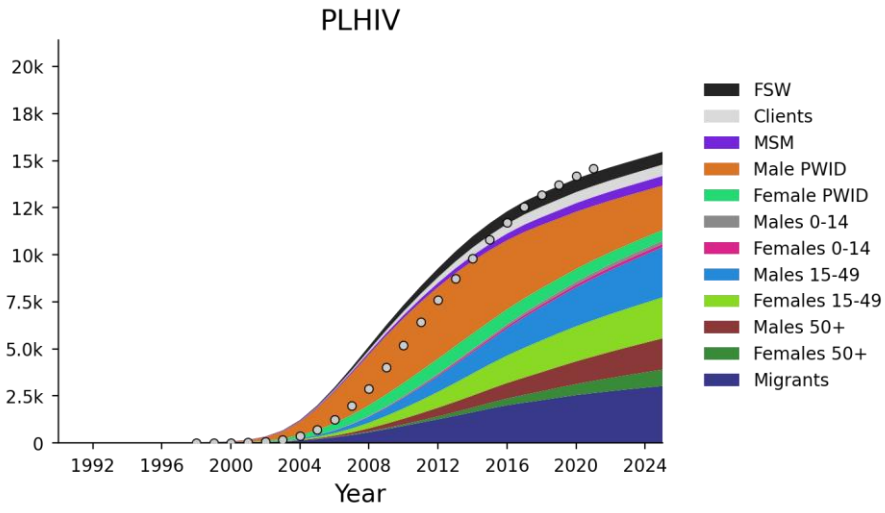

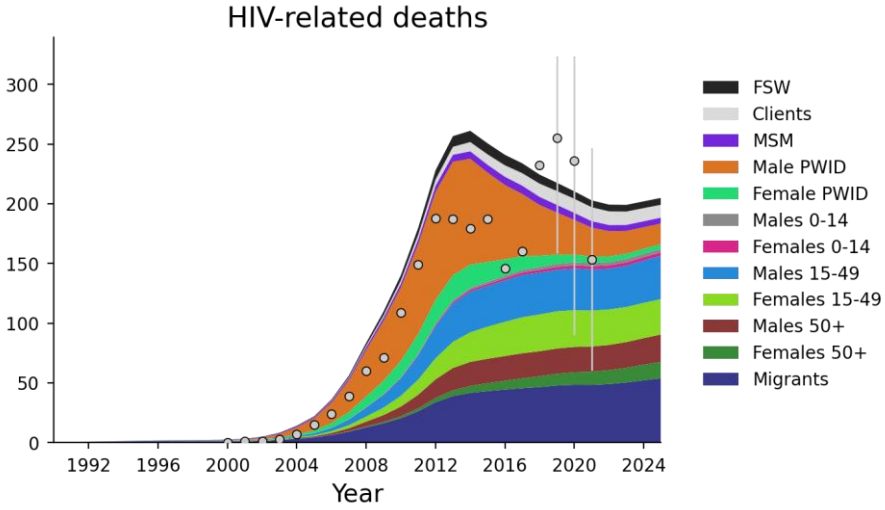

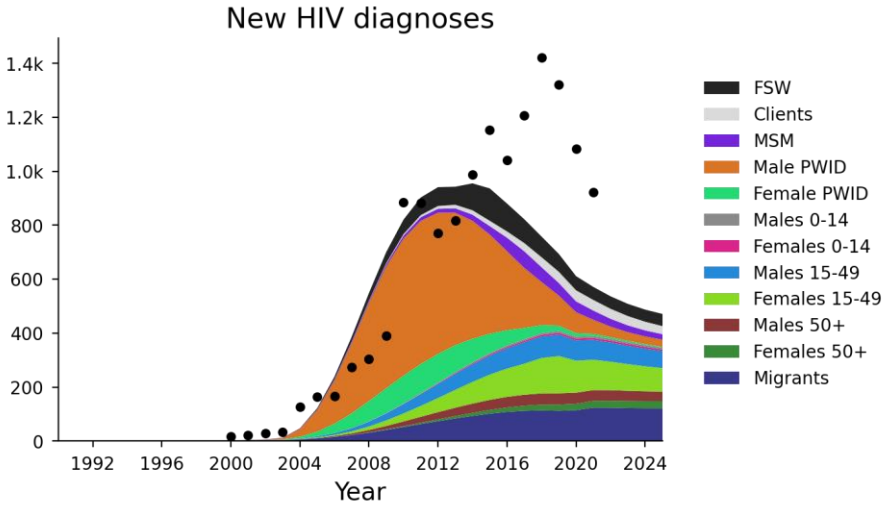

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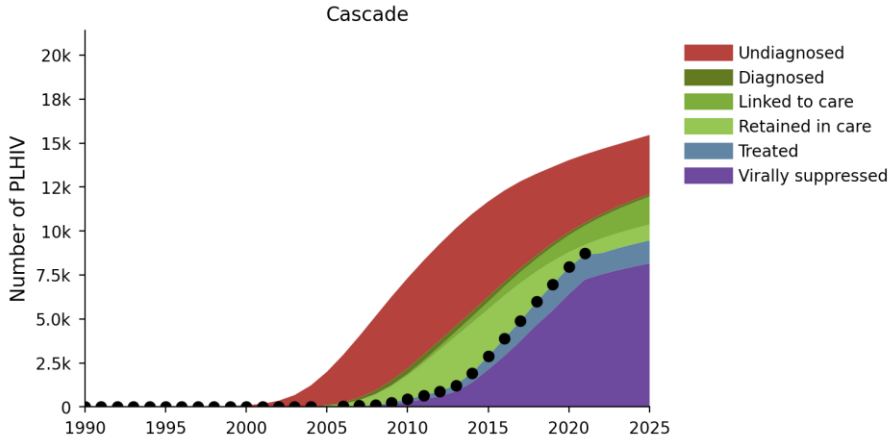

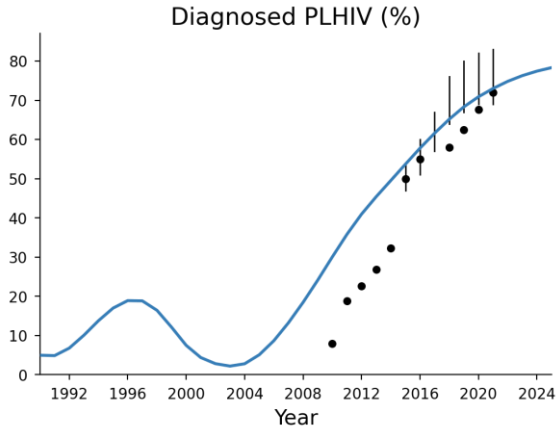

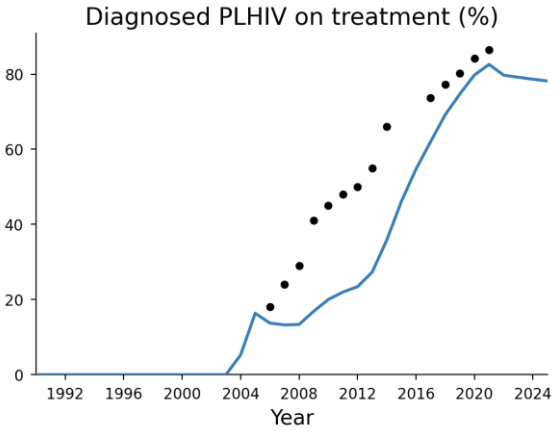

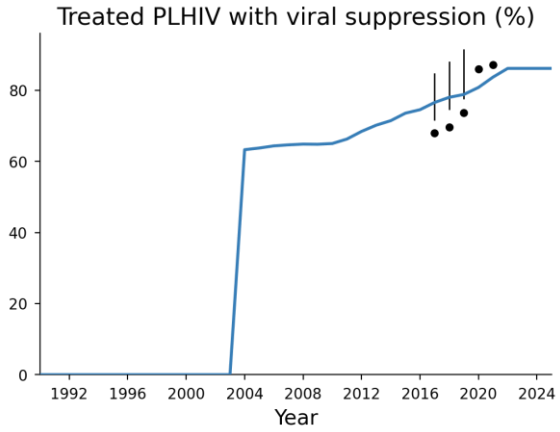

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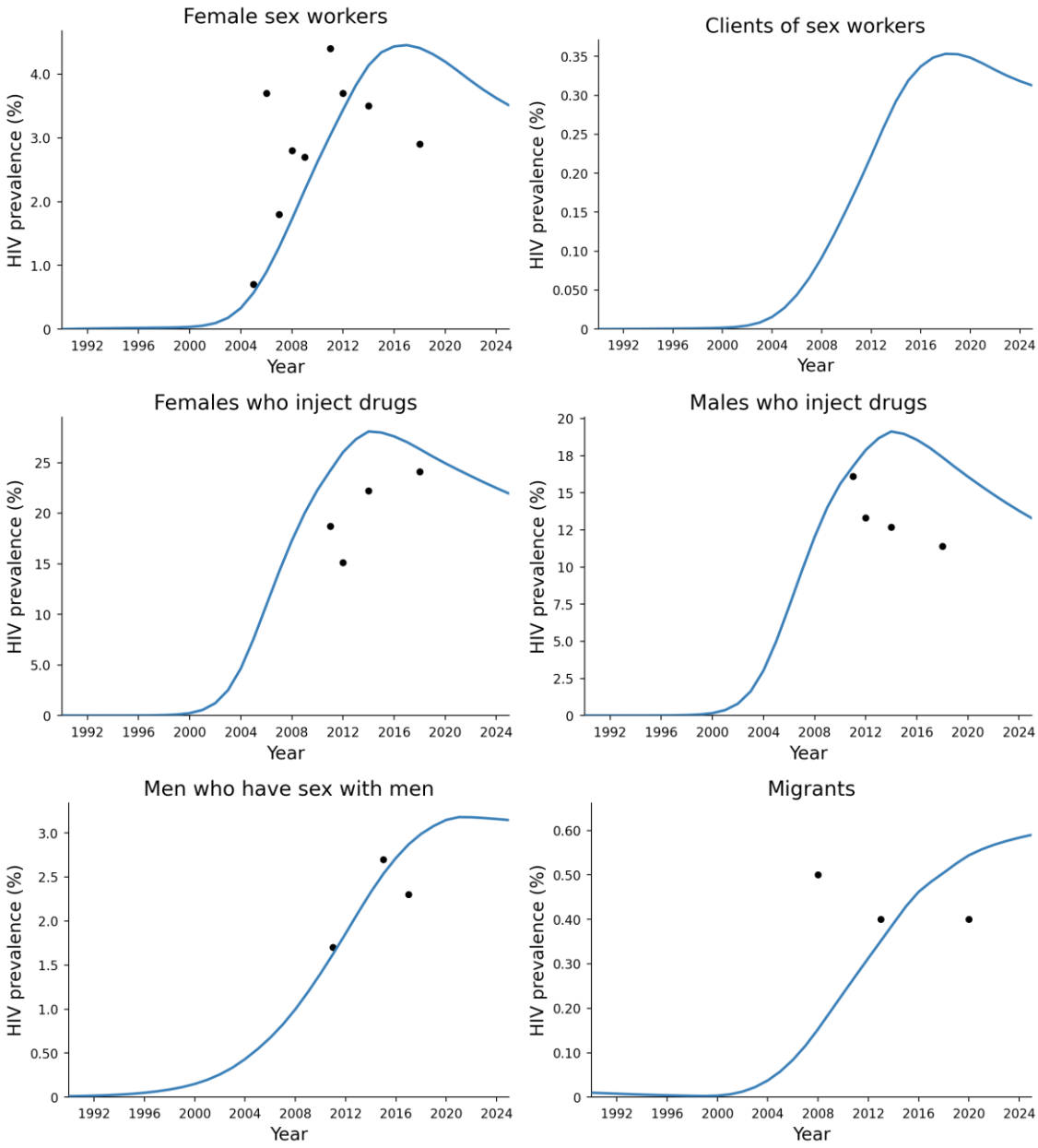

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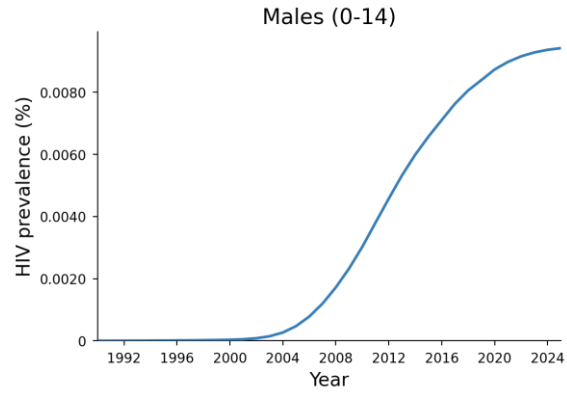
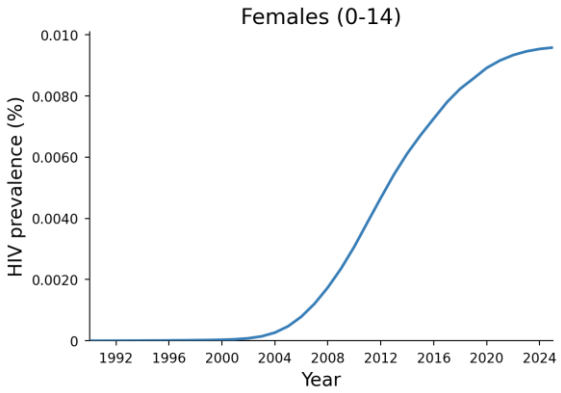
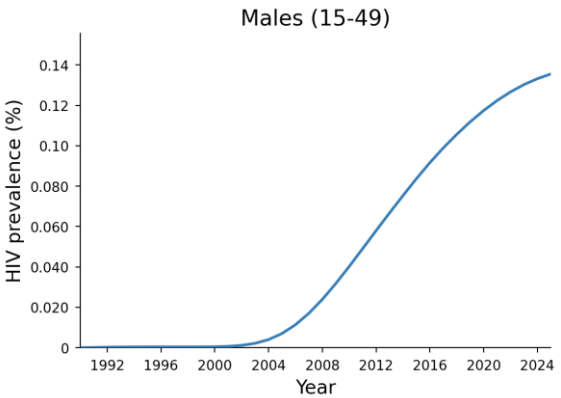
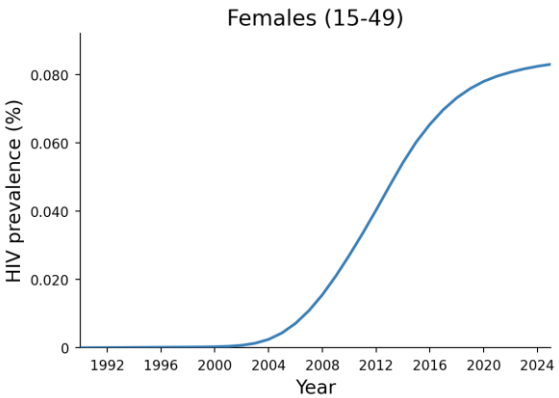
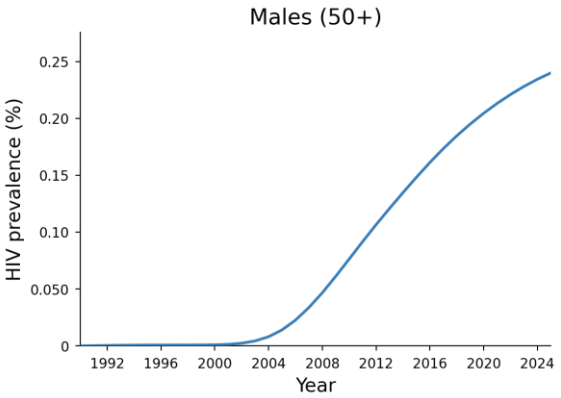
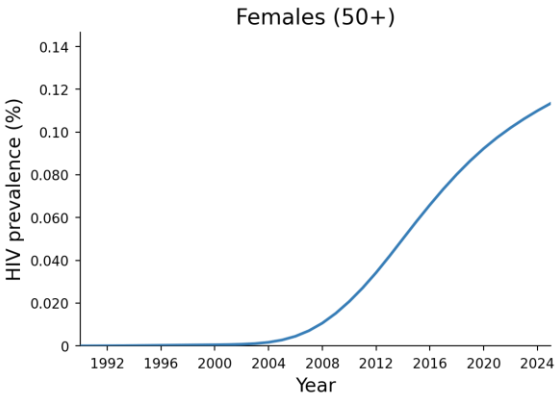












Appendix 3. HIV program costing and impacts

Table A3. HIV program unit costs and saturation values

HIV program	Unit cost (USD)*^	Saturation (low)	Saturation (high)
Antiretroviral therapy	$142.55	95%	100%
PMTCT[#]	$177.63	95%	100%
HIV testing and prevention programs for FSW	$53.44	50%	85%
HIV testing and prevention programs for MSM	$43.25	50%	85%
HIV testing and prevention programs, including NSP, for PWID	$88.86	60%	85%
HIV testing and prevention programs for migrants	$8.03	5%	70%
HIV testing services (general population; for pregnant women and newly married couples)	$0.91	5%	50%

ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; NSP, Needle-syringe program; PMTCT, Prevention of mother-to-child transmission; PWID, people who inject drugs.

[#] Estimated number of women who received ART for PMTCT was 216 in 2021 (2); unit cost was estimated using total sending and the estimated PMTCT coverage.
* Procurement costs of HIV tests and condoms were provided separately, but for FSW, MSM, PWID and migrants have been added to other program costs to give a single unit cost.

^ An average unit cost across 2019-2021 was calculated for each program, to account for the varied spending in each year due to procurement activities.

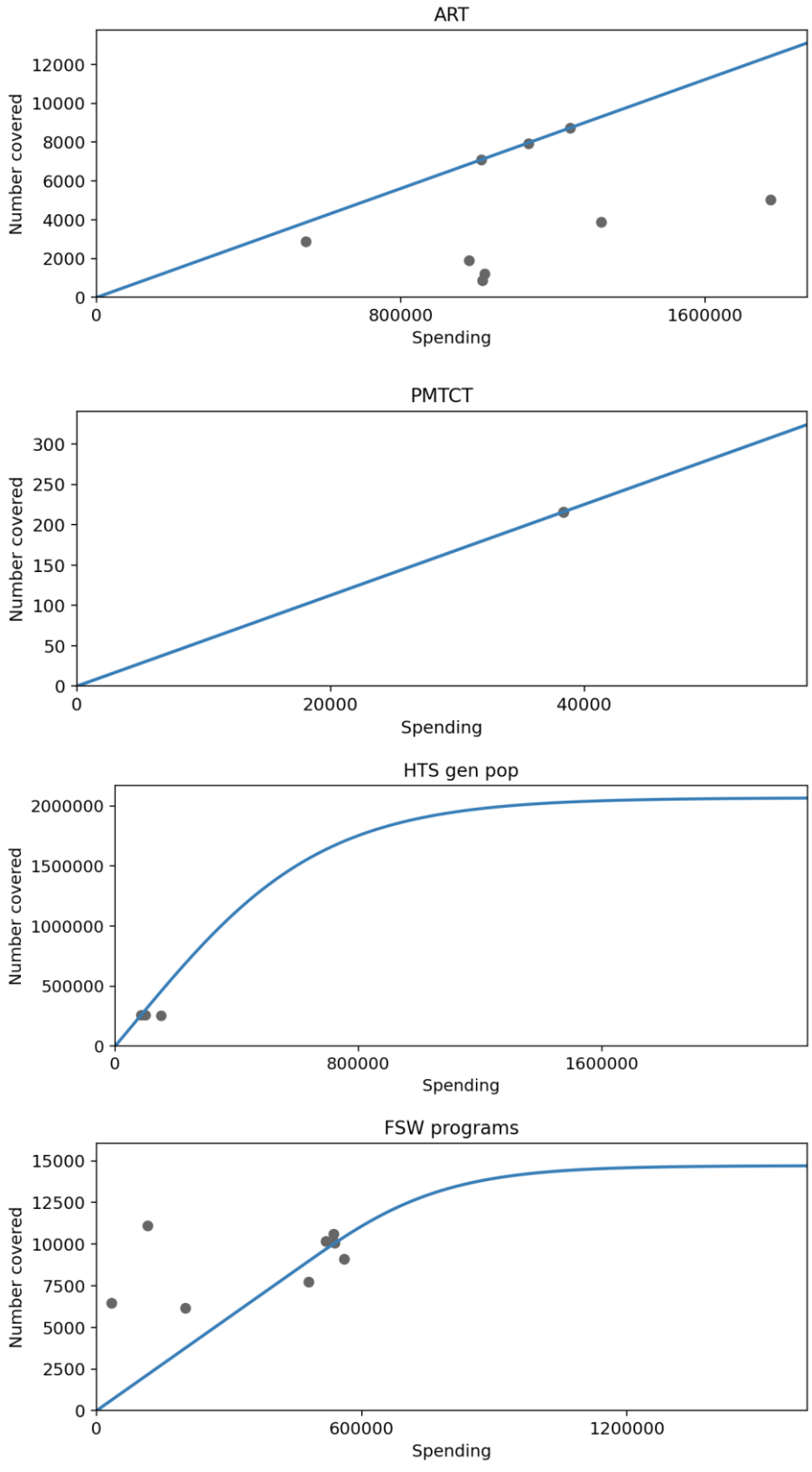
Table A4. Data inputs of impact of programs

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 casual acts	Male PWID, FSW	25%	30%	40%	50%
FSW programs	Condom use for casual acts	Males 15-49, FSW	35%	38%	50%	80%
FSW programs	Condom use for casual acts	Migrants, FSW	15%	15%	40%	45%
MSM programs	Condom use for casual acts	MSM, MSM	60%	65%	99%	100%
PWID programs	Condom use for casual acts	Male PWID, FSW	25%	30%	40%	50%
PWID programs	Condom use for casual acts	Male PWID, Female PWID	20%	40%	50%	70%

PWID programs	Condom use for casual acts	Male PWID, Females 15-49	20%	25%	30%	50%
Migrants	Condom use for casual acts	Migrants, FSW	15%	15%	45%	45%
Migrants	Condom use for casual acts	Migrants, Females 15-49	20%	20%	40%	50%
Migrants	Condom use for casual acts	Migrants, Females 50+	20%	20%	40%	50%
FSW programs	Condom use for commercial acts	Clients, FSW	40%	45%	68%	90%
FSW programs	Condom use for commercial acts	Male PWID, FSW	25%	25%	52%	80%
FSW programs	Condom use for commercial acts	Migrants, FSW	20%	20%	45%	78%
FSW programs	HIV testing rate (average tests per year)	FSW	0.05	0.20	0.70	0.80
MSM programs	HIV testing rate (average tests per year)	MSM	0.05	0.18	0.50	0.80
PWID programs	HIV testing rate (average tests per year)	Male PWID	0.05	0.10	1.30	1.38
PWID programs	HIV testing rate (average tests per year)	Female PWID	0.05	0.10	1.30	1.40
Migrants	HIV testing rate (average tests per year)	Migrants	0.00	0.00	0.45	0.45
HTS gen pop	HIV testing rate (average tests per year)	Males 15-49	0.01	0.02	0.30	0.40
HTS gen pop	HIV testing rate (average tests per year)	Females 15-49	0.05	0.12	0.40	0.50
PWID programs	Probability of needle sharing (per injection)	Male PWID	10%	15%	0%	0%
PWID programs	Probability of needle sharing (per injection)	Female PWID	10%	15%	0%	0%
Migrants	Proportion of people living with HIV who immigrate who are diagnosed prior to arrival	Migrants	30%	40%	90%	100%
PMTCT	Number of people on PMTCT	Total	0	0	-	-
ART	Number of people on treatment	Total	0	0	-	-

ART, antiretroviral therapy; FSW, female sex worker; HTS gen pop, HIV testing services for general population; MSM, men who have sex with men; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs.
- The number of people modeled as receiving ART and PMTCT 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 population of each program.



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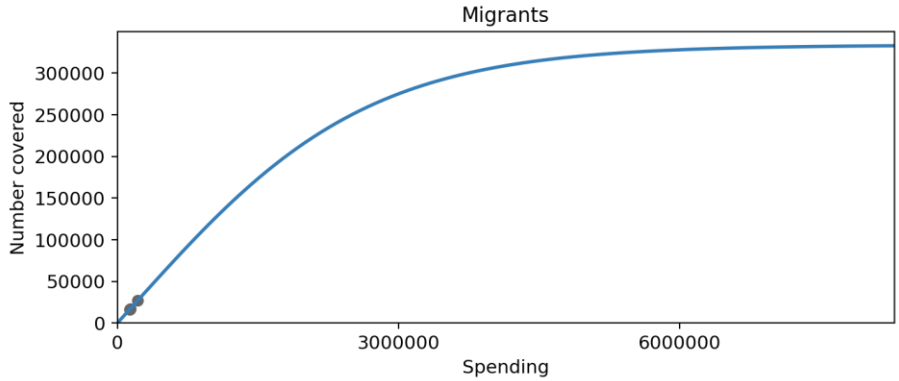

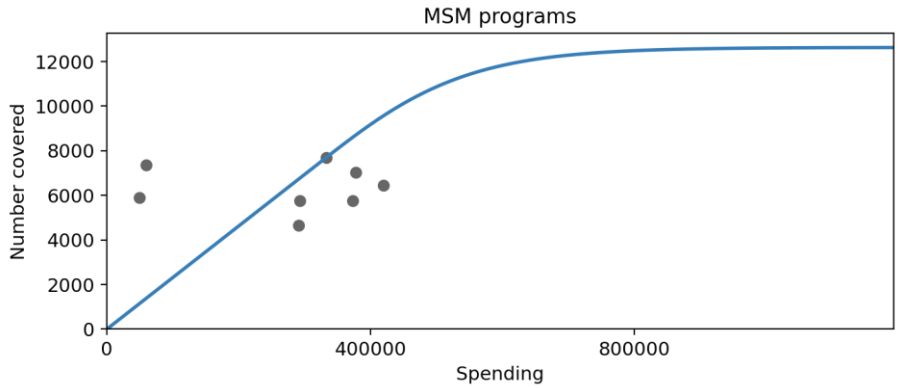

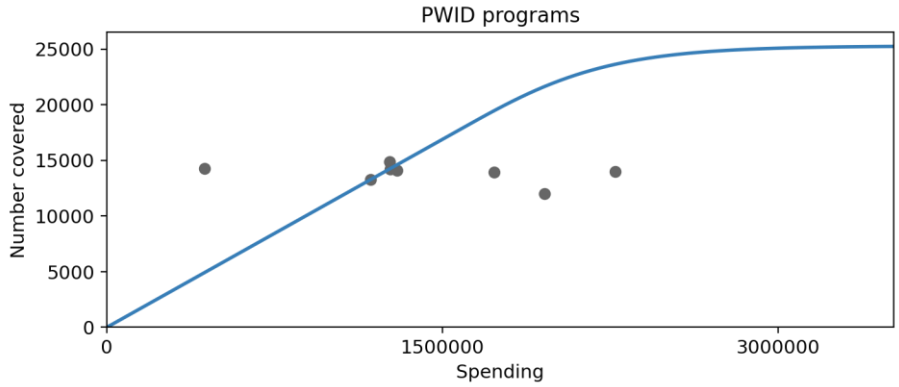

Appendix 4. Annual HIV budget allocations at varying budgets

Table A5. Annual HIV budget 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)	$1,245,887	$1,507,659	$1,603,180	$1,633,361	$1,663,498	$1,683,115
PMTCT	$38,369	$46,189	$51,442	$50,976	$50,927	$51,152
HIV testing and prevention program for FSW	$538,411	$344,913	$715,200	$831,904	$816,718	$880,488
HTS for general population	$342,278	$0	$0	$171,139	$171,139	$444,144
HIV testing and prevention for MSM	$333,050	$0	$0	$166,525	$166,525	$166,525
HIV testing and prevention for migrants	$216,202	$47,378	$333,144	$445,408	$693,494	$937,716
HIV testing and prevention for PWID and NSP	$1,178,081	$0	$216,242	$592,965	$1,303,047	$1,675,278
Total targeted HIV program budget	$3,892,278	$1,946,139	$2,919,209	$3,892,278	$4,865,348	$5,838,417

*Based on unit costs (estimates from Table A3) multiplied by coverage
FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men; NSP, needle-syringe program; PMTCT, prevention of mother to child transmission; PWID, people who inject drugs.

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

	Latest reported budget (2021)
Enabling environment	$23,287
Human resources	$324,882
Infrastructure	$25,609
Monitoring and evaluation	$29,967
Management	$274,529
Other HIV care	$0
Other HIV costs	$417
Social protection	$54,605
STI	$7,757
Total non-targeted HIV program budget	$741,053

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