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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 allocations decisions to maximize the impact of HIV programs. An allocative efficiency analysis was conducted in partnership with the Kazakhstan Scientific Center Dermatology and Infection Diseases, Ministry of Health, the Global Fund, UNAIDS, Swiss Tropical and Public Health Institute, and the Burnet Institute. The Optima HIV model (2) was applied to estimate the optimized resource allocation across a mix of HIV programs.

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 (3). Caution should be taken in interpreting future HIV resource needs from these results until additional epidemiological data can confirm the current underlying trend.
- Kazakhstan has a concentrated HIV epidemic with a high and stable prevalence among people who inject drugs (8.3% in 2020), a high and rapidly increasing prevalence among men who have sex with men (6.9% in 2021), and continued risk experienced by female sex workers (1.3% prevalence in 2021).
- In 2021 an estimated US$39.6M was spent on targeted HIV interventions, with antiretroviral therapy (ART) accounting for 48% of this. The unit cost for ART in Kazakhstan remains high compared to other countries.
- In a baseline scenario where 2021 spending on programs was maintained, including a fixed annual spending on ART, there were estimated to be 21,620 new HIV infections, 3,771 HIV-related deaths and 115,253 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **Optimizing spending would involve deprioritizing HIV testing among the general population to enable continued scale up of ART, pre-exposure prophylaxis for men who have sex with men, and needle-syringe programs for people who inject drugs.** This optimization prioritizes high impact interventions that address the current treatment gap as well as the high proportion of new HIV infections occurring among people who inject drugs and men who have sex with men.
- Optimized reallocation of 2021 spending can advance epidemic gains without additional resources and was estimated to avert 16,778 (78%) new infections, 2,345 (62%) deaths and 61,382 (53%) DALYs over 2023-2030 relative to the baseline scenario of continued 2021 spending.
- With additional resources available, priorities were identified as continued scale-up of PrEP and programs for people who inject drugs, followed by investment in programs for men who have sex with men and female sex workers to curb the rising prevalence among these groups.
- **HIV investment in Kazakhstan is projected to be on-track to reach the 95% diagnosis target by 2030 with optimized allocation of 2021 spending.** With continued expansion of ART coverage according to optimized allocation or decreases in the procurement cost of antiretroviral drugs, it may be possible to reach 92% treatment coverage by 2030. Meeting the treatment and viral suppression targets may require novel programs to improve adherence and retention in treatment that are not costed in this analysis.

1 Background

Kazakhstan has a concentrated HIV epidemic among key populations including people who inject drugs (PWID), men who have sex with men (MSM), and female sex workers (FSW). In recent years, the primary mode of transmission has shifted from injecting drug use to sexual transmission (4, 5). HIV prevalence remains greatest among PWID, at 8.3% in 2020 based on sentinel surveillance (6). A rapid rise is HIV prevalence among MSM has been reported from 1.2% in 2013 (7) to 6.9% in 2021 (6), while HIV prevalence among FSW has remained relatively stable, estimated to be 1.3% in 2021 (6). Of note, prevalence estimates based on sentinel surveillance may be biased towards those using government services and may not be representative of broader key population groups.

Kazakhstan attained upper-middle-income status in 2006 and has experienced a resulting decrease in HIV funding from international funding organizations as well as exclusion from voluntary license agreements that pharmaceutical companies negotiate with generic drug manufacturers (8). As a result, Kazakhstan has had one of the highest treatment costs of countries in the EECA region (8). However, through changes to procurement and extensive advocacy leading to a new licensing agreement improving access to generic drugs (9, 10), the country has succeeded in reducing treatment costs and expanding treatment coverage. The HIV response in Kazakhstan is guided by the Approval of the State National Program of Health Development of the Republic of Kazakhstan 2020-2025, last updated in 2022. In Kazakhstan, ART is fully funded by the government and is provided free of charge to patients, and the domestic share of overall HIV spending increased from 82% to 87% between 2013 and 2021 (11).

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 (12, 13). This is the third Optima HIV analysis in Kazakhstan, 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** (overall and Global Fund specific) by targeted HIV intervention to minimize HIV infections and deaths by 2030 under five funding scenarios of 50, 75, 100, 125, 150 percentage of the current HIV funding? What is the expected cascade (gap) under these scenarios?

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 Kazakhstan. 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 Kazakhstan, 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$39.6M 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 (2).

3.1 Populations and HIV programs

Populations and HIV programs considered in this analysis were:

- Key populations
    - Female sex workers (FSW)
    - Clients of sex workers (Clients)
    - Men who have sex with men (MSM)
    - Males who inject drugs (Male PWID)
    - Females who inject drugs (Female PWID)
    - Prisoners
- General populations
    - Male 0-14 (M0-14)
    - Female 0-14 (F0-14)
    - Male 15-49 (M15-49)
    - Female 15-49 (F15-49)
    - Male 50+ (M50+)

    - Female 50+ (F50+)
- Targeted HIV programs
    - Antiretroviral therapy (ART)
    - Prevention of mother-to-child transmission (PMTCT)
    - Opioid substitution therapy (OST)
    - Needle-syringe programs (NSP)
    - Pre-exposure prophylaxis for MSM (PrEP)
    - HIV testing and prevention programs for female sex workers (FSW programs)
    - HIV testing and prevention programs for men who have sex with men (MSM programs)
    - HIV testing and prevention programs for people who inject drugs (PWID programs)
    - HIV testing services for the general population (HTS)
    - Condom promotion and distribution (Condoms)

3.2 Model constraints

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

3.3 Treatment retention parameters

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

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

3.4 Model weightings

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

4 Findings

4.1 Objective 1

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

2021 HIV spending. In Kazakhstan total spending on HIV from domestic and international sources was US$69.2 in 2021, incorporating US$39.6M targeted HIV spending for the programs considered above and US$29.6M non-targeted spending. Nearly half of targeted spending was for ART (48%), 42% for HTS and 2% for testing and prevention programs for PWID (Figure 2; Table A5). Non-targeted spending, which was not included in the optimization analysis, encompassed expenditure for human resources, management and infrastructure costs, monitoring and evaluation, programs supporting an enabling environment and some HIV care costs (Table A6).

Resource needs to maintain 2021 ART coverage. In 2021, ART coverage among diagnosed people living with HIV was 75%. If ART unit costs remain constant (US$855 in 2021), ART spending would need to increase by US$6.5M (34% 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, including meeting the needs for additional treatment, a counterfactual "Baseline" of fixed annual spending on ART was used, although this would result in different epidemic projections (Figure 1b).

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 Kazakhstan, 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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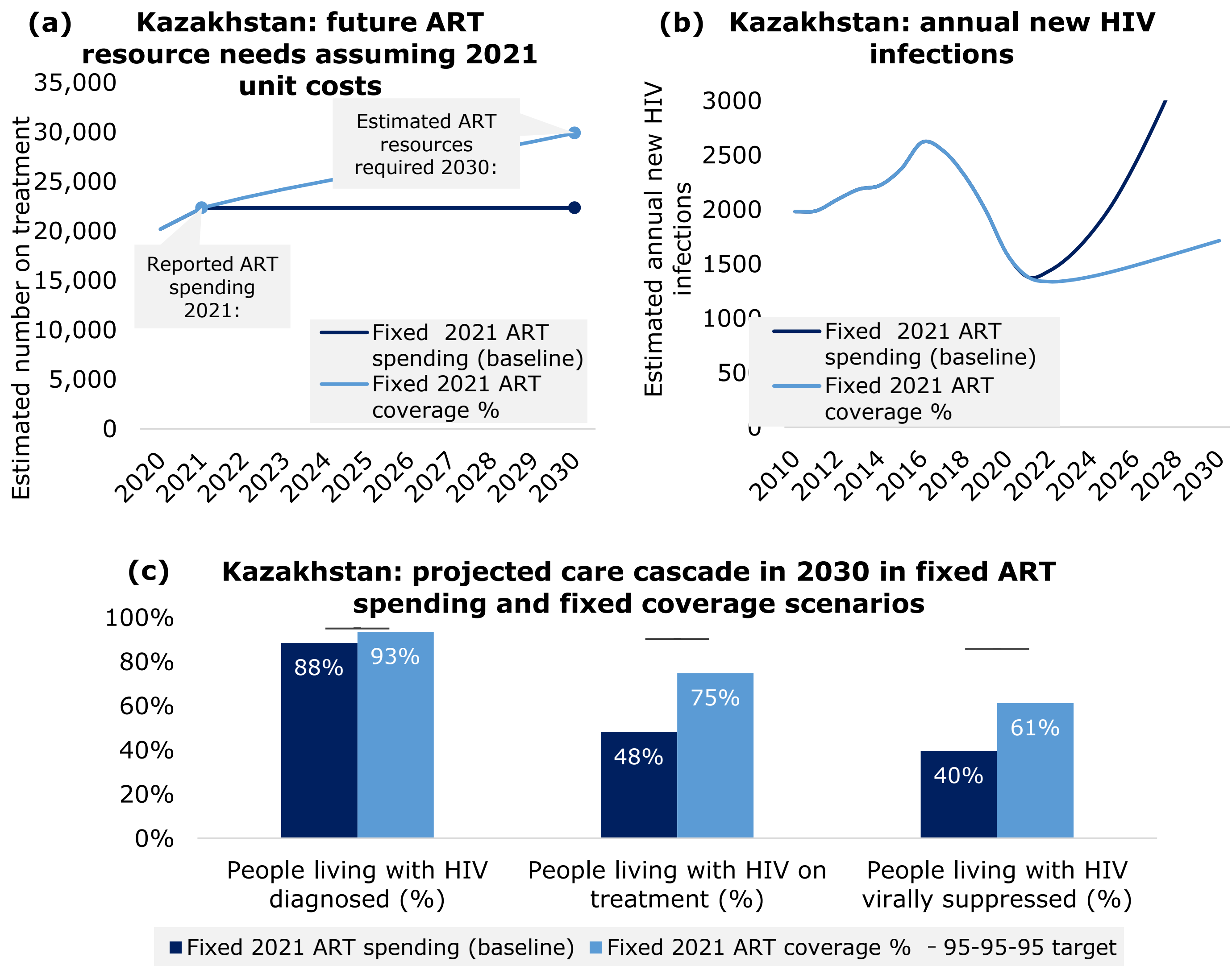

Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021 proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant; (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 21,620 new HIV infections, 3,771 HIV-related deaths and 115,253 HIV-attributable DALYs over 2023-2030 (Table 1). Without additional spending on ART, the HIV care cascade in this scenario was projected to be "88-54-82" in the year 2030 (i.e. 88% people diagnosed, 54% people diagnosed on treatment and 82% people on treatment virally suppressed) (Figure 1). The low proportion of people on treatment in 2030 reflects that ART spending will need to continue increasing over time just to maintain a constant percentage coverage, since more people will continually be diagnosed.

Optimized resource allocation of 2021 spending. Optimization of 2021 spending identified that additional impact may be possible by reallocating some HTS spending among the general population to enable further scale-up of ART, PrEP focused among MSM, as well as NSP and testing and prevention programs for PWID (Figure 2). Assuming that treatment gap could be closed through enhanced linkage to care and adherence programs, increased investment in ART could reduce mortality as well as new infections through treatment-as-prevention. Scaling up PrEP for MSM is very cost-effective in this context, since the prevalence of HIV among MSM is high (6.9% in 2021 (6)) and new infections among MSM are projected to continue rapidly increasing as a proportion of all HIV infections under status quo conditions (see Figure A1). Maintaining high levels of prevention programs for PWID is also critical, since the prevalence of HIV among PWID remains high and in 2021 an estimated 34% of new infections occurred among PWID. The model deprioritized general population testing to enable greater investment into these higher impact programs, include testing targeted through PWID programs. 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 (14).

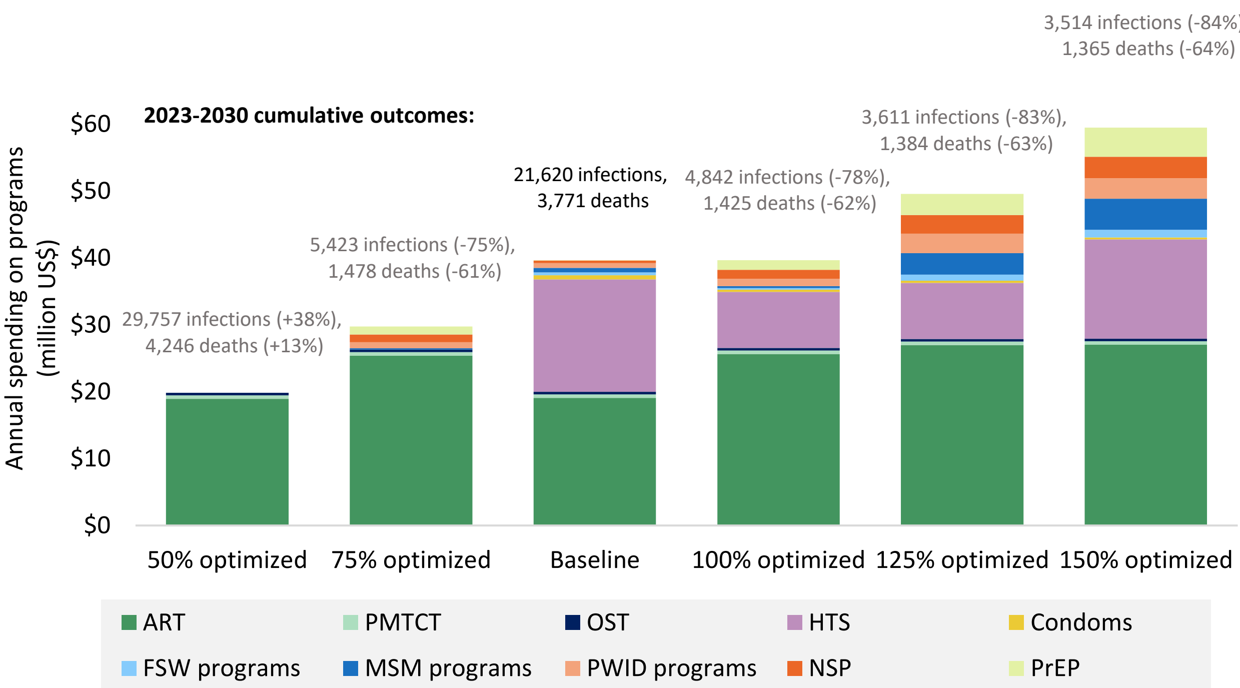

Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030. Percentage optimized refers to the percentage of baseline HIV funding at a given budget level. ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services 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; NSP, needle-syringe programs.

Optimized resource allocation at different budget levels. As the total budget envelope increased, the priorities were identified as continued scale up of PrEP and programs for PWID, followed by investment in programs for MSM and FSW to curb the rising prevalence among these groups (Figure 2). While the epidemic among MSM and FSW contributes relatively less for Kazakhstan than PWID (an estimated 29% and 1% of new infections in 2021, respectively, compared to 34% of new infections among PWID [Optima output]), the epidemic in these groups is rising within the country as well as the region and so prevention programs are also critical.

If funding were reduced, priorities were identified as maintaining as many people on treatment as possible, followed by HIV prevention including PrEP programs for MSM, as well as prevention and NSP programs for PWID.

Impact of optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending could avert 16,778 new infections (78%), 2,345 deaths (62%) and 61,382 DALYs (53%) over 2023-2030. This benefit increases to 84% infections, 64% deaths and 55% DALYs averted with an optimized 150% budget (Figure 3; Table 1).

Most of the projected impact in Kazakhstan comes from improving the second 95 by retaining diagnosed people on treatment, assuming that with additional resources allocated more individuals can be placed and kept on treatment. Subsequently, even at 75% optimized resource allocation, which maximizes treatment spending, projected epidemic gains are close to those achievable with 100% of current funding. Procurement of lower-cost Dolutegravir may support the expansion of ART in Kazakhstan given higher tolerance of newer Dolutegravir-based regimens (15) which has previously not been accessible in Kazakhstan due to pricing (16).

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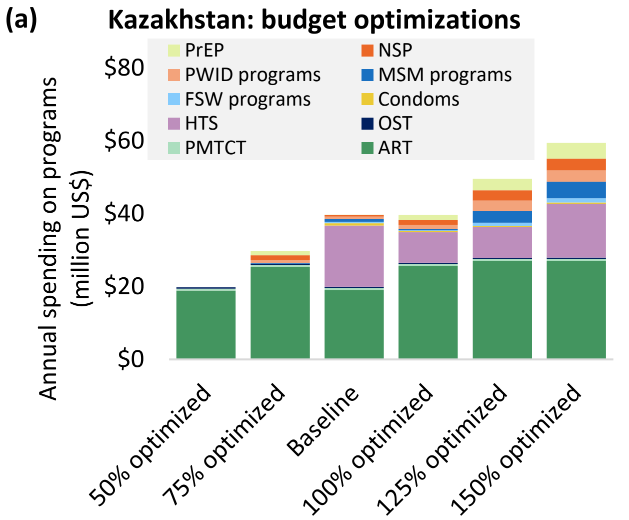

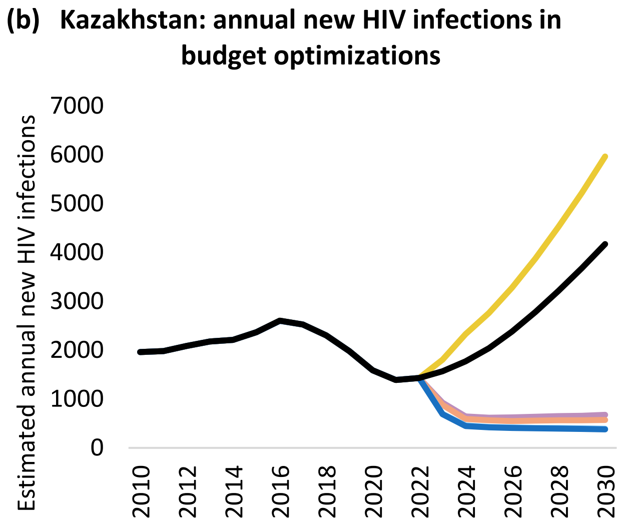

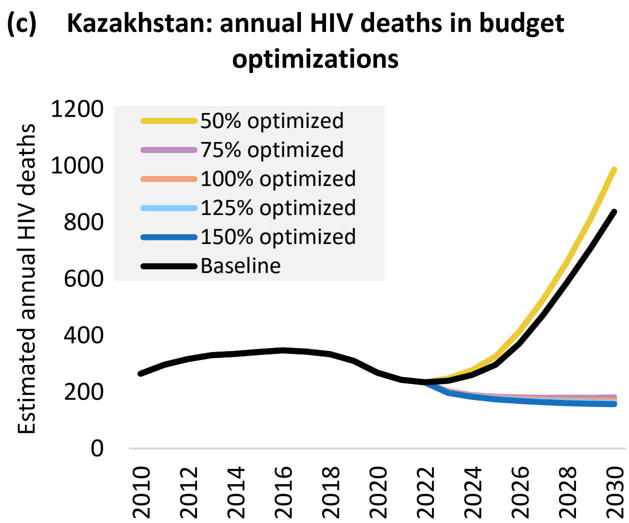

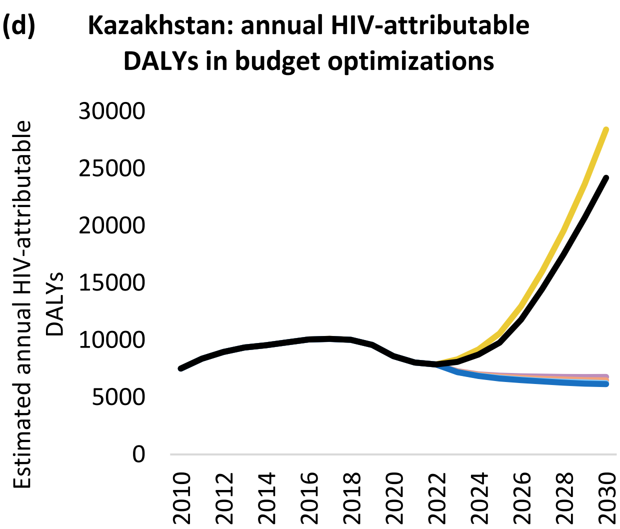

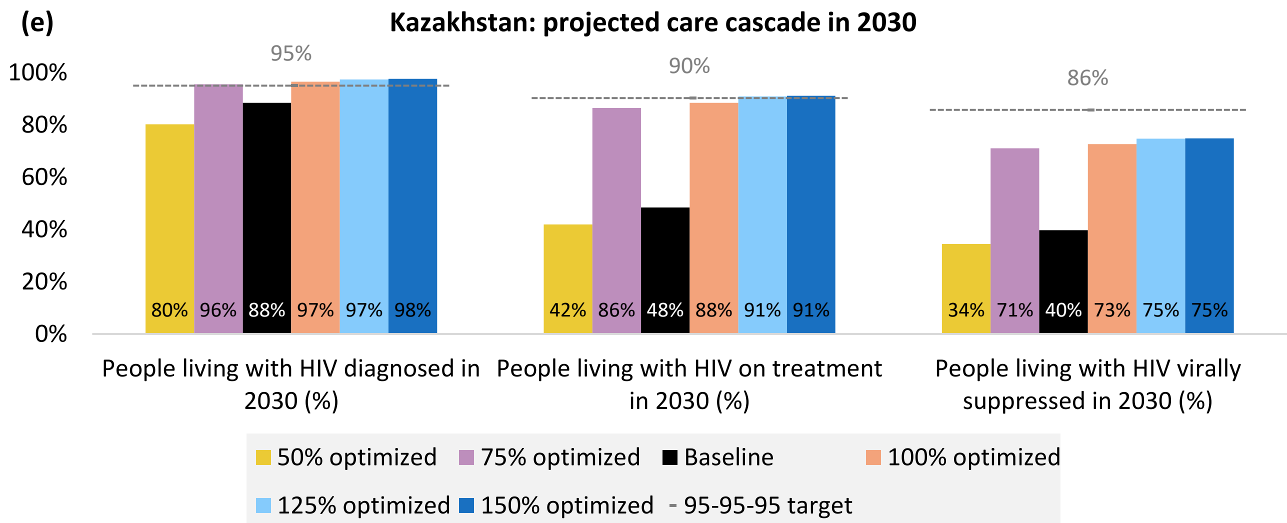

Figure 3. Model outcomes from budget optimization scenarios aiming to minimize infections and deaths. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of current HIV funding; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; 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 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; NSP, needle-syringe programs.

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 41,876 (+194%) more new infections, 11,707 (+310%) more deaths and 293,237 (+254%) 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	63,495	15,478	408,490	194%	310%	254%
50% optimized	29,757	4,246	128,684	38%	13%	12%
75% optimized	5,423	1,478	55,158	-75%	-61%	-52%
Baseline	21,620	3,771	115,253			
100% optimized	4,842	1,425	53,871	-78%	-62%	-53%
125% optimized	3,611	1,384	52,701	-83%	-63%	-54%
150% optimized	3,514	1,365	52,228	-84%	-64%	-55%
*95-95-95**	3,376	1,195	48,370	-84%	-68%	-58%

*Optimization reached 98-95-95; 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?*

With 100% optimized spending, Kazakhstan is projected to achieve the 95% diagnosis target by 2030 and be within reach of the 95% treatment target (Figure 3e).

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 92% of diagnosed people living with HIV will be on treatment in 2030 with 100% optimized spending. In addition to ART spending, novel programs may be necessary in Kazakhstan 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 98-95-95 through the 100% optimized scenario plus assumed realization of treatment and viral suppression targets could avert an additional 1,466 (30%) new infections, 230 (16%) deaths and 5,502 (10%) DALYs compared to 100% spending optimized scenario (Figure 4).

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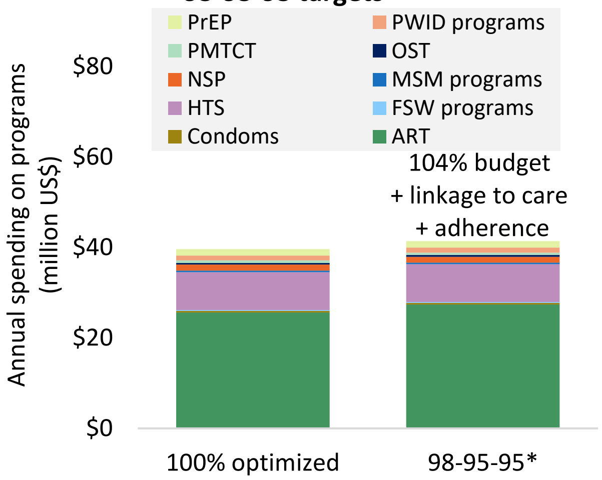
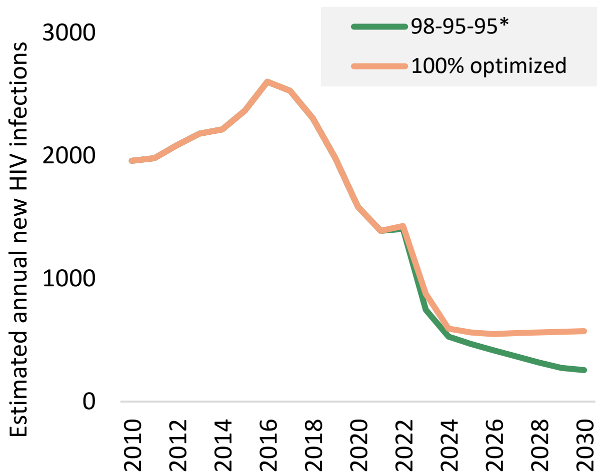
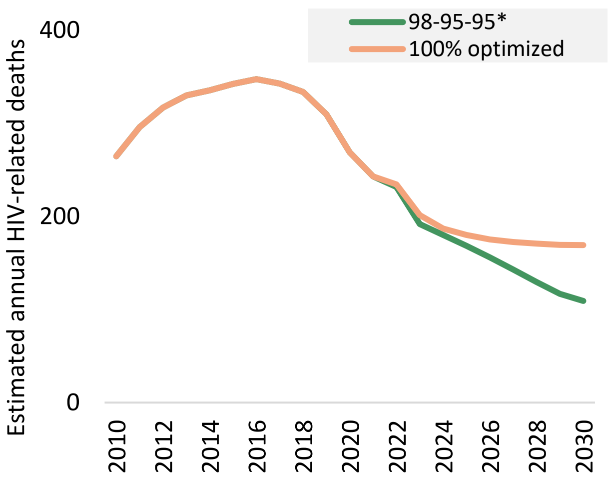
(a) Kazakhstan: optimized budget to reach 95-95-95 targets



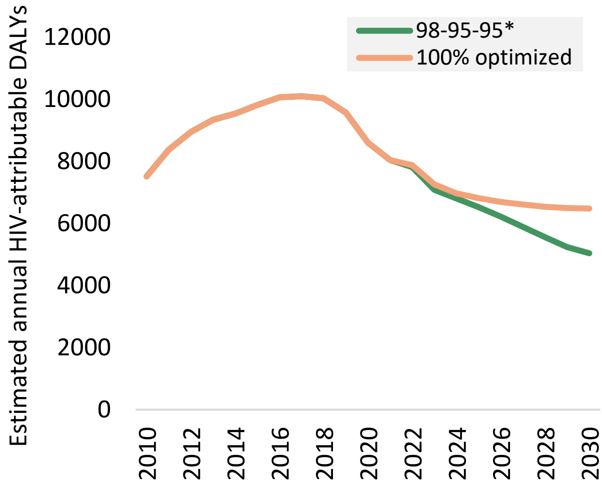
(b) Kazakhstan: annual new HIV infections in 95-95-95 scenario



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



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



(e) Kazakhstan: projected care cascade

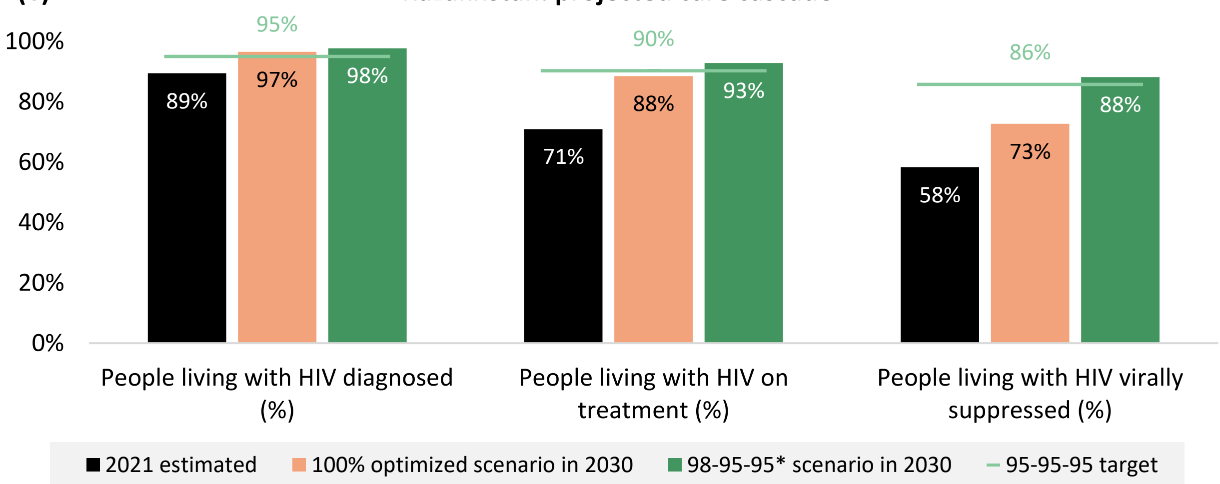


Figure 4. Optimized HIV budget level and allocation to achieve 95-95-95 targets by 2030. *Kazakhstan is projected to reach 98-95-95 by 2030 with 100% optimized budget allocation plus assumed achievements reaching treatment and viral suppression targets. Panels show (a) optimal budget allocations; (b) 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; NSP, needle-syringe programs.

5 Comparison with past spending

Based on previous Optima analyses, spending on targeted HIV programs in Kazakhstan has increased over time, from US$16.5M in 2013 to US$39.6M in 2021 (Figure 5). The increase in total spending on ART coupled with substantial reductions in ART unit cost−from US$2,279 per person per year in 2013 (13), to US$1,438 in 2018 (12), to $855 per person per year in 2021−has enabled extensive scale-up of treatment coverage. Overall, coverage increased from 3,571 people on ART in 2013 to 22,315 people on ART in 2021, which has likely played an important role in reducing both new infections and deaths.

There has also been a shift in spending across other programs, with increased emphasis on HIV testing and prevention programs focused on PWID (including OST) and MSM, and decreased emphasis on NSP and programs for FSW. The increase in testing coverage and spending on HTS is largely due to the program expanding access to free tests to foreigners and partners of pregnant women, and absorbing these costs have increased the unit cost for HIV testing. However, by improving implementation efficiency and reducing costs for treatment, overall the country has achieved coverage targets for key populations and treatment at lower than estimated costs. This has enabled additional investment in HTS that would otherwise not have been prioritized within the spending envelope. These investments in HIV have put the country on-track for achieving 95% diagnosis by 2030 according to Optima HIV model projections based on the reported behavioral changes and estimated program impacts. Further evidence is needed to confirm the reported behavioral changes in people reached by surveys are representative of all key populations.

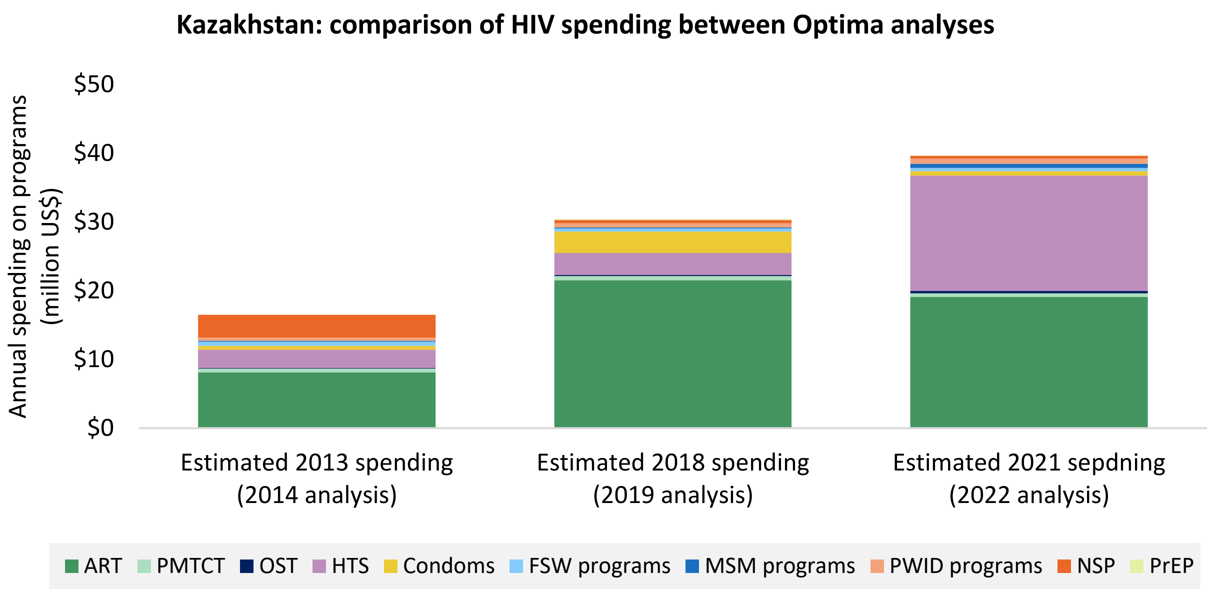


Figure 5. Estimated budget allocations from 2014, 2019 and 2022 Optima analyses. ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services targeting general population; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission; PrEP, pre-exposure prophylaxis.

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)(3), 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, 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 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. There may be opportunities for additional efficiency gains through appropriate geographical targeting.
- **Cost functions for each program** are a key driver of model optimizations. Cost functions determine how program coverage will change if funding is reallocated, as well as maximum achievable program coverage. There is uncertainty in the shapes of these cost functions, values which could influence how easily or how high programs could be scaled up.
- **Changes to unit costs:** The model assumes fixed cost functions over time; however unit costs are subject to vary over time depending on changing supply and implementation costs, which would change the cost functions in the model.
- **Currency:** The COVID-19 pandemic, war in Ukraine and global economic crises have led to instability in currencies over the past few years. Spending is reported in US$, but what this value represents in local currency may change over time in unknown ways.
- **Retention in care.** This analysis did not consider programs that could improve retention in care for people diagnosed, or viral suppression for people on treatment. These programs will be essential to achieving the 95-95-95 targets and future analyses should focus on quantifying the spending and impacts of relevant programs.
- **Other efficiency gains** such as improving technical or implementation efficiency were not considered in this analysis.
- **Equity** in program coverage or HIV outcomes was not captured in the model but should be a key consideration in program implementation. Policy makers and funders are encouraged to consider resources required to improve equity, such as through investment in social enablers to remove human rights-based barriers to health, and technical or implementation efficiency gains. 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 Kazakhstan, finding that an optimized resource allocation can have an impact on reducing infections and deaths as well as achieving 95-95-95 targets. HIV prevalence remains highest among PWID but is increasing among MSM. Program priorities were identified as increased treatment scale-up where possible, expand PrEP for men who have sex with men, and scale-up NSP for PWID, followed by programs for FSW. The unit cost for ART in Kazakhstan remains high compared to other countries in the region, and opportunities to procure ART at lower costs would enable treatment scale up with less resources, thus enabling greater investment in other program priorities. 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.

Acknowledgements

This Optima HIV modeling analysis was conducted as a collaboration between the Kazakhstan 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

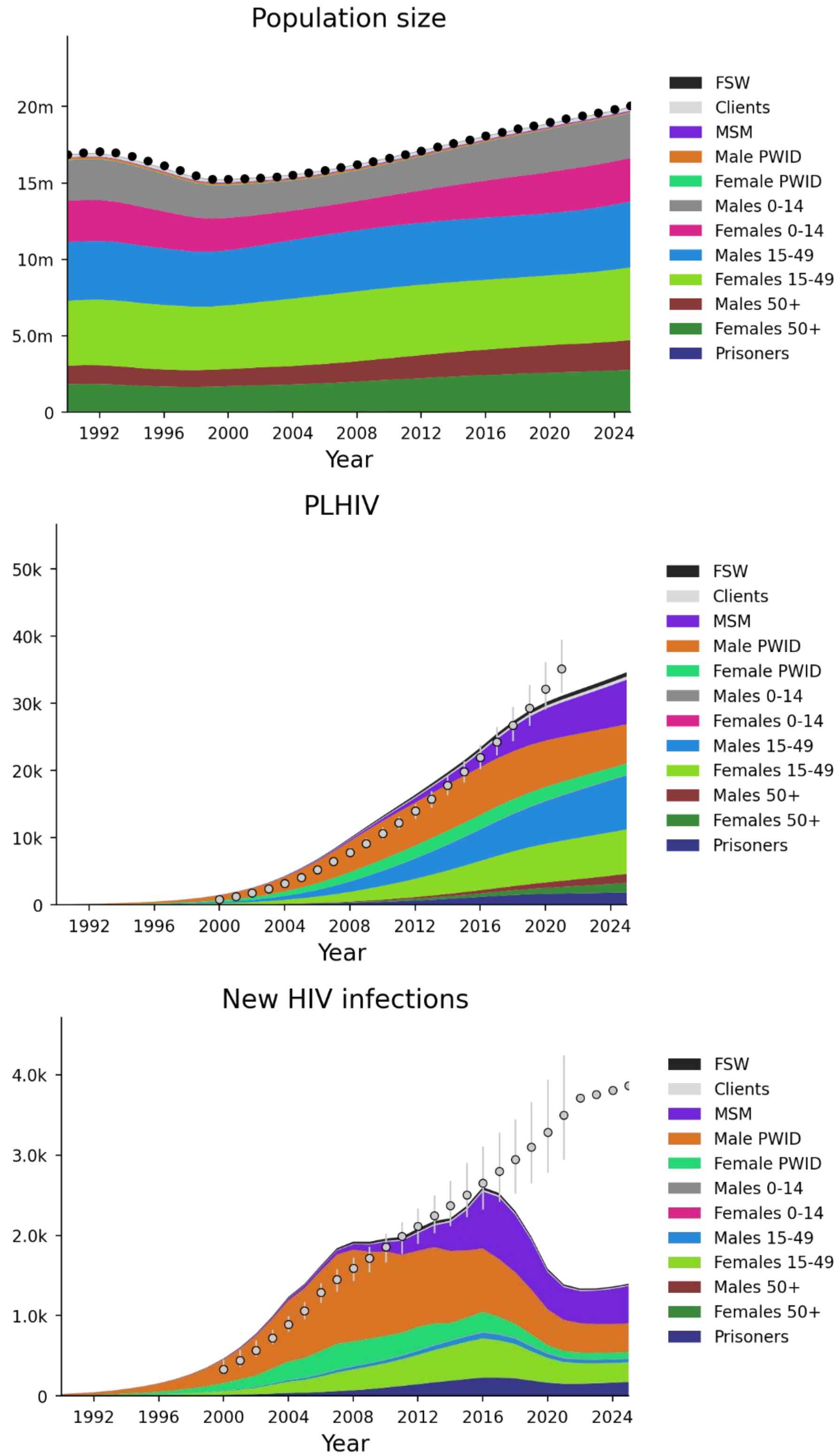
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

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

Source: Optima HIV User Guide Volume VI Parameter Data Sources

Appendix 2. Model calibration

Figure A1. Calibration outputs. Dots represent official country estimates based on World Population Prospects, Spectrum model, surveillance surveys, program data and UNAIDS.



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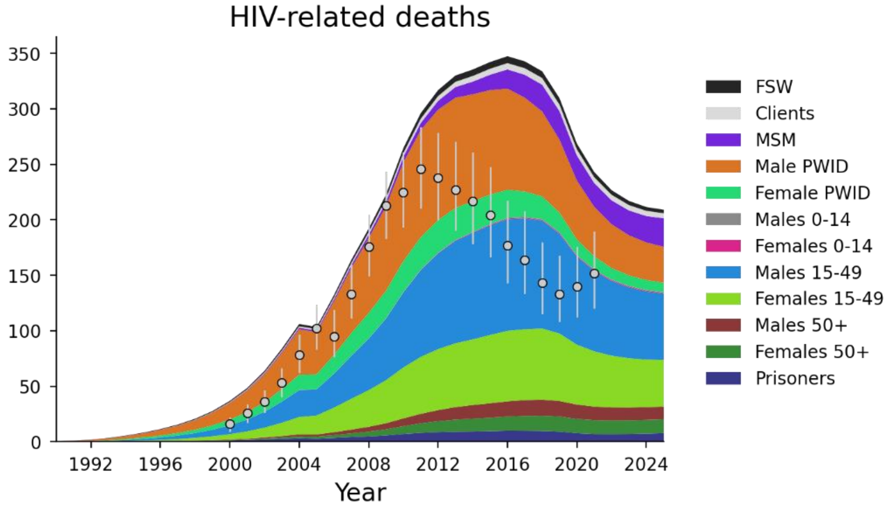
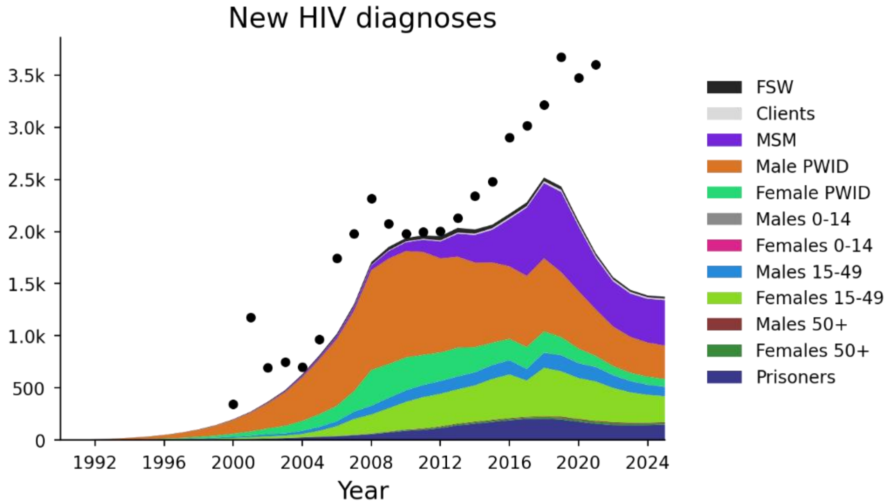
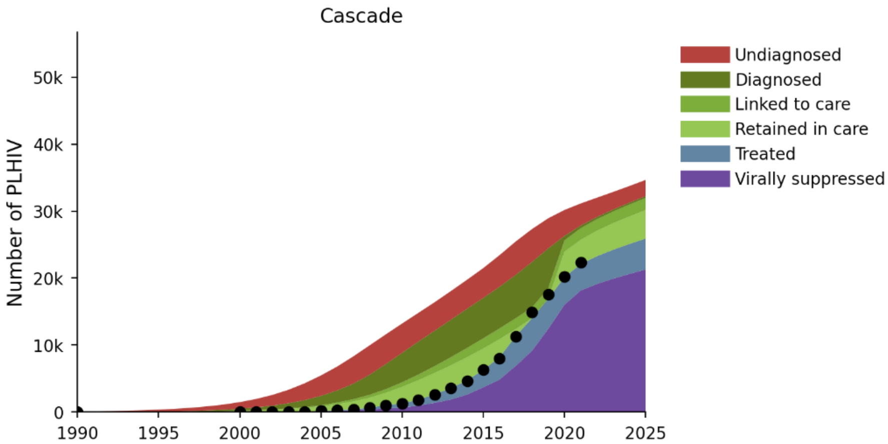
Allocation of HIV resources towards maximizing the impact of funding







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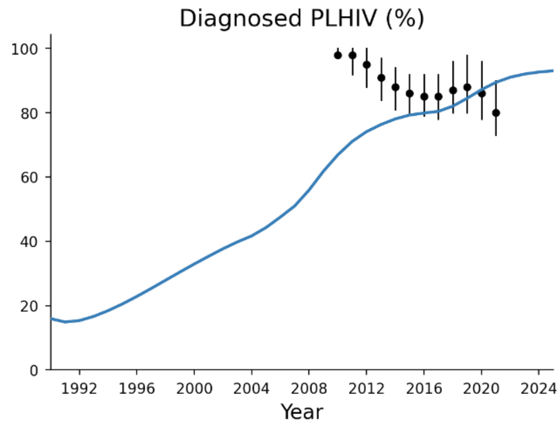
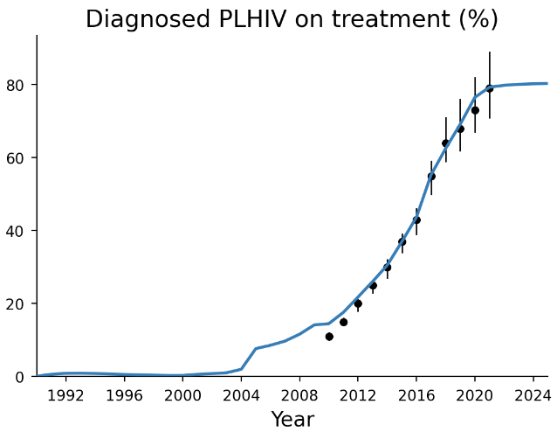
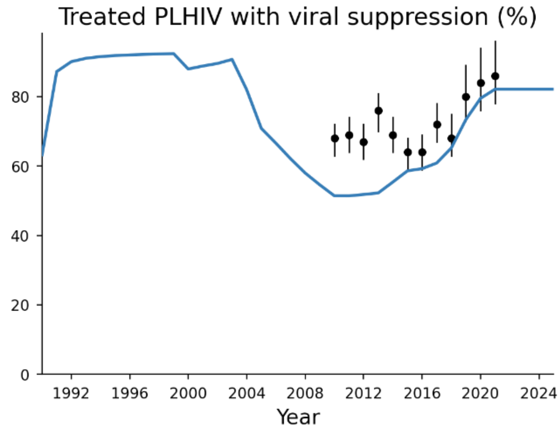
Allocation of HIV resources towards maximizing the impact of funding







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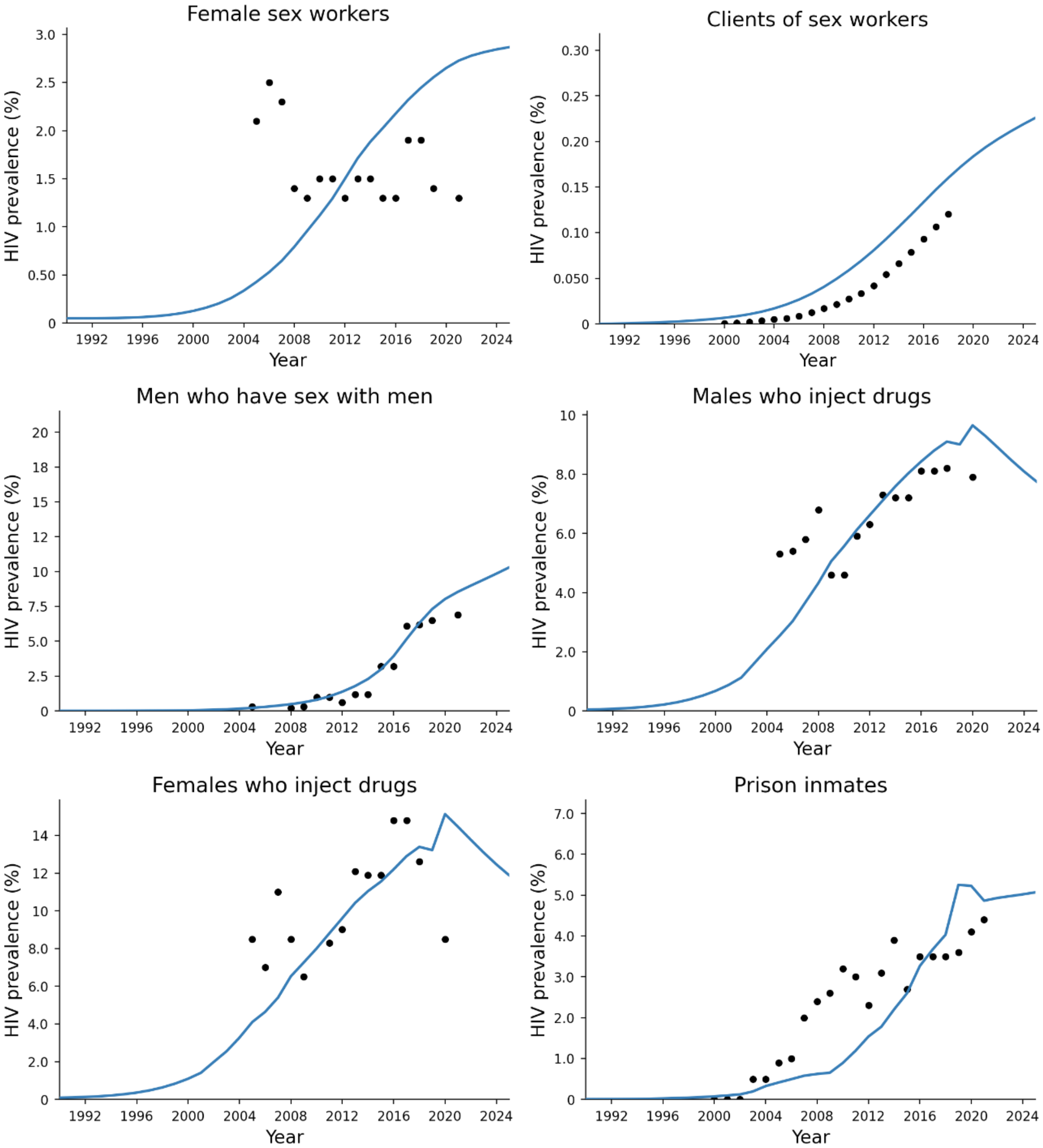
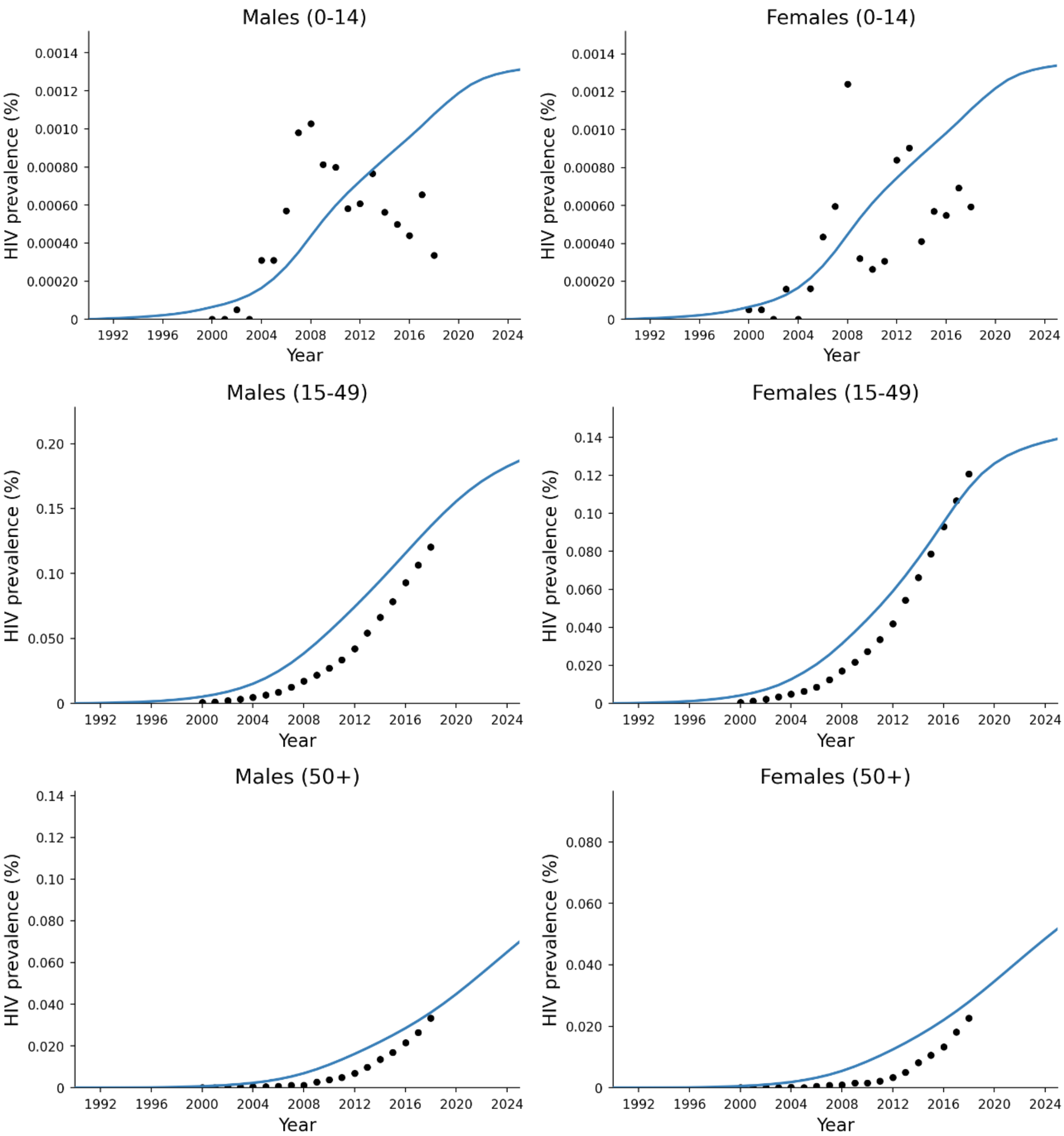




Males (0-14)
Females (0-14)
Males (15-49)
Females (15-49)
Males (50+)
Females (50+)
HIV prevalence (%)
Year
1992
1996
2000
2004
2008
2012
2016
2020
2024

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	$855.22	95%	100%
Condom promotion and distribution	$1.10	0%	85%
HIV testing services	$4.75	0%	85%
Needle-syringe programs	$7.91	0%	95%
Opioid substitution therapy	$908.95	10%	10%
Pre-exposure prophylaxis	$60.69	5%	90%
Prevention of mother-to-child transmission	$648.29	95%	100%
Programs for female sex workers	$23.98	30%	85%
Programs for men who have sex with men	$47.77	30%	85%
Programs for people who inject drugs	$14.02	30%	85%

* 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

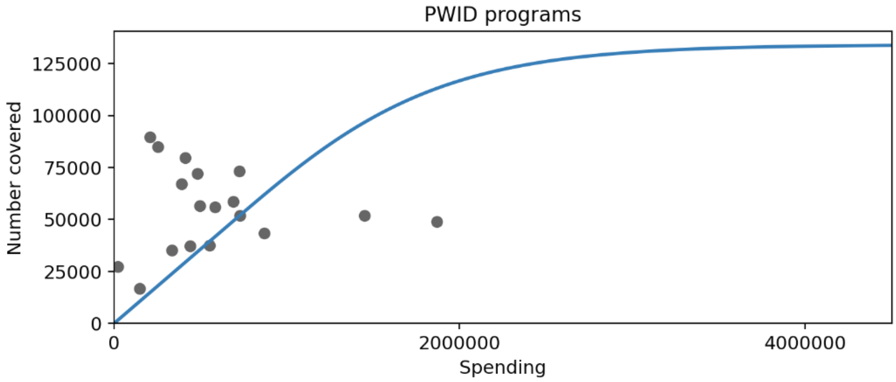
HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
Condoms	Condom use for casual acts	Clients, Females 15-49	80%	80%	90%	90%
Condoms	Condom use for casual acts	MSM, MSM	92%	92%	96%	96%
Condoms	Condom use for casual acts	Male PWID, Female PWID	73%	73%	90%	90%
Condoms	Condom use for casual acts	Male PWID, Females 15-49	72%	72%	90%	90%
Condoms	Condom use for casual acts	Males 0-14, Females 0-14	0%	0%	20%	20%
Condoms	Condom use for casual acts	Males 15-49, FSW	60%	60%	80%	80%
Condoms	Condom use for casual acts	Males 15-49, Female PWID	76%	76%	90%	90%
Condoms	Condom use for casual acts	Males 15-49, Females 15-49	80%	80%	90%	90%
Condoms	Condom use for casual acts	Males 50+, Females 15-49	53%	53%	65%	65%
Condoms	Condom use for casual acts	Males 50+, Females 50+	30%	30%	40%	40%
Condoms	Condom use for casual acts	Prisoners, Prisoners	7%	7%	45%	45%

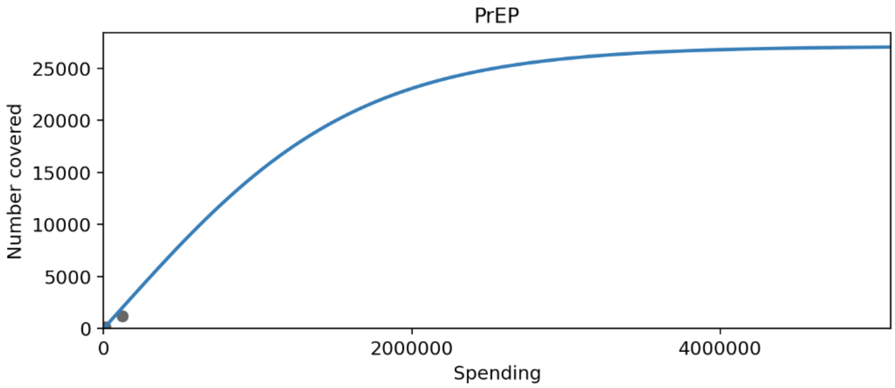
FSW programs	Condom use for casual acts	Male PWID, Female PWID	73%	73%	77%	77%
FSW programs	Condom use for casual acts	Males 15-49, Female PWID	76%	76%	77%	77%
FSW programs	Condom use for casual acts	Males 15-49, FSW	60%	60%	92%	92%
MSM programs	Condom use for casual acts	MSM, MSM	92%	92%	97%	97%
MSM programs	Condom use for casual acts	Prisoners, Prisoners	7%	7%	74%	74%
PWID programs	Condom use for casual acts	Male PWID, Female PWID	73%	73%	95%	95%
PWID programs	Condom use for casual acts	Male PWID, Females 15-49	72%	72%	93%	93%
PWID programs	Condom use for casual acts	Male PWID, Female PWID	73%	73%	95%	95%
PWID programs	Condom use for casual acts	Males 15-49, Female PWID	76%	76%	95%	95%
PWID programs	Condom use for casual acts	Prisoners, Prisoners	7%	7%	56%	56%
FSW programs	Condom use for commercial acts	Male PWID, Female PWID	90%	90%	95%	95%
FSW programs	Condom use for commercial acts	Clients, FSW	28%	28%	70%	70%
FSW programs	Condom use for commercial acts	Male PWID, FSW	95%	95%	98%	98%
HTS	HIV testing rate (average tests per year)	FSW	0.71	0.71	0.80	0.80
HTS	HIV testing rate (average tests per year)	Clients	0.19	0.19	0.56	0.56
HTS	HIV testing rate (average tests per year)	MSM	0.71	0.71	0.80	0.80
HTS	HIV testing rate (average tests per year)	Male PWID	0.74	0.74	0.82	0.82
HTS	HIV testing rate (average tests per year)	Female PWID	0.44	0.44	0.84	0.84
HTS	HIV testing rate (average tests per year)	Males 0-14	0.34	0.34	0.04	0.04
HTS	HIV testing rate (average tests per year)	Females 0-14	0.40	0.40	0.04	0.04
HTS	HIV testing rate (average tests per year)	Males 15-49	0.44	0.44	0.82	0.82
HTS	HIV testing rate (average tests per year)	Females 15-49	0.71	0.71	0.82	0.82
HTS	HIV testing rate (average tests per year)	Males 50+	0.74	0.74	0.41	0.41
HTS	HIV testing rate (average tests per year)	Females 50+	0.44	0.44	0.41	0.41
HTS	HIV testing rate (average tests per year)	Prisoners	0.34	0.34	1.25	1.25
FSW programs	HIV testing rate (average tests per year)	Female PWID	0.40	0.40	0.72	0.72

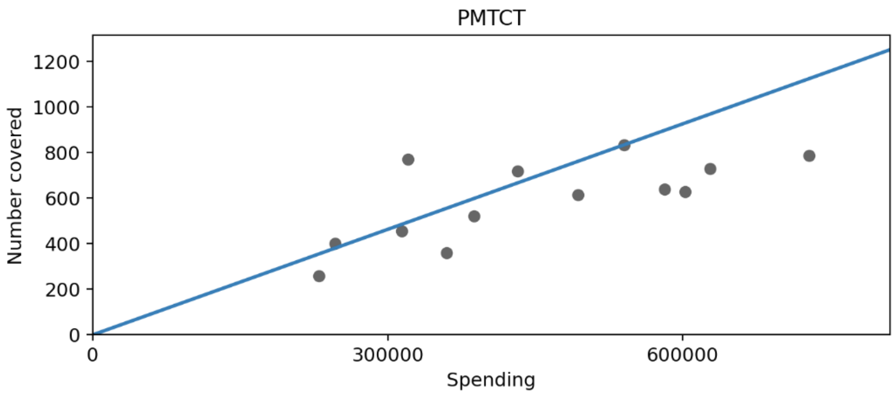
FSW programs	HIV testing rate (average tests per year)	FSW	0.71	0.71	1.03	1.03
MSM programs	HIV testing rate (average tests per year)	MSM	0.74	0.74	1.60	1.60
MSM programs	HIV testing rate (average tests per year)	Prisoners	0.44	0.44	0.91	0.91
PWID programs	HIV testing rate (average tests per year)	Male PWID	0.34	0.34	1.34	1.34
PWID programs	HIV testing rate (average tests per year)	Female PWID	0.40	0.40	1.15	1.15
PWID programs	HIV testing rate (average tests per year)	Prisoners	0.44	0.44	0.91	0.91
NSP	Probability of needle sharing (per injection)	Male PWID	64%	64%	28%	28%
NSP	Probability of needle sharing (per injection)	Female PWID	64%	64%	28%	28%
NSP	Probability of needle sharing (per injection)	Prisoners	24%	24%	7%	7%
PWID programs	Probability of needle sharing (per injection)	Male PWID	64%	64%	42%	42%
PWID programs	Probability of needle sharing (per injection)	Female PWID	64%	64%	42%	42%
PWID programs	Probability of needle sharing (per injection)	Prisoners	24%	24%	8%	8%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	MSM	4%	4%	95%	95%
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	-	-

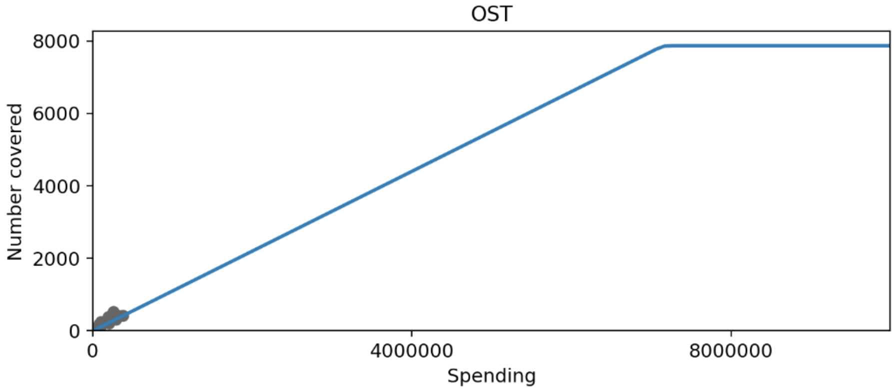
ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services for the general population; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs; PMTCT, prevention of mother to child transmission; PrEP, pre-exposure prophylaxis
- The number of 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 Kazakhstan. Data sources include program data and GAM.

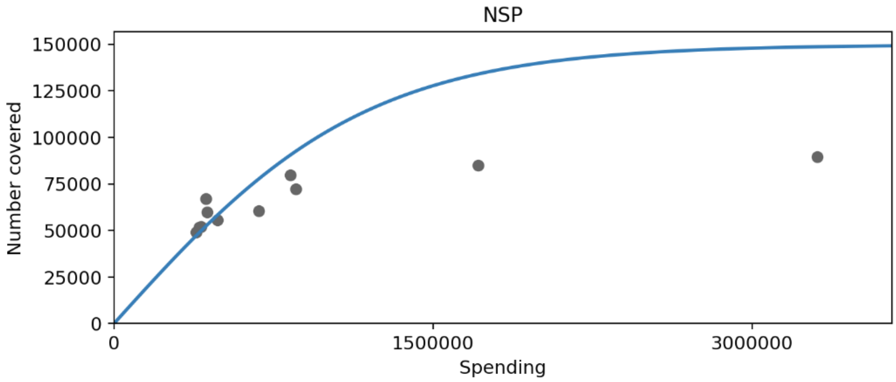




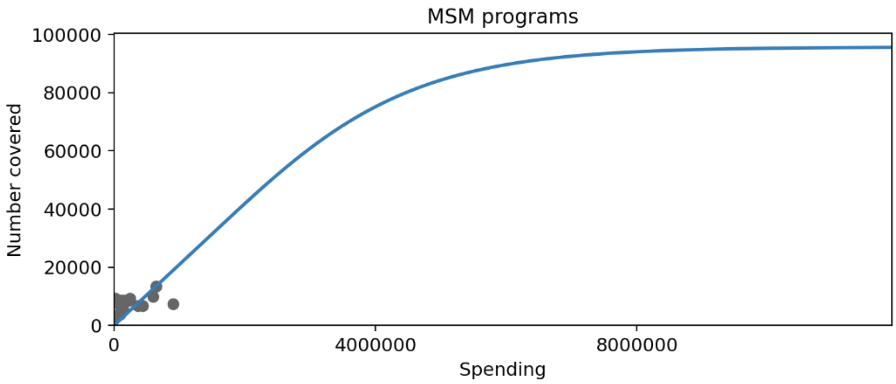




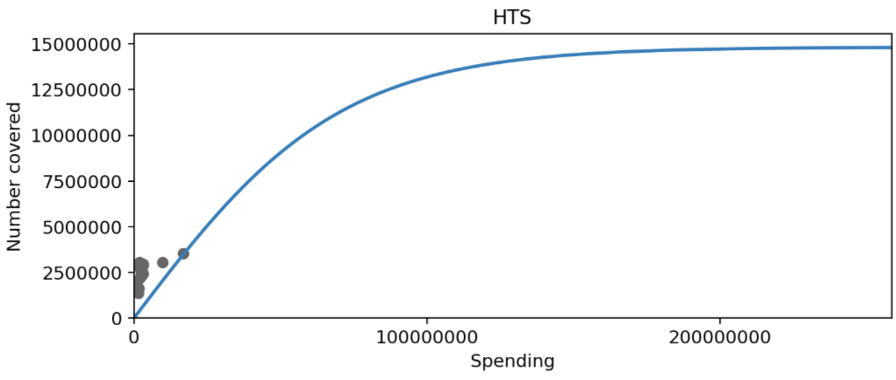
OST
8000
6000
4000
2000
0
Number covered
0
4000000
8000000
Spending



NSP
150000
125000
100000
75000
50000
25000
0
Number covered
0
1500000
3000000
Spending



MSM programs
100000
80000
60000
40000
20000
0
Number covered
0
4000000
8000000
Spending



HTS
15000000
12500000
10000000
7500000
5000000
2500000
0
Number covered
0
100000000
200000000
Spending

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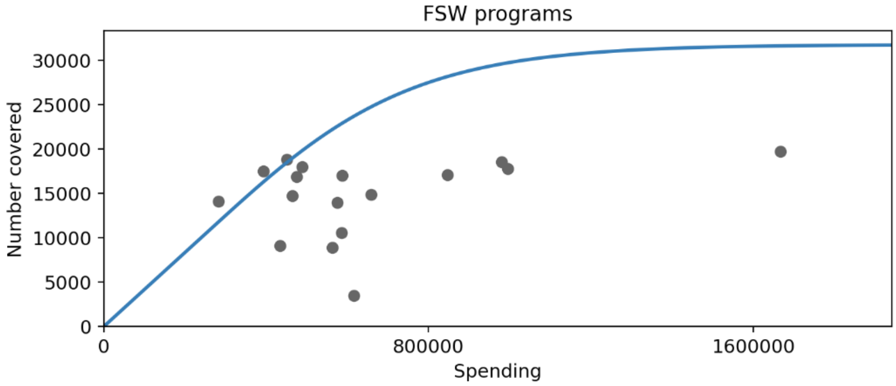

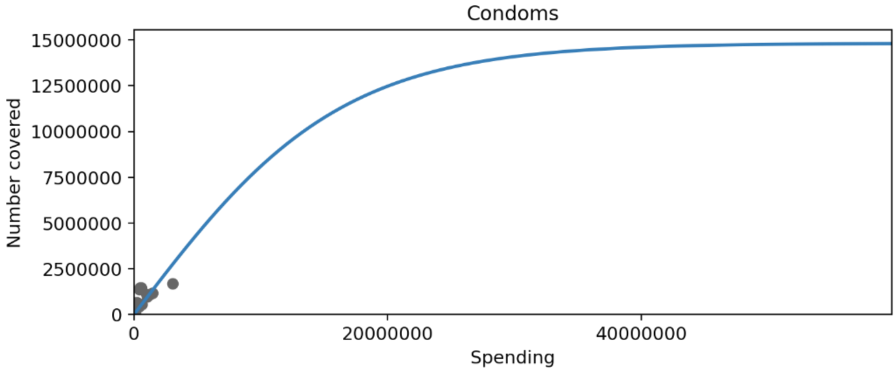

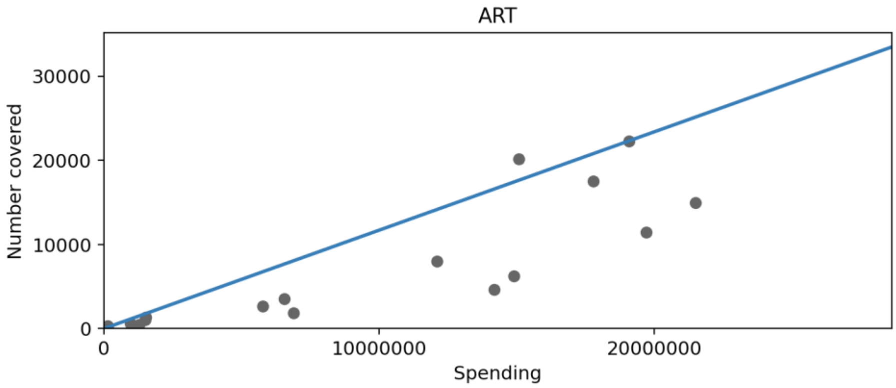

Appendix 4. Annual HIV budget allocations at varying budgets

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

	100% latest reported (2021)	50% optimized	75% optimized	100% optimized	125% optimized	150% optimized
ART	19,084,277	18,911,940	25,396,739	25,632,581	26,980,305	27,003,295
Condoms	626,094	0	0	313,047	313,047	313,047
FSW programs	451,133	0	0	225,566	925,484	1,156,974
HTS	16,770,608	0	0	8,385,304	8,385,304	14,830,981
MSM programs	643,685	0	160,921	321,842	3,191,617	4,610,834
NSP	410,179	0	1,195,525	1,322,212	2,777,581	3,228,378
OST	375,396	372,006	375,396	375,396	375,396	375,396
PMTCT	540,676	535,793	540,676	540,676	540,676	540,676
PWID programs	727,054	0	908,187	1,110,797	2,932,779	3,062,124
PrEP	10,378	0	1,152,165	1,412,057	3,127,161	4,337,515
Total targeted HIV program budget	39,639,479	19,819,740	29,729,609	39,639,479	49,549,349	59,459,219

ART, antiretroviral therapy; FSW, female sex worker; HTS, HIV testing services among 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; PrEP, pre-exposure prophylaxis.

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

	Latest reported budget (2021)
Enabling environment	$496,068
Human resources	$9,354,812
Infrastructure	$1,661,049
Monitoring and evaluation	$2,909,860
Management	$1,248,811
Other HIV care	$11,358,064
Other HIV costs	$2,570,175
Total non-targeted HIV program budget	$29,598,842

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