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

SERBIA

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Optima HIV

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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 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 Institute of Public Health of Serbia "Dr Milan Jovanovic Batut", the Global Fund, UNAIDS, Swiss Tropical and Public Health Institute, and the Burnet Institute.

Summary and key recommendations for HIV resource optimization include:

- Serbia has a concentrated HIV epidemic with a high prevalence among men who have sex with men (6% in 2021) (2); prevalence among people who inject drugs and sex workers were estimated to be 2.3% and 1.5%, respectively (3).
- In 2021 an estimated US$18.3M was spent on targeted HIV interventions, 98% of which were on antiretroviral therapy (ART) and opioid substitution therapy (OST), funded by Republic Health Insurance Fund. An estimated US$0.4M was spent in 2021 on HIV testing and counselling services and prevention activities, funded by Ministry of Health, Global Fund and other international funding partners.
- The cost of delivering HIV treatment in Serbia is relatively high (US$6,778 per person per year), and just maintaining current ART coverage levels will require high ongoing spending unless efficiency can be improved through procurement of cheaper antiretrovirals.
- **Potential savings from reduced ART unit costs (e.g. through procurement of cheaper antiretrovirals) could be reinvested among HIV programs funded by the Republic Health Insurance Fund; optimally this would include further scale-up of ART followed by investment in pre-exposure prophylaxis (PrEP).** There are people currently diagnosed but not on treatment, and if they could be reached, this could reduce mortality and new infections. Currently, PrEP is only available out-of-pocket in Serbia, but an implementation protocol is being developed with potential for PrEP to be included by Republic Health Insurance Fund as part of the prevention package to further reduce new HIV infections.
- In a baseline scenario with 2021 spending on all programs maintained, including a fixed annual spending on ART, there were an estimated 2,020 new HIV infections, 302 HIV-related deaths and 9,207 HIV-attributable disability-adjusted life years (DALYs) over 2023-2030.
- **Optimizing 2021 spending among HIV programs co-funded by the Ministry of Health and Global Fund would involve scale-up of HIV programs for men who have sex with men.** This optimization addresses the high proportion of new HIV infections occurring among men who have sex with men.
- **With additional resources available, priorities were identified as increased investment in HIV testing services and prevention programs for men who have sex with men and people who inject drugs.** Despite the lack of evidence of increased HIV infections among people who inject drugs, recent behavioral data suggest a possible increase in needle sharing behavior (4), therefore continued HIV surveillance for people who inject drugs remains a high priority.
- Moving from the 86-76-86 care cascade modeled in 2021[1] to reach the 95-95-95 targets by 2030 will require progress on all pillars. Meeting the 95% diagnosis target may be possible with optimized allocation of an additional US$6.4M per annum, or a total 135% of 2021 targeted spending. Meeting the 95% treatment and 95% viral suppression targets will require continued expansion of ART coverage through ongoing increases in spending or decreases in procurement costs, and novel programs to improve linkage to care and treatment adherence that are not costed in this analysis.

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

1 Background

In 2021 Serbia had an estimated population size of 7.3 million and an estimated 3,600 people living with HIV (2, 5). Serbia has an HIV epidemic concentrated primarily among men who have sex with men (MSM), with an estimated population size of 40,000 in 2018 and HIV prevalence of 6% in 2021 (2). Sex workers (SW), including female and male sex workers, as well as people who inject drugs (PWID) are other important key population groups. Sex workers have a relatively smaller population size, with a latest population estimate of 3,901, and approximately 30% were male in years pre-pandemic (4, 6). The HIV prevalence among male sex workers was believed to be similar to MSM due to clients being mostly males, but estimated prevalence was as high as 20% in 2021; prevalence among female sex workers was estimated to be 0.5% in 2021 (2). Population size of PWID was estimated to be 20,000 in 2014 with a decreasing trend; the prevalence of HIV was estimated to be 2.3% among PWID in 2021 however uncertainty remains due to small sample size (4). National data suggest that frequency of injecting increased by around 1.4-fold since 2008; prevalence of using shared needles/syringes has also increased from approximately 16% to >30% between 2013 to 2021, although this may reflect changed survey methodology more than underlying change in behavior (4, 7). In line with increasing HIV prevalence among other countries in the region (3, 8), these data warrant continued HIV surveillance among PWID in Serbia.

The HIV response in Serbia has been mostly funded from domestic sources; available data suggested 70% of reported HIV expenditure was from domestic sources in 2013 (9), and this percentage increased to 99% in 2015 (10) after the Global Fund (GF) ended its support of HIV prevention services in Serbia (11). In 2021, total annual spending on HIV programs was estimated to be US$19.5M based on national program data. In Serbia, drug costs of antiretroviral therapy (ART) and opioid substitution therapy (OST) were covered by Republic Health Insurance Fund (RHIF) and together accounted for 98% of the US$18.3M targeted HIV program expenditures. On the other hand, prevention and testing services, including counselling and preventative activities for key populations, and voluntary HIV counselling and testing services provided in community as well as by a nationwide network of public health institutes for all populations, were co-funded by the Ministry of Health (MoH), GF and other international funding organizations (10). GF grant support since 2019 has been focused on institutionalizing HIV prevention services under the MoH, and since 2019, over US$0.3M has been provided each year for HIV prevention interventions among key populations in Serbia, accounting for over half of the expenditures on programs co-funded by MoH and GF.

The national response to the HIV epidemic is guided by Serbia's National Strategy for Prevention and Control of HIV Infection and AIDS (2018-2025). The strategy recognizes the main areas of prevention, treatment and care for people living with HIV (PLHIV), human rights protection, stigma and discrimination, quality standards, and strategic information for action. ART is fully funded by RHIF: in 2021, 2,289 PLHIV were on treatment, but an estimated one quarter of people who know their status were not covered by ART, most of whom may have

been diagnosed prior to 2016 when the treatment eligibility was determined by initial CD4 count at the time of diagnosis (2).

This is the first Optima HIV analysis in Serbia, 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 Ministry of Health and Institute of Public Health of Serbia "Dr Milan Jovanovic Batut". Epidemiological and program data were provided by the country team and validated during a regional workshop that was held in September 2022 in Istanbul, Turkey. Country teams were consulted before and after the workshop on data collation and validation, objective and scenario building, and results validation. Demographic, epidemiological, behavioral, programmatic, and expenditure data from various sources including UNAIDS Global AIDS Monitoring and National AIDS Spending Assessment reports, integrated bio-behavioral surveillance surveys, national reports and systems were collated. In Serbia, 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$18.3M of the total annual spending. The allocative efficacy analysis was conducted using Optima HIV, an epidemiological model of HIV transmission overlayed with a programmatic component and a resource optimization algorithm. A detailed description of the Optima HIV model has been published by Kerr et al (12).

3.1 Populations and HIV programs

Populations considered in this analysis were:

- Key populations
  - Men who have sex with men (MSM)
  - Male sex workers (MSW)
  - Female sex workers (FSW)
  - Males who inject drugs (MWID)
  - Females who inject drugs (FWID)
- General populations
  - Males 0-17 (M0-17)
  - Females 0-17 (F0-17)
  - Males 18-49 (M18-49)
  - Females 18-49 (F18-49)
  - Males 50+ (M50+)
  - Females 50+ (F50+)

Targeted HIV programs were disaggregated by funding source. Programs considered in this analysis were:

A) Targeted HIV programs - RHIF
  - Antiretroviral therapy (ART)
  - Opioid substitution therapy (OST)
  - Pre-exposure prophylaxis (PrEP)

B) Targeted HIV programs – MoH/GF
  - HIV testing and prevention programs for MSM (MSM programs)
  - HIV testing and prevention programs for PWID and needle-syringe program (NSP) (PWID programs)
  - HIV testing and prevention programs for sex workers (SW programs)
  - HIV voluntary counseling and testing for the general population and key population through the network of public health institutions (HIV VCT)

3.2 Model constraints

Within the optimization analyses, no one on treatment, including ART or OST, can be removed from treatment, unless by natural attrition. Minimum constraint of 100% was applied to HIV VCT programs to acknowledge their significance in diagnosing PLHIV, as suggested by in-country experts. 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. This weighting was selected to balance progress against both indicators while reflecting a higher importance of preventing deaths. Objective 3 weightings were to reach 95% diagnosis by 2030 with the minimal possible total spending.

3.5 Budget optimizations

Programs with different funding sources were optimized separately; this is because funds cannot be re-allocated from RHIF programs to MoH/GF programs, or the other way around. A supplementary optimization analysis with combined funding is presented in Appendix 5. For each optimization, assumptions were made regarding the baseline scenario, as described below.

Note the baseline projections for each optimized allocation differ from each other and from the baseline projection for the 95-95-95 scenario, due to different assumptions on programs spending (Table 1). Both baseline scenarios for optimization analysis were designed to capture the impacts of optimizing only one set of all programs including the potential for increased or decrease resource allocation through only one funding source, while assuming "Business as usual" would continue via the other funding source. Baseline scenarios are not intended to be compared with each other.

A) RHIF programs optimization:

RHIF programs refer to ART, OST and PrEP programs in this analysis. Note that PrEP is not currently funded; organized system for use of PrEP is not in place and users pay for PrEP out-of-pocket. The PrEP protocol, referral and delivery model is under development with a potential to be funded by the Republic Health Insurance in Serbia. This program was included due to growing interest in funding PrEP from in-country stakeholders; assumptions were suggested by in-country experts, including a unit cost of US$800, a focus on MSM and MSW, and 100% coverage for exposure events for individuals covered by PrEP (further details in Table A3-A4).

The purpose of RHIF programs optimization is to explore optimized budget allocation plans and their impacts with different budget levels. Because of the constraints on not removing

anyone from ART or OST, only optimization at 125% and 150% of current spending allow for reprioritization of budget. Additionally, optimization of spending among RHIF programs at an increased total budget level can be interpreted as a proxy to inform prioritization within ART, OST and PrEP when any additional resources were made available by reduced ART unit cost.

The impacts of optimized scenarios were compared against the baseline scenario, which assumed that annual spending on ART, OST and PrEP was maintained. This is a counterfactual scenario created for comparison with budget optimizations and is different to an epidemic projection where spending on ART increases over time to maintain a fixed percentage of people diagnosed on treatment. The parameters affected by prevention programs were assumed to be constant so impacts from optimization within RHIF programs can be distinguished; the costs of prevention programs were not considered when conducting optimization for RHIF programs.

B) MoH/GF programs optimization:

MoH/GF programs refer to prevention programs for MSM, PWID, SWs, and HIV VCT for general and key population in this analysis. Optimized resource allocation was explored for scenarios with different budget levels.

The impacts of optimized scenarios were compared against the baseline scenario, which assumed annual spending on MoH/GF programs was maintained with constant coverage proportion of ART (with implied increases in spending) and OST; the costs of RHIF programs were not considered when conducting optimization for MoH/GF programs. A comparison of assumptions on programs coverage under RHIF programs optimization and MoH/GF programs optimization is summarized in Table 1.

Table 1. Comparison of assumptions of baseline scenario when optimizing RHIF programs or MoH/GF programs

	HIV prevention programs	*ART and OST programs*
Baseline scenario for RHIF programs optimization	Fixed proportion (i.e. coverage proportion of prevention programs remain the same as 2021 level, implying a slight decrease in spending due to projected lower key population sizes in the future)	Fixed spending
Baseline scenario for MoH/GF programs optimization	Fixed spending	Fixed proportion of ART, fixed spending on OST (i.e. (1) coverage proportion of ART among diagnosed PLHIV remain as 2021 level, implying an increase in ART spending due to a rising number of diagnosed PLHIV, with that increase depending on the allocation to MoH/GF programs, and (2) a slight increase in the proportion of people who use drugs covered by OST due to a projected

		decrease in the number of PWID in the future)

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 Serbia total reported spending on HIV from domestic and international sources was US$19.5M in 2021, incorporating US$18.3M targeted HIV spending for the programs considered above (includes domestic funding from RHIF (98%) and MoH/GF (2%)), and US$1.2M non-targeted spending. The majority of targeted spending was for ART (85%) and OST (13%), each funded through RHIF. MoH/GF funding supported HIV VCT conducted through public health institutions and community-based prevention and testing programs for MSM, PWID and SW (Figure 2; Table A5, Table A6). PrEP is not currently funded but the protocol, referral and delivery model are under development to be considered for inclusion under RHIF funding. 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 other non-targeted HIV program costs (Table A8).

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$6778 in 2021), annual spending on ART would need to increase by US$3.3M (21% of 2021 ART spending) from 2022 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 achieve greater ART coverage and approach 95 targets, additional funds beyond US$3.3M annually would be required if the unit cost of ART is sustained.

Different from a fixed ART coverage scenario, a counterfactual "baseline" scenario with fixed annual spending on ART was used to compare scenarios with optimized allocation of resources within a fixed budget envelope among RHIF programs, including meeting the needs for additional treatment. The different epidemic projections of a fixed ART spending scenario and fixed ART coverage scenario are shown in Figure 1b and 1c.

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 modeled or costed in this analysis. Although treatment

is available to all diagnosed people living with HIV in Serbia, 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).

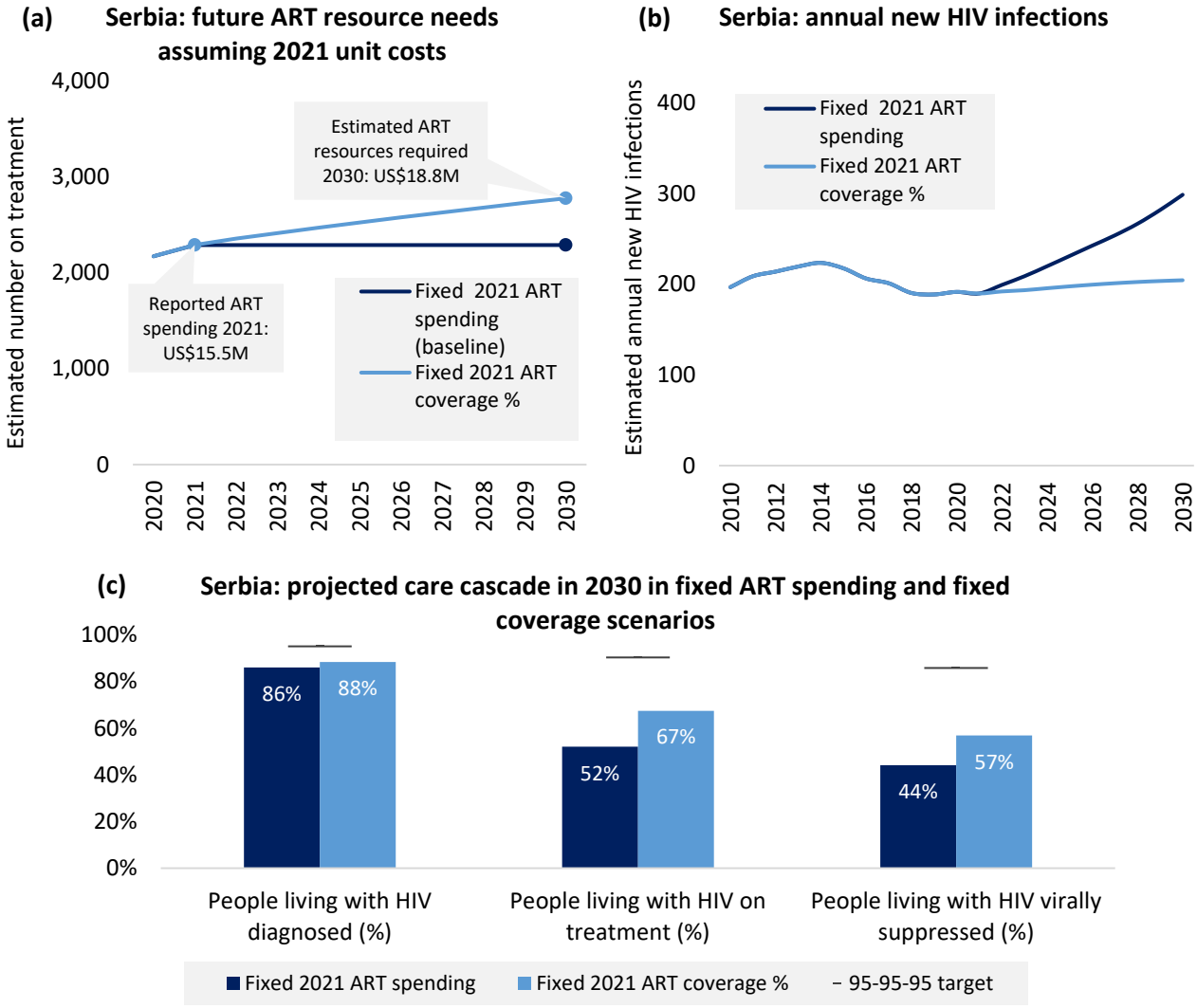


Figure 1. Fixed proportional coverage of people living with HIV on ART compared to fixed ART spending: resource needs and epidemic outcomes by 2030. Panels show (a) Resources required to maintain 2021 proportional coverage of ART among people living with HIV until 2030 if ART unit cost remains constant;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

Optimized resource allocation of RHIF spending:

Baseline scenario. Under the baseline scenario assuming fixed annual spending on ART and OST, the model projects that there would be 2,003 new HIV infections, 302 HIV-related deaths

and 9,192 HIV-attributable DALYs over 2023-2030 (assumption details in section 3.5 (A)). The HIV care cascade in this scenario was projected to be "86-61-85" in the year 2030 (i.e. 86% people diagnosed, 61% people diagnosed on treatment and 85% people on treatment virally suppressed) (Figure 1; Table 2).

The low proportion of people on treatment in 2030 reflects that ART spending (or ART coverage if unit cost could be reduced) will need to increase over time just to maintain constant percentage treatment coverage, since more people will continue to be diagnosed. Current estimated unit cost of ART in Serbia is US$6,778, which is much higher compared to other upper-middle income countries in the EECA region that also receive support from GF (13). Procurement of new drug regimens, price negotiations and licensing agreements to reduce the unit cost of ART would improve the implementation efficiency of the HIV treatment program in Serbia (13). Under the current budget structure, cost-savings could be reallocated to further increase the number of people on ART, increase spending on OST, or support the provision of PrEP.

Optimized RHIF resource allocation at different budget levels. Optimization of 125% and 150% of 2021 spending level identified that further scale-up of ART should be prioritized, followed by PrEP (Figure 2a). Assuming that more 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.

At levels of spending beyond 150%, the main gap in care cascade is the loss to follow-up of people diagnosed, 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.

Impact of RHIF budget optimization on HIV epidemic. Compared with the baseline scenario, optimization of 125% of 2021 RHIF spending could avert 780 new infections (39%), 74 deaths (25%) and 1,812 (20%) DALYs over 2023-2030 (Figure 4). This benefit increases to 51% infections, 26% deaths and 21% DALYs averted with an optimized 150% budget

Optimized resource allocation of MoH/GF spending:

Baseline scenario. Under the baseline scenario assuming fixed annual spending on prevention programs and HIV VCT, and fixed coverage of ART, the model projects that there would be 1,726 new HIV infections, 264 HIV-related deaths and 8,220 HIV-attributable DALYs over 2023-2030 (assumption details in section 3.5 (B)). In the year 2030 the HIV care cascade would be "88-73-85" (i.e. 88% people diagnosed, 73% people diagnosed on treatment and 85% people on treatment virally suppressed) (Figure 4, Table 3).

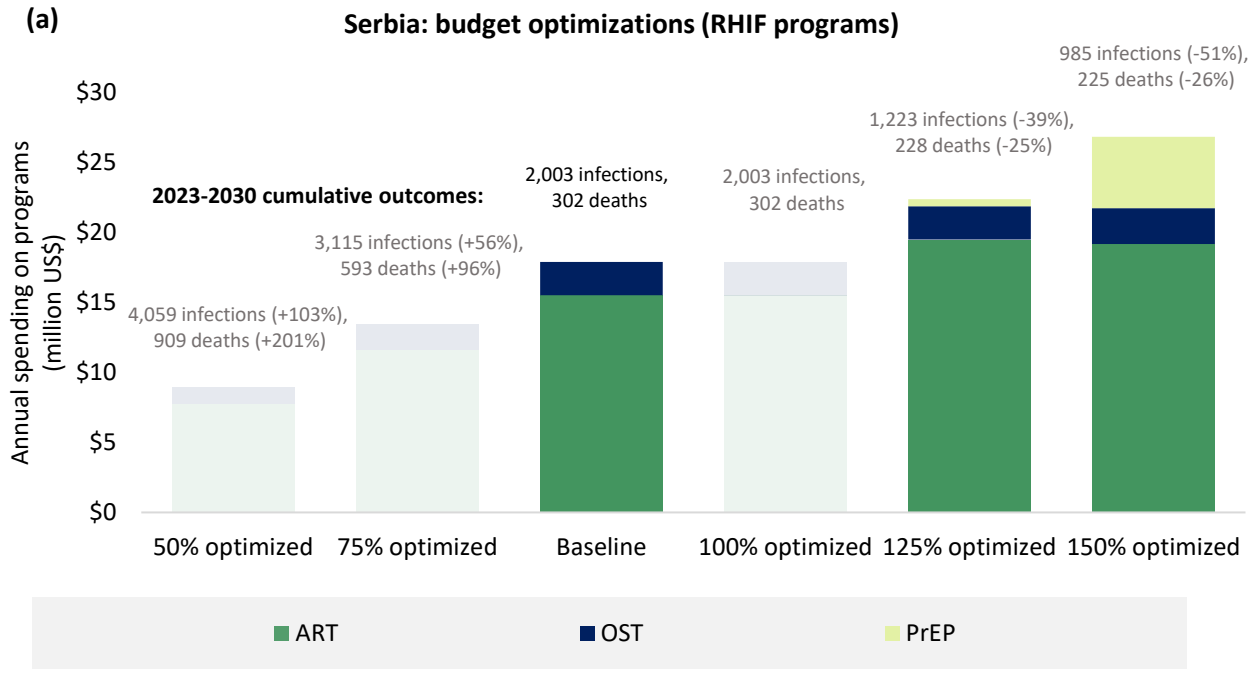
Optimized MoH/GF resource allocation of 2021 spending. Optimization of 2021 spending among MoH/GF programs prioritized scaling up testing and prevention programs for MSM, with the budget reallocating from programs for PWID and SW (Figure 2b). The prioritization

of programs for MSM addresses the continued disease burden and new infections among MSM- it was estimated 85% of new infections in 2021 occurred among MSM and this percentage is projected to increase. The model deprioritized programs for other key populations to enable greater investment into these higher impact programs.

Optimized MoH/GF resource allocation at different budget levels. As the total budget envelope among MoH/GF programs increased, the priorities were identified as continued investment in programs for PWID to curb the potential rising prevalence among this group. Funding was reduced for programs for people who inject drugs in 2014 in line with ending the GF grant. There was no domestic financing of prevention programs for key populations in the period 2015-2019, while limited international funds were available for needle-syringe programs in the region outside of GF. Recent behavioral data from 2021 suggests there may have been some increase in needle sharing among people who inject drugs (4).There is no evidence of increasing HIV infections among people who inject drugs, but continued HIV surveillance for people who inject drugs remains a high priority.

If funding among MoH/GF programs were reduced, priorities were identified as maintaining HIV VCT programs, MSM programs, followed by PWID programs.

Impact of MoH/GF budget optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 MoH/GF budget spending could avert 15 new infections (1%) and zero deaths over 2023-2030 (Figure 4). This increases to 8% infections, 2% deaths and 2% DALYs averted with an optimized 150% budget (+US$178,000). The relatively low projected impact is because the MoH/GF optimization only includes 2% of total spending, and increases in absolute budget amounts (e.g. 150%) are small.



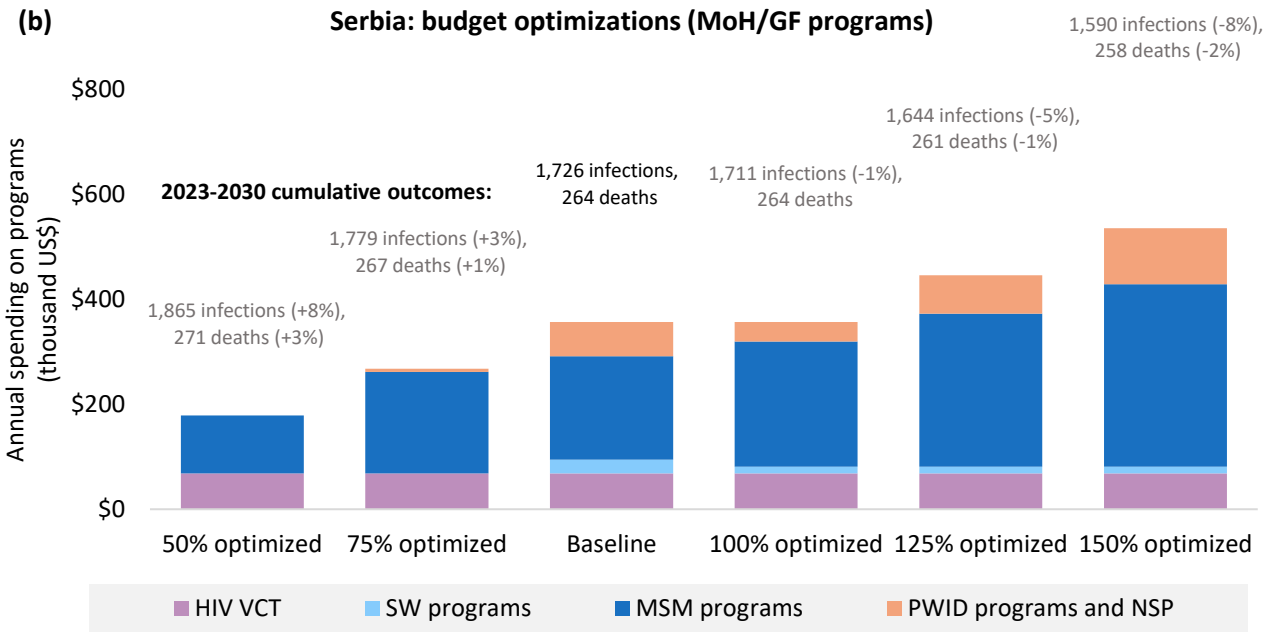


Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030. Percentage optimized refers to the percentage of baseline HIV funding at a given budget level. Panel show (a) budget optimization among RHIF programs; and (b) budget optimization among MoH programs. ART, antiretroviral therapy; DALY, disability-adjusted life year; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, needle-syringe program; OST, opioid substitution therapy; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.

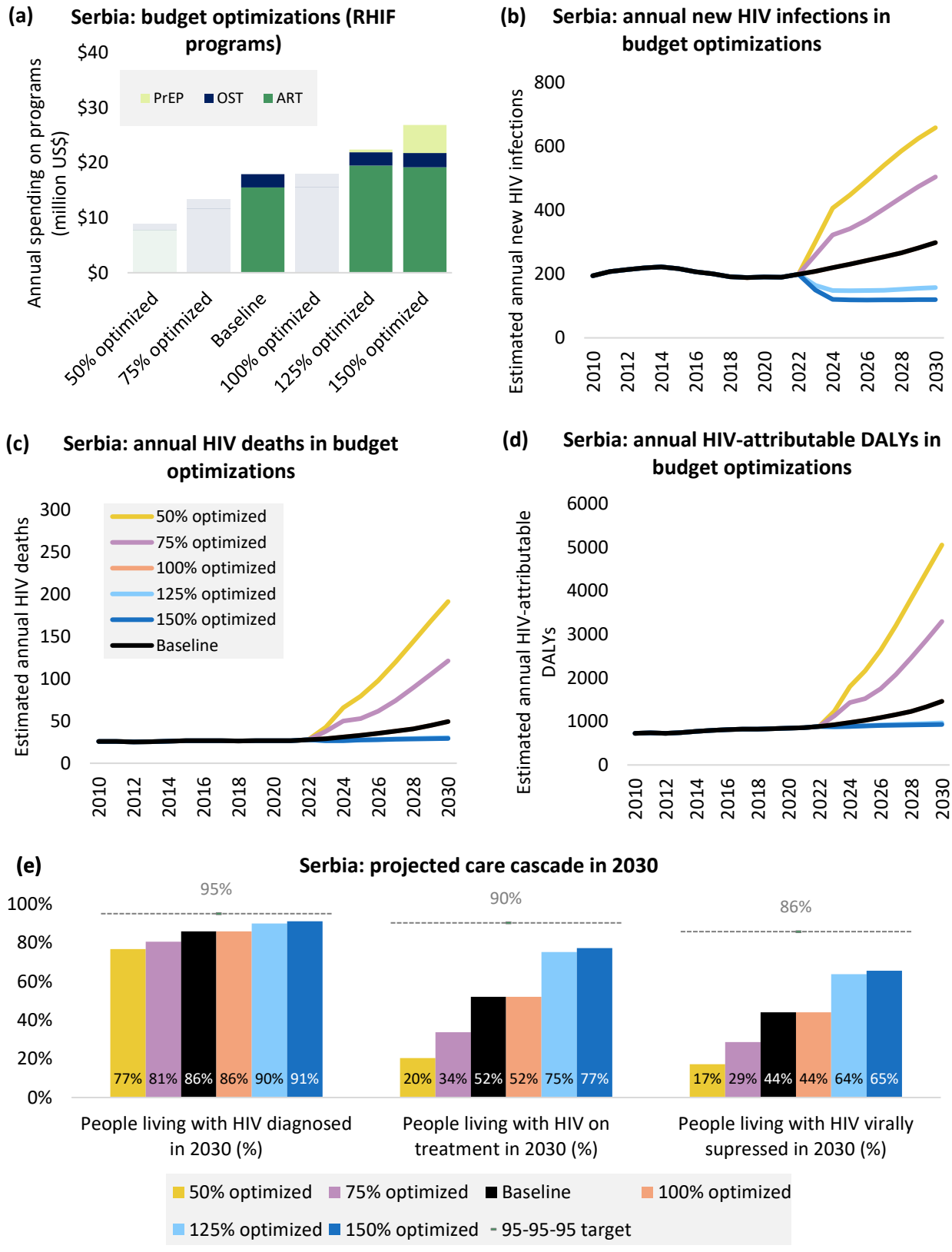


Figure 3. Model outcomes from budget optimization among RHIF programs scenarios aiming to minimize infections and deaths. Panels show (a) optimal budget allocations under varying levels of annual HIV

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. ART, antiretroviral therapy; DALY, disability-adjusted life year; OST, opioid substitution therapy; PrEP, pre-exposure prophylaxis.

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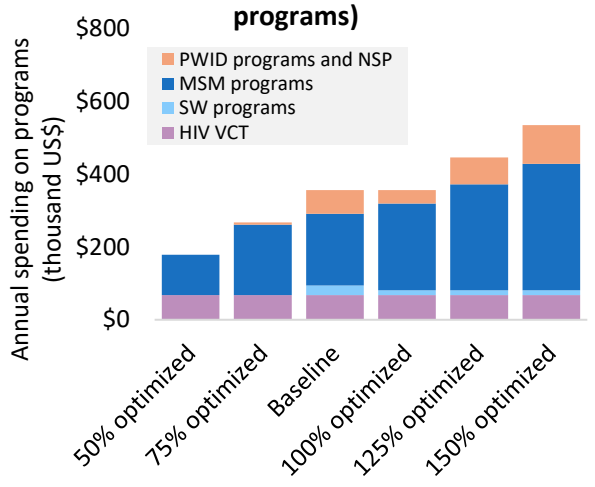
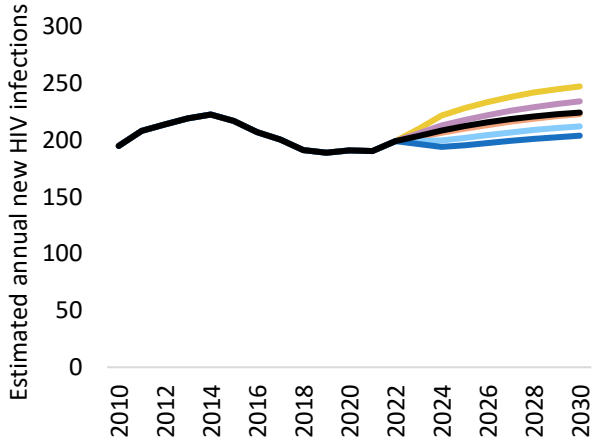
Allocation of HIV resources towards maximizing the impact of funding

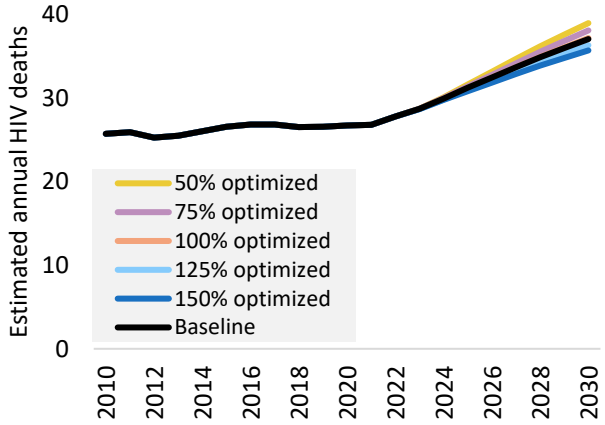
(a) Serbia: budget optimizations (MoH/GF programs)



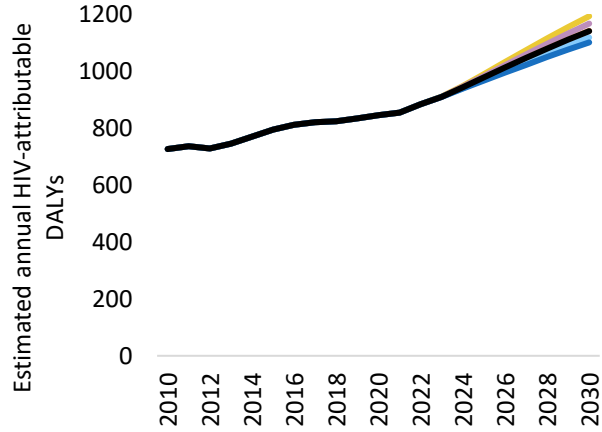
(b) Serbia: annual new HIV infections in budget optimizations



(c) Serbia: annual HIV deaths in budget optimizations



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



(e) Serbia: projected care cascade in 2030

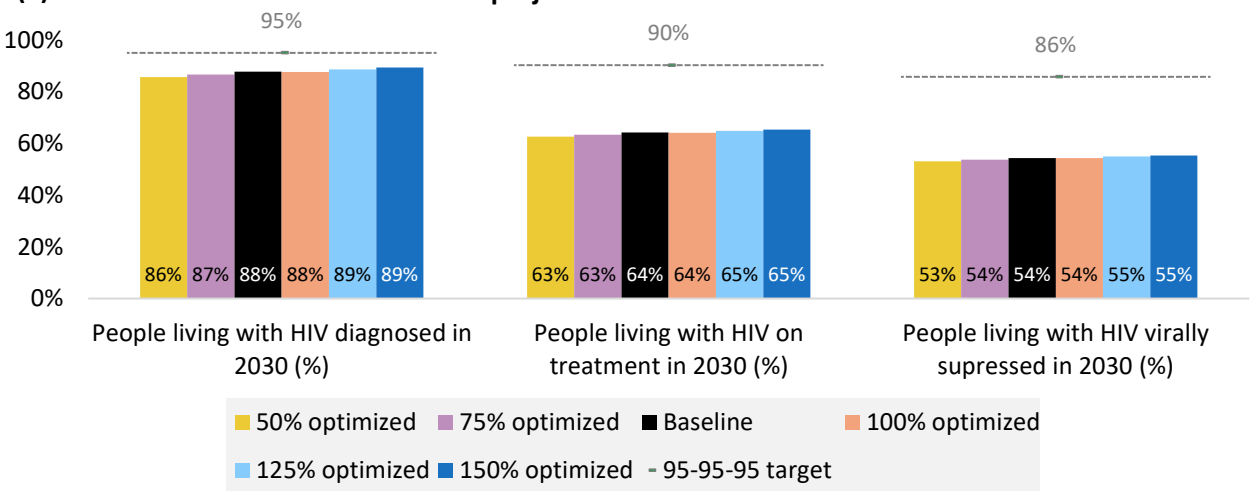


Figure 4. Model outcomes from budget optimization scenarios among MoH/GF programs aiming to minimize infections and deaths. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of current HIV funding; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) projected care cascade for the year 2030. DALY, disability-adjusted life year; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, needle-syringe program; PWID, people who inject drugs; SW, sex workers.

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** and DALYs?*

Zero HIV RHIF spending. The continued investment in HIV programs is essential to avoid epidemic rebound. In a scenario with no HIV spending on RHIF programs from 2023, the model estimates that there would be additional 3,698 (+185%) new infections, 1,219 (+404%) more deaths and 30,022 (+327%) more DALYs over 2023-2030, compared to the baseline scenario of fixed annual spending on RHIF programs (Table 2).

Table 2. Cumulative new HIV infection, HIV-related deaths, HIV-related DALYs between 2023-2030 under different scenarios of optimizing budget among RHIF programs, 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 on RHIF programs from 2023	5,701	1,521	39,214	185%	404%	327%
Baseline	2,003	302	9,192			
125% optimized	1,223	228	7,380	-39%	-25%	-20%
150% optimized	985	225	7,256	-51%	-26%	-21%

Percentage optimized refers to percentage of baseline spending.

Zero HIV MoH spending. In a scenario with no HIV spending on MoH/GF programs from 2023, the model estimates that there would be additional 252 (+15%) new infections, 12 (+5%) more deaths and 341 (+4%) more DALYs over 2023-2030, compared to the baseline scenario of fixed annual program spending (Table 3).

Table 3. Cumulative new HIV infection, HIV-related deaths, HIV-related DALYs between 2023-2030 under different scenarios of optimizing budget among MoH/GF programs, 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 on MoH/GF programs from 2023	1,978	276	8,561	15%	5%	4%
50% optimized	1,865	271	8,416	8%	3%	2%
75% optimized	1,779	267	8,311	3%	1%	1%
Baseline	1,726	264	8,220			
100% optimized	1,711	264	8,218	-1%	-	-
125% optimized	1,644	261	8,126	-5%	-1%	-1%
150% optimized	1,590	258	8,056	-8%	-2%	-2%

Percentage optimized refers to percentage of baseline spending.

4.3 Objective 3

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

Based on both baseline and 100% optimized spending (all sources), Serbia'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).

To reach the 95% diagnosis target, a minimal additional US$6.4M per annum, or a total 135% of 2021 spending, was required over 2023-2030 (Figure 5; Table A7). The total US$24.7M was optimized by achieving high coverage of treatment (87% of spending allocated to ART) and full scale-up of prevention programs for MSM and PWID (2% and 1% of spending, respectively). Continued expansion of programs for MSM and PWID is projected to be enough to reach the 95% diagnosis target. Continued expansion of ART coverage through ongoing increases in spending or decreases in the procurement cost of antiretroviral drugs will support progress toward the 95% treatment target.

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

Achieving the 95-95-95 targets could avert 1,340 (66%) new infections, 153 (51%) deaths and 3,701 (40%) DALYs compared to the baseline scenario of fixed 2021 spending on programs and no improvements to linkage to care or treatment adherence (Figure 5).

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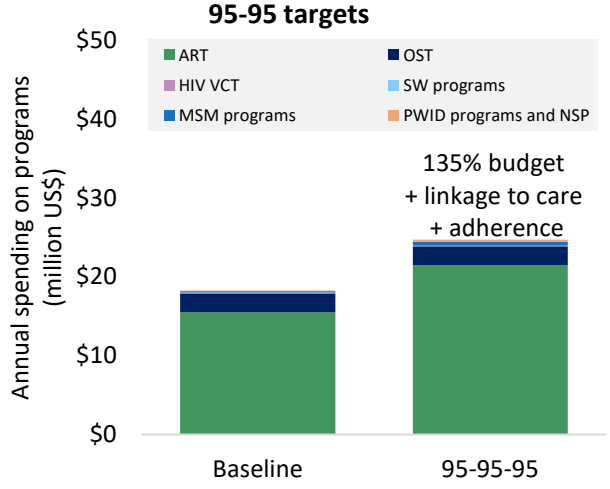
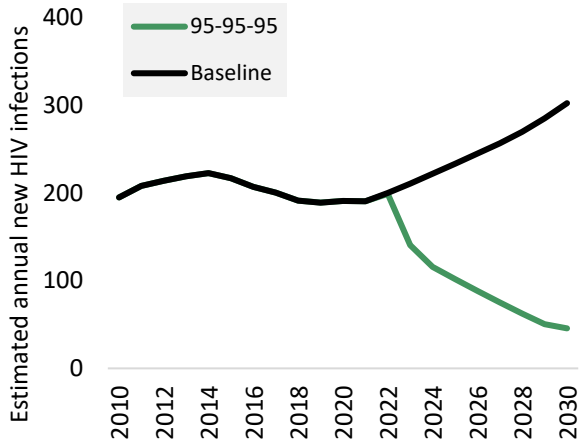
Allocation of HIV resources towards maximizing the impact of funding

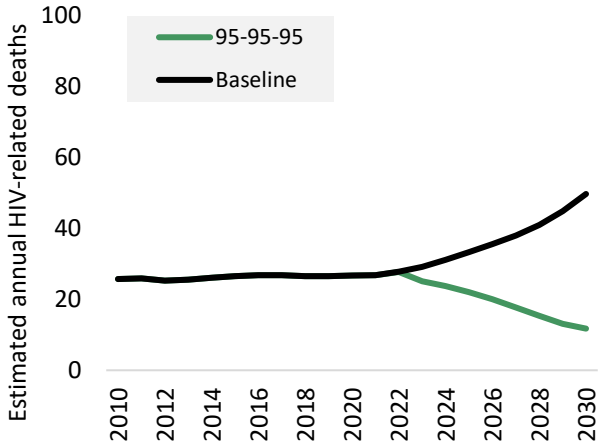
(a) Serbia: optimized budget to achieve 95-95-95 targets



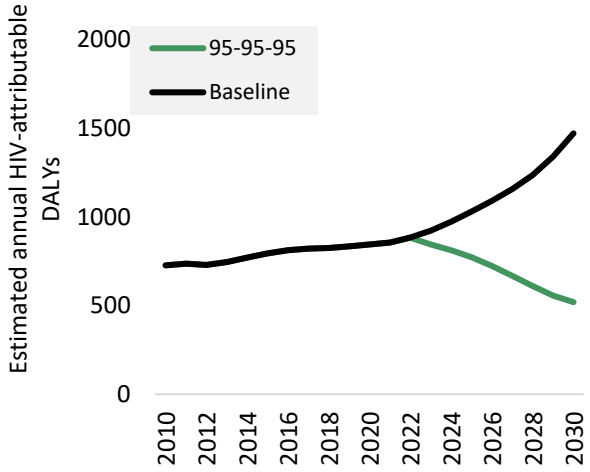
(b) Serbia: annual new HIV infections in 95-95-95 scenario



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



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



(e) Serbia: projected care cascade

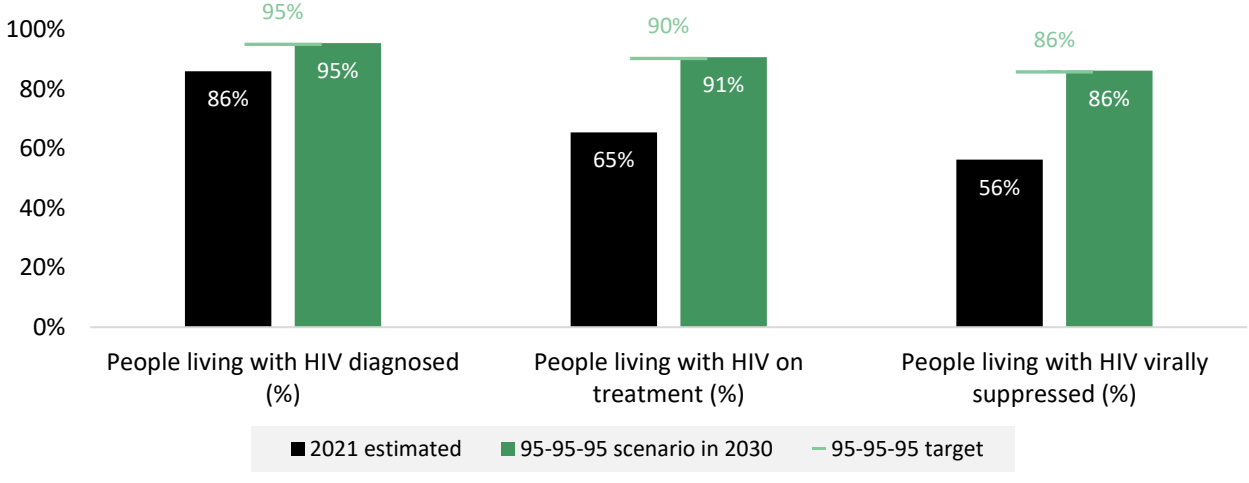


Figure 5. Optimized HIV budget level and allocation to achieve 95-95-95 targets by 2030. Panels show (a) optimal budget allocations; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) estimated care cascade in baseline year 2021 and projected for the year 2030 as a proportion of all people living with HIV. ART, antiretroviral therapy; DALY, disability-adjusted life year; SW, sex worker; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; OST, opioid substitution therapy; PWID, people who inject drugs.

5 Comparison with past spending

This is the first Optima analysis for Serbia, so no comparison of previous HIV spending between Optima analyses is available.

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, particularly since national consensus estimates are considered less reliable than mathematical estimates, for which the latest reported estimates are from 2011 for MSM and SWs and 2014 for PWID in Serbia. Key populations stigma may lead to underestimation of population size. This may influence estimates of people living with HIV and subsequently, service and funding needs for each key population.
- **Epidemiological indicators** come from IBBS among key population surveys or surveillance and programmatic data that have varying degrees and types of biases. Uncertainty in these indicators combined with uncertainty in population sizes can lead to uncertainty in model calibration and projected baseline outcomes and subsequently, service and funding needs for each key population.
- **Effect (i.e. impact) sizes for interventions** are taken from global literature (e.g. the effectiveness of condom use for preventing infections). Actual program impacts may vary depending on context or quality of implementation.
- **Geographical heterogeneity** is not modeled, and outcomes represent national averages. There may be opportunities for additional efficiency gains through appropriate geographical targeting.
- **Cost functions for each program** are a key driver of model optimizations. Cost functions determine how program coverage will change if funding is reallocated, as well as maximum achievable program coverage. There is uncertainty in the shapes of these cost functions, values which could influence how easily or how high programs could be scaled up.
- **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.
- **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.
- **Other:** Baseline scenario projections should be interpreted with caution, as assumptions were made when projecting future trends in a baseline scenario. In this analysis, several baseline scenarios were created with different assumptions in order to capture the impact of optimizing spending from only one budget source at a time (see details in section 3.5 and Table 1). These baseline scenarios are not intended to be compared with each other and represent counterfactuals; for example in the RHIF programs optimization baseline the baseline is what could happen if no additional spending was available for HIV treatment, so the comparison between the optimized and baseline allocations captures the need for ongoing investment rather than the most likely projections.

7 Conclusions

This modeling analysis evaluated the allocative efficiency of direct HIV programs in Serbia. The high cost of ART (US$6,778 per person per year) is a barrier to optimizing resource allocation and reaching 95-95-95 targets, and improvements will require scaled up investment or cost efficiencies. Program priorities for RHIF were increasing investment or identifying means to reduce the unit cost of ART to enable maintenance and scale-up of treatment before scaling up PrEP.

Current ART costs per person per year are 180-450 times more than the cost of MSM, PWID and SW prevention programs per person per year. These key population prevention and testing programs could be optimized for higher impact with small absolute increase in spending (+US$178,000), reducing infections and future ART need. If cheaper ART drugs could be procured, then savings in HIV treatment could potentially be reinvested in HIV prevention programs, but this is currently limited by the HIV financing mechanisms in Serbia. Program priorities for MoH/GF were scaling up testing and prevention program coverage among MSM, followed by programs for PWID. 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 Serbia country team and international partners.

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University College London: Tom Palmer

UNAIDS: Eleanora Hvazdziova

8 Appendices

Appendix 1. Model parameters

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

Interaction-related transmissibility (% per act)		
	Insertive penile-vaginal intercourse	0.04%
	Receptive penile-vaginal intercourse	0.08%
	Insertive penile-anal intercourse	0.11%
	Receptive penile-anal intercourse	1.38%
	Intravenous injection	0.80%
	Mother-to-child (breastfeeding)	36.70%
	Mother-to-child (non-breastfeeding)	20.50%
Relative disease-related transmissibility		
	Acute infection	5.60
	CD4 (>500)	1.00
	CD4 (500) to CD4 (350-500)	1.00
	CD4 (200-350)	1.00
	CD4 (50-200)	3.49
	CD4 (<50)	7.17
Disease progression (average years to move)		
	Acute to CD4 (>500)	0.24
	CD4 (500) to CD4 (350-500)	0.95
	CD4 (350-500) to CD4 (200-350)	3.00
	CD4 (200-350) to CD4 (50-200)	3.74
	CD4 (50-200) to CD4 (<50)	1.50
Changes in transmissibility (%)		
	Condom use	95%
	Circumcision	58%
	Diagnosis behavior change	0%
	STI cofactor increase	265%
	Opioid substitution therapy	54%
	PMTCT	90%
	ARV-based pre-exposure prophylaxis	95%
	ARV-based post-exposure prophylaxis	73%
	ART not achieving viral suppression	50%
	ART achieving viral suppression	100%
Disutility weights		
	Untreated HIV, acute	0.18
	Untreated HIV, CD4 (>500)	0.01
	Untreated HIV, CD4 (350-500)	0.03
	Untreated HIV, CD4 (200-350)	0.08
	Untreated HIV, CD4 (50-200)	0.29
	Untreated HIV, CD4 (<50)	0.58
	Treated HIV	0.08

Source: Optima HIV User Guide Volume VI Parameter Data Sources

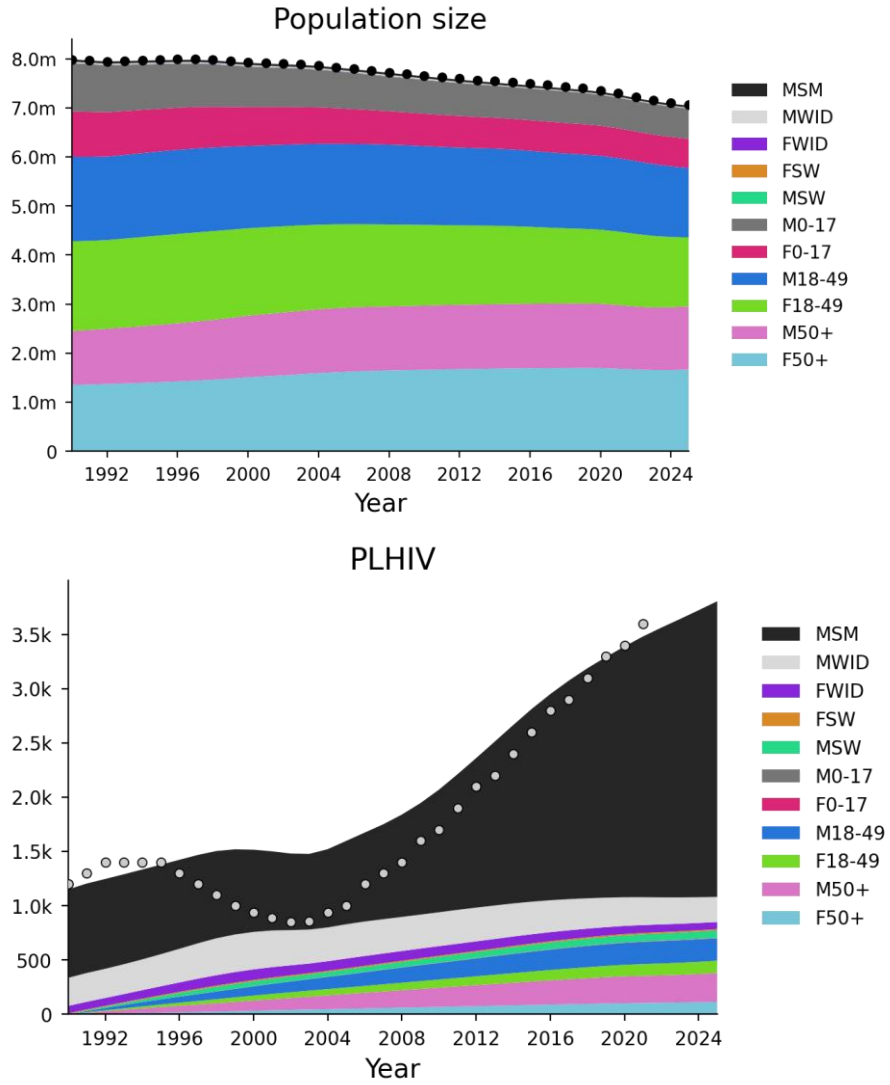
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

Treatment recovery due to suppressive ART (average years to move)		
	CD4 (350-500) to CD4 (>500)	2.20
	CD4 (200-350) to CD4 (350-500)	1.42
	CD4 (50-200) to CD4 (200-350)	2.14
	CD4 (<50) to CD4 (50-200)	0.66
	Time after initiating ART to achieve viral suppression (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.



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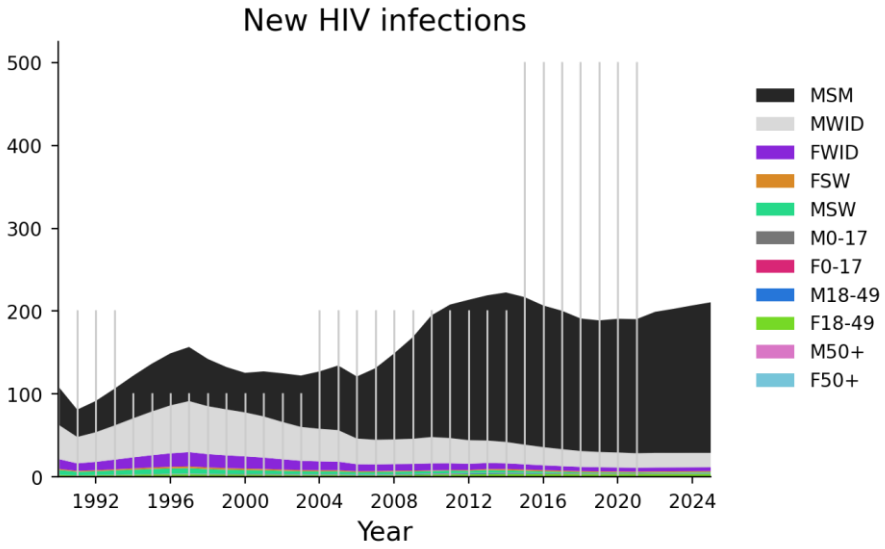

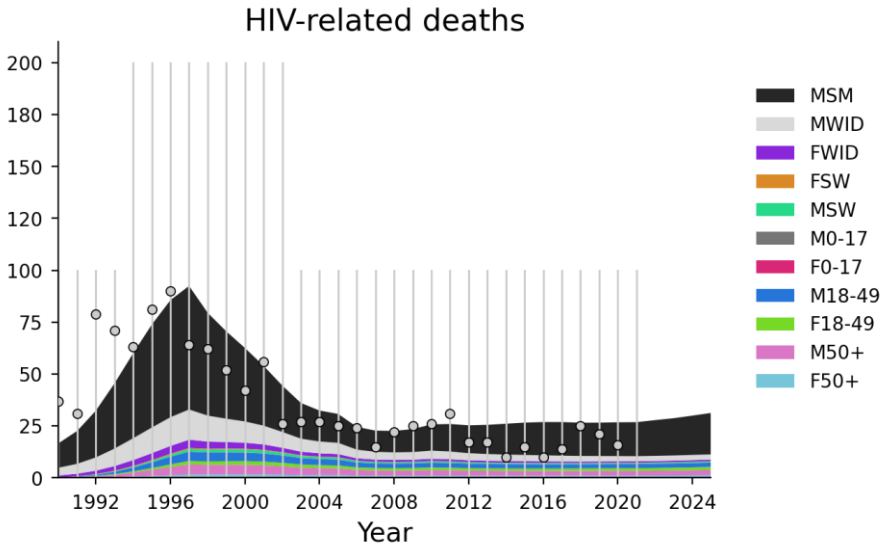

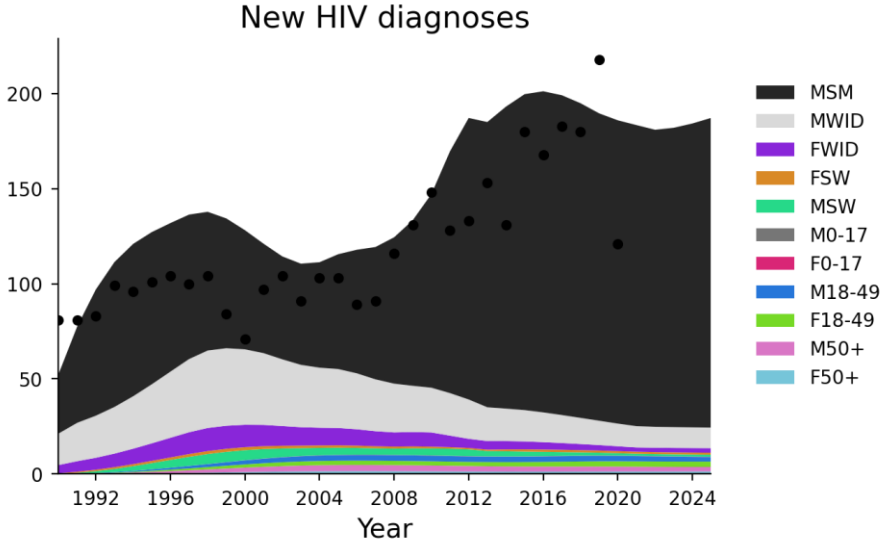

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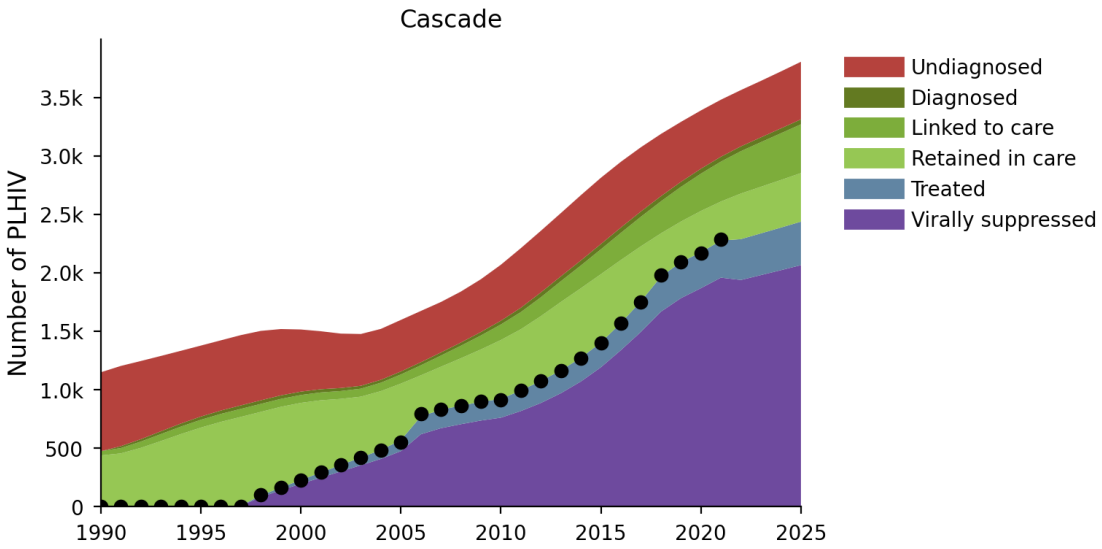
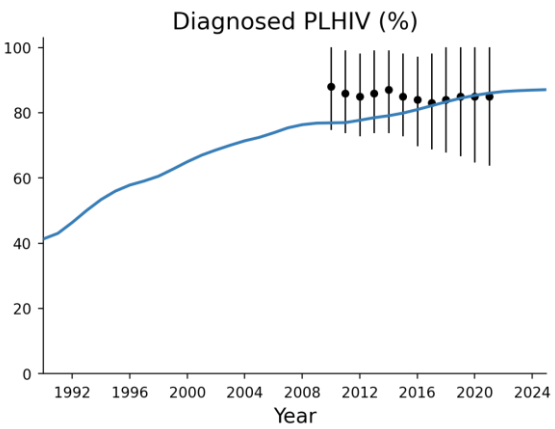
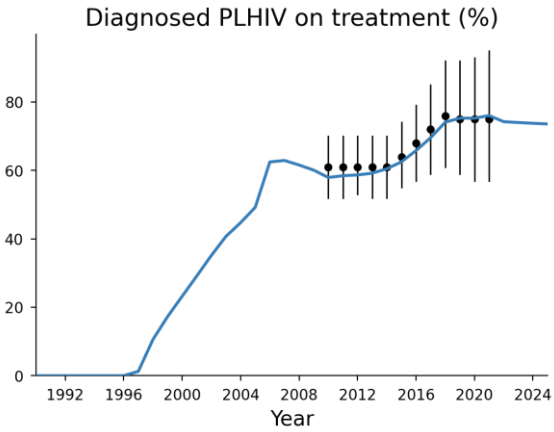
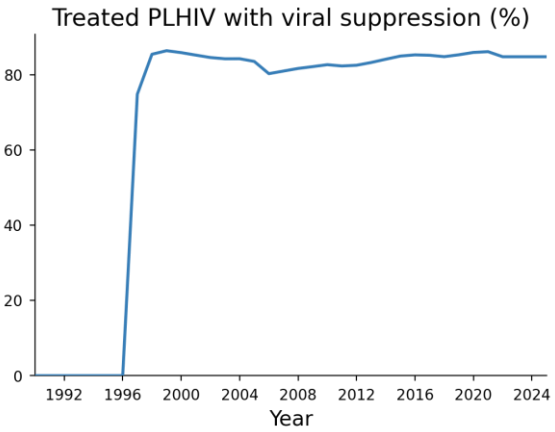
Allocation of HIV resources towards maximizing the impact of funding









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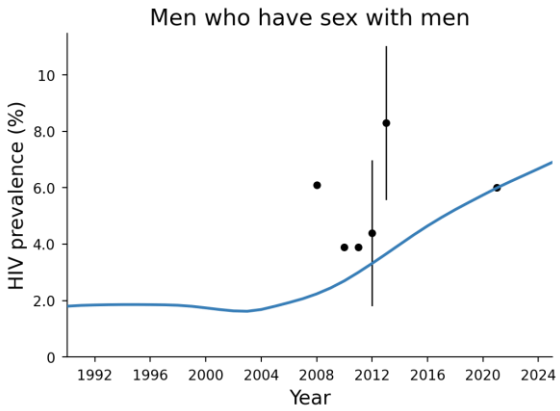
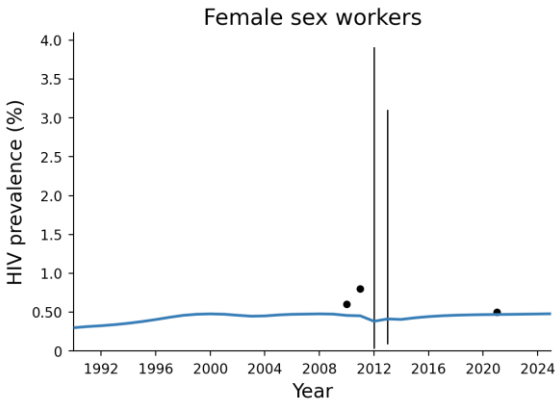
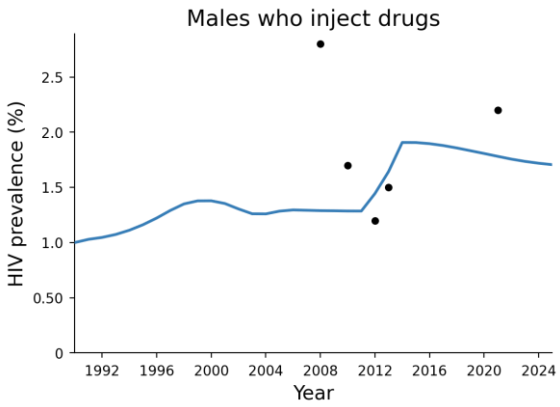
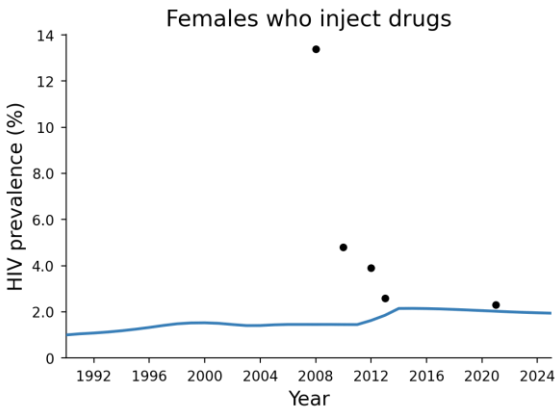
Allocation of HIV resources towards maximizing the impact of funding









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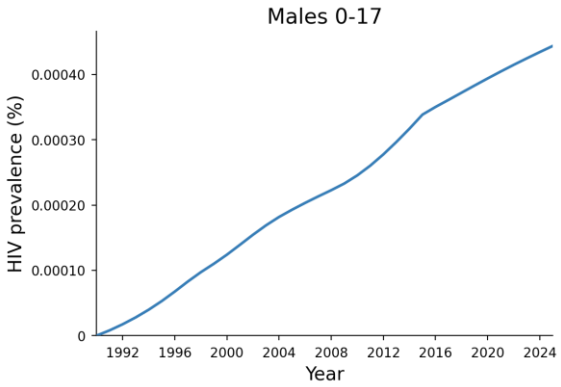
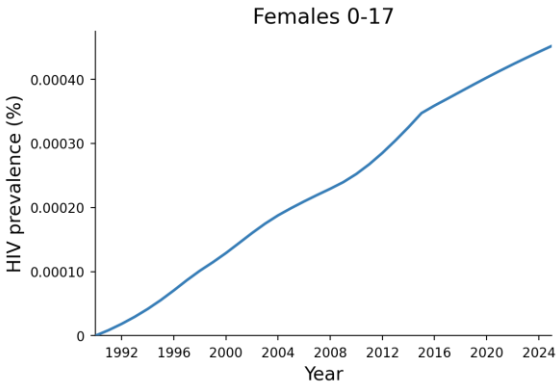
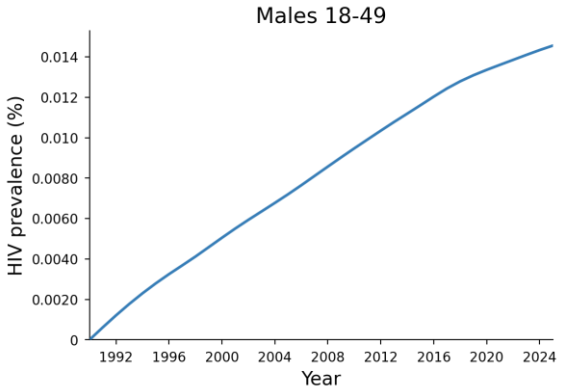
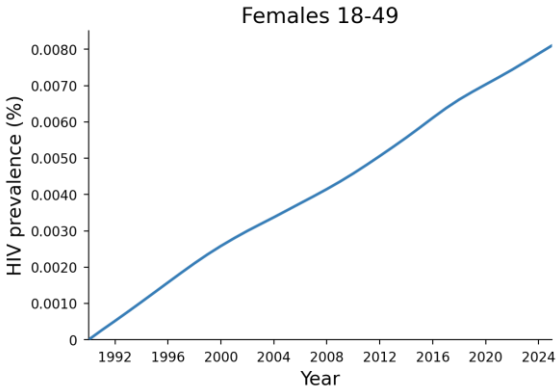
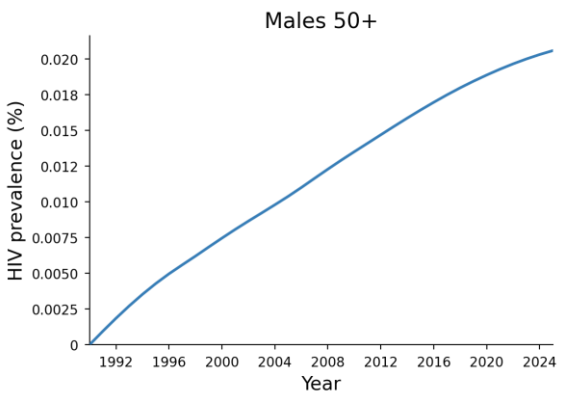
Allocation of HIV resources towards maximizing the impact of funding

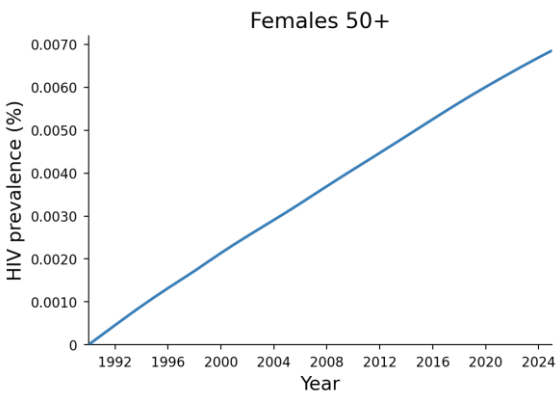












Appendix 3. HIV program costing and impacts

Table A3. HIV program unit costs and saturation values

HIV program	Unit cost (USD)	Saturation (low)	Saturation (high)
Antiretroviral therapy	$6,778.06	95%	100%
Pre-exposure prophylaxis (potential)*	$800.00	0%	25%
HIV testing and prevention programs for MSM	$14.96	30%	70%
HIV testing and prevention programs for PWID and NSP	$19.19	15%	50%
HIV testing and prevention programs for sex workers	$37.36	15%	50%
HIV VCT services (IPHs, general pop and key population)	$26.59†	0%	10%
Opioid substitution therapy	$377.13	30%	80%

ART, antiretroviral therapy; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, Needle-syringe program; IPH, the Institute of Public Health; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.

* PrEP is not currently funded however has potential to be funded by Republic Health Insurance Fund; the unit cost is only for analysis purpose as suggested by in-country experts. All programs, except OST and ART include costs of procurement, materials and human resources.

† Derived unit costs for VCT from 2020 and 2021 were impacted by COVID-19 and not reflective of future costs. The estimated unit cost was based on 2019 spending on HIV VCT, excluding non-targeted spending for epidemiological monitoring.

Table A4. Data inputs of impact of programs

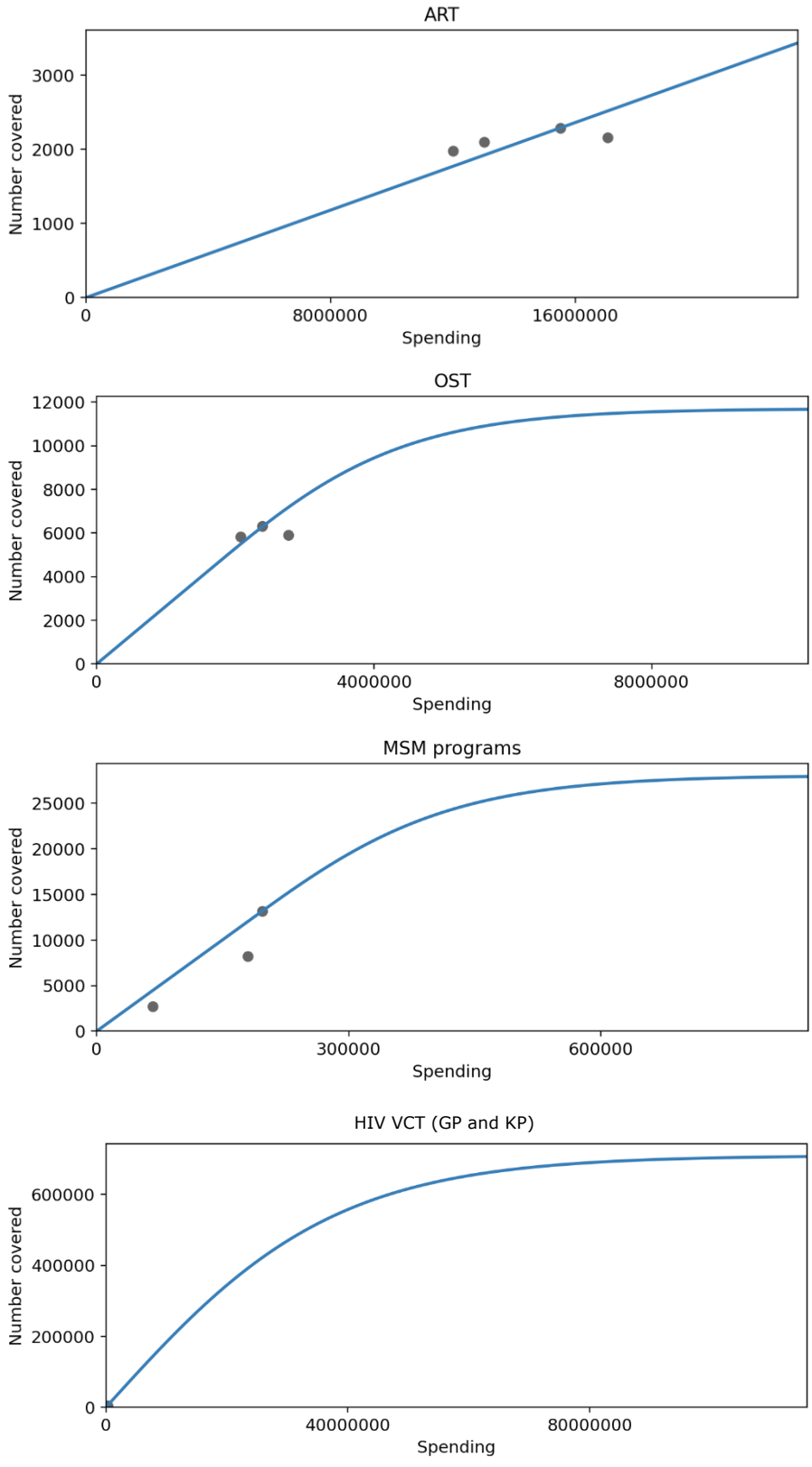
HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
PWID programs and NSP	Probability of needle sharing (per injection)	MWID	40%	40%	15%	15%
PWID programs and NSP	Probability of needle sharing (per injection)	FWID	31%	31%	20%	20%
SW programs	Condom use for commercial acts	MSM, FSW	92%	92%	99%	99%
SW programs	Condom use for commercial acts	MSM, MSW	93%	93%	99%	99%
SW programs	Condom use for commercial acts	MWID, FSW	80%	80%	90%	90%
SW programs	Condom use for commercial acts	MSW, MSM	93%	93%	99%	99%
SW programs	Condom use for commercial acts	MSW, M18-49	89%	89%	95%	99%
SW programs	Condom use for commercial acts	M18-49, FSW	88%	89%	95%	98%

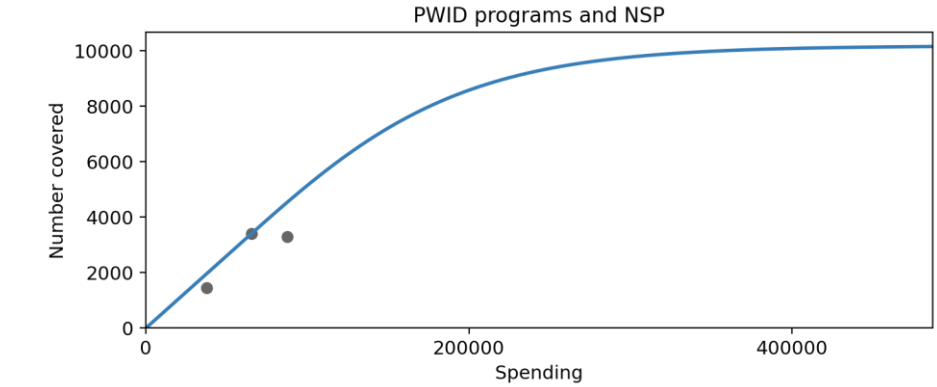
SW programs	Condom use for commercial acts	M18-49, MSW	89%	89%	95%	99%
SW programs	Condom use for commercial acts	M50+, FSW	85%	90%	95%	99%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	MSM	3%	3%	100%	100%
PrEP	Proportion of exposure events covered by ARV-based pre-exposure prophylaxis	MSW	0%	0%	100%	100%
MSM programs	HIV testing rate (average tests per year)	MSM	0.40	0.44	0.70	0.70
PWID programs and NSP	HIV testing rate (average tests per year)	MWID	0.05	0.06	0.35	0.45
PWID programs and NSP	HIV testing rate (average tests per year)	FWID	0.04	0.04	0.15	0.15
SW programs	HIV testing rate (average tests per year)	FSW	0.45	0.45	0.85	0.95
SW programs	HIV testing rate (average tests per year)	MSW	0.15	0.20	0.30	0.40
HIV VCT	HIV testing rate (average tests per year)	MSM	0.40	0.44	0.50	0.50
HIV VCT	HIV testing rate (average tests per year)	MWID	0.05	0.06	0.15	0.30
HIV VCT	HIV testing rate (average tests per year)	FWID	0.04	0.04	0.10	0.10
HIV VCT	HIV testing rate (average tests per year)	FSW	0.45	0.45	0.80	0.80
HIV VCT	HIV testing rate (average tests per year)	MSW	0.15	0.20	0.30	0.30
HIV VCT	HIV testing rate (average tests per year)	M0-17	0.00	0.00	0.01	0.01
HIV VCT	HIV testing rate (average tests per year)	F0-17	0.00	0.00	0.01	0.01
HIV VCT	HIV testing rate (average tests per year)	M18-49	0.02	0.02	0.04	0.05
HIV VCT	HIV testing rate (average tests per year)	F18-49	0.02	0.02	0.02	0.02
HIV VCT	HIV testing rate (average tests per year)	M50+	0.01	0.01	0.01	0.01
HIV VCT	HIV testing rate (average tests per year)	F50+	0.01	0.01	0.01	0.01
MSM programs	Condom use for casual acts	MSM, MSM	45%	45%	80%	80%
MSM programs	Condom use for casual acts	MSM, MSW	40%	40%	80%	80%
MSM programs	Condom use for casual acts	MSM, F18-49	40%	40%	80%	80%
MSM programs	Condom use for casual acts	MSW, MSM	40%	40%	80%	80%

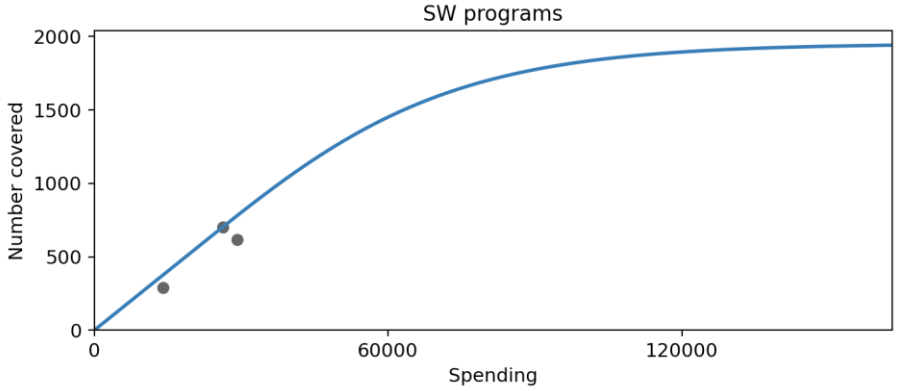
PWID programs and NSP	Condom use for casual acts	MWID, FWID	75%	76%	90%	90%
PWID programs and NSP	Condom use for casual acts	MWID, F18-49	55%	58%	75%	80%
SW programs	Condom use for casual acts	MSM, MSW	40%	40%	80%	80%
SW programs	Condom use for casual acts	MSW, MSM	45%	45%	80%	80%
SW programs	Condom use for casual acts	MSW, F18-49	50%	52%	75%	75%
SW programs	Condom use for casual acts	M18-49, FSW	45%	48%	75%	75%
SW programs	Condom use for casual acts	M50+, FSW	28%	30%	55%	55%
OST	Number of PWID on OST	Total	0	0	-	-
ART	Number of people on treatment	Total	0	0	-	-

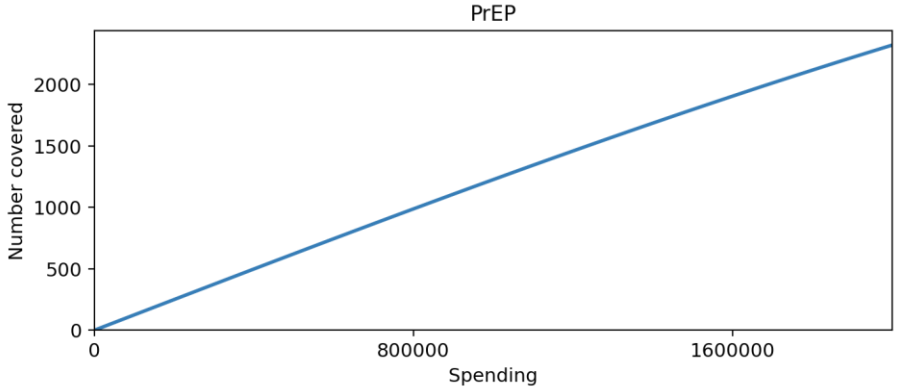
ART, antiretroviral therapy; FSW, female sex workers; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSW, male sex workers; MSM, men who have sex with men; NSP, Needle-syringe program; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.
- The number of people modeled as receiving ART 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.









NB. HIV VCT refers to voluntary counseling and testing for the general population and key population through the network of public health institutions.

Appendix 4. Annual HIV budget allocations at varying budgets

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

	100% latest reported (2021)	50% optimized	75% optimized	100% optimized	125% optimized	150% optimized
Antiretroviral therapy (ART)	15,514,976	7,757,488	11,636,232	15,514,976	19,492,805	19,185,198
Opioid substitution therapy (OST)	2,384,990	1,192,495	1,788,743	2,384,990	2,384,990	2,384,990
PrEP				-	497,162	5,279,761
Total targeted HIV program budget RHIF	17,899,966	8,949,983	13,424,975	17,899,966	22,374,958	26,849,949

ART, antiretroviral therapy; OST, Opioid substitution therapy; PrEP, pre-exposure prophylaxis; RHIF, Republic Health Insurance Fund

Table A6. Annual HIV budget (US$) allocations among targeted HIV programs funded by MoH/GF at varying budgets for 2023 to 2030

	100% latest reported (2021)	50% optimized	75% optimized	100% optimized	125% optimized	150% optimized
HIV voluntary counselling and testing services (general population and key population)*	68,105	68,105	68,105	68,105	68,105	68,105
HIV testing and prevention targeting MSM	196,948	110,353	193,560	238,515	291,155	347,661
HIV testing and prevention targeting PWID and NSP	65,560	-	6,022	37,145	73,734	106,457
HIV testing and prevention targeting SW	26,304	-	-	13,152	13,152	13,152
Total targeted HIV program budget MoH/GF	356,917	178,458	267,688	356,917	446,146	535,375

GF, Global Fund; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MoH, Ministry of Health; MSW, male sex workers; MSM, men who have sex with men; NSP, Needle-syringe program; PWID, people who inject drugs; SW, sex workers.

* VCT spending in 2020 and 2021 were impacted by COVID-19 and not reflective of future costs. Most recent spending was derived from 2019 spending on HIV VCT, excluding non-targeted spending for epidemiological monitoring.

Table A7. Annual HIV budget (US$) allocations among targeted HIV programs for 2023 to 2030, to reach 95-95-95 targets

	100% latest reported (2021)	135% budget optimized* (To reach 95-95-95 targets)
Antiretroviral therapy (ART)	15,514,976	21,459,482
Opioid substitution therapy (OST)	2,384,990	2,384,990
HIV voluntary counselling and testing (VCT) (general population and key population)	68,105	68,105
HIV testing and prevention targeting MSM	196,948	514,765
HIV testing and prevention targeting PWID and NSP	65,560	257,545
HIV testing and prevention targeting SW	26,304	13,152
Total targeted HIV program budget	18,256,883	$24,698,040

ART, antiretroviral therapy; FSW, female sex workers; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, Needle-syringe program; PWID, people who inject drugs; SW, sex workers.
* To reach the 95% diagnosis target, a minimal additional total 134% of 2021 targeted HIV spending, was required over 2023-2030. Please note, 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 and not included.
N.B. PrEP was not scaled up in the scenario of optimized budget allocation for achieving 95-95-95 targets, hence is not presented in the table above.

Table A8. Latest reported budget of non-targeted HIV programs, 2021

	Latest reported budget (2021)
Enabling environment	$12,296
Human resources	$74,783
Monitoring and evaluation	$95,502
Management	$368,594
Other HIV care	$16,846
Other HIV costs	$680,455
Total non-targeted HIV program budget	$1,248,476

Appendix 5. Additional results: funding all sources

Additional analysis was done to explore optimized resource allocation by targeted HIV interventions with combined funding (i.e. **without splitting programs by funding source**) to minimize HIV infections and deaths by 2030 under five funding scenarios of 50, 75, 100, 125 and 150 percentage of current targeted HIV funding.

Optimized MoH/GF resource allocation of 2021 spending. Optimization of 2021 spending suggested reallocating some spending on PWID and SW programs to enable scale-up of prevention programs for MSM (Figure A3, Table A10). This recommendation is consistent with optimized resource allocation of MoH/GF spending and responds to the concentrated disease burden among MSM in Serbia. Notwithstanding the significance of retaining individuals on treatment, the relative cost-efficiency of MSM programs for preventing new HIV infections necessitates the prioritization of HIV prevention programs for MSM at the 100% budget level. At the existing unit costs for MSM programs and ART, US$15 and US$6778 per person per year respectively, for the cost of providing ART to one person in a year it may be possible to reach 452 individuals with HIV prevention programs for MSM. If cheaper ART drugs could be procured, then savings in HIV treatment could potentially be reinvested in HIV prevention programs, but this is currently limited by the HIV financing mechanisms in Serbia.

Optimized resource allocation at different budget levels. As the total budget envelope increases, the priorities were identified as further scale-up of MSM programs, scale-up of ART and programs for PWID. Assuming that more people could be accessed for treatment through enhanced linkage to care and adherence programs, then this could reduce mortality as well as new infections through treatment-as-prevention. Despite no evidence suggesting increasing HIV infections among PWID, the increased needle sharing behavior observed in the field and reflected by 2021 behavioral data is concerning (4), and maintaining HIV surveillance for PWID is critical. The higher estimated unit cost of PrEP (US$800) relative to other HIV testing and prevention targeting MSM means that it is prioritized only at the 150% budget level alongside scale-up of programs for SWs.

If total funding were reduced, ethical constrains on the model mean that maintaining as many people on treatment as possible would be prioritized.

Impact of budget optimization on HIV epidemic. Compared with the baseline scenario, optimized reallocation of 2021 spending (without splitting programs by funding source) could avert 22 new infections (1%) over 2023-2030. At 100% spending and considering program constraints, the current budget allocation is close to being optimized, thus the impact of optimized reallocation is minimal. However, the projected impact increases at higher budgets and at 150% budget, optimized reallocation could avert 58% infections, 28% deaths and 24% DALYs over 2023-2030 (Figure A4, Table A9).

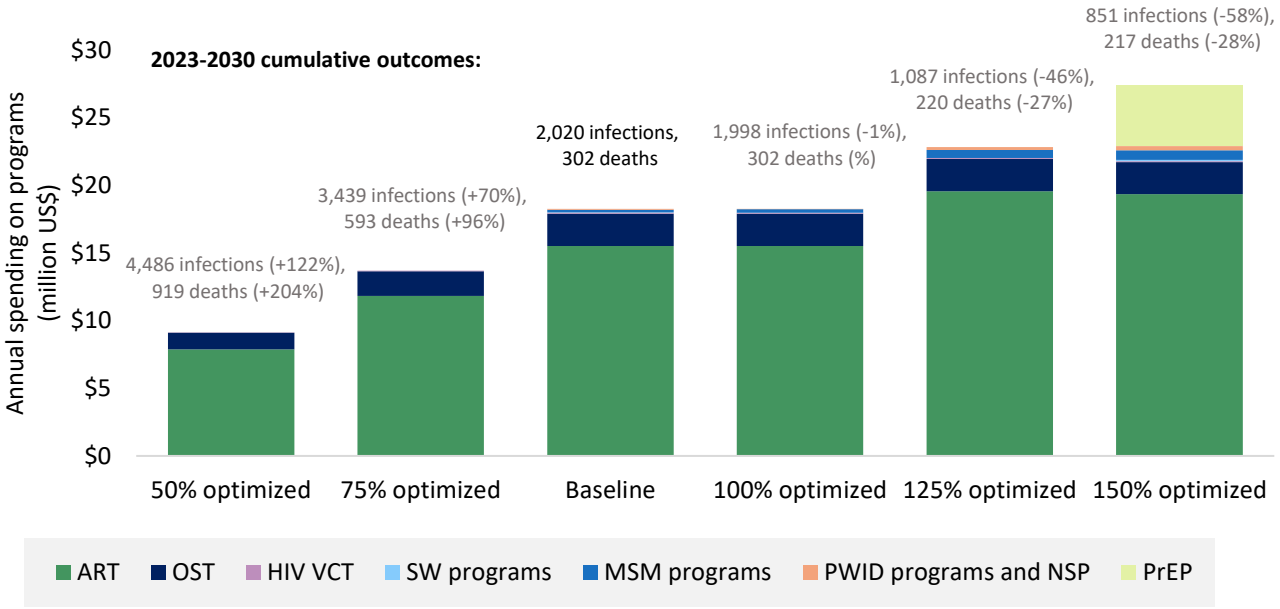


Figure A3 Optimized allocations under varying levels of annual HIV budgets for 2023 to 2030, to minimize new infections and HIV-related deaths by 2030: Combined funding sources. Percentage optimized refers to the percentage of baseline HIV spending (i.e. 2021 spending). ART, antiretroviral therapy; DALY, disability-adjusted life year; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, needle-syringe program; OST, opioid substitution therapy; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.

Table A9. Cumulative new HIV infection, HIV-related deaths, HIV-related DALYs between 2023-2030 under different scenarios of optimizing budget, and differences in impacts compared to the baseline scenario of fixed 2021 spending on programs: Combined funding sources

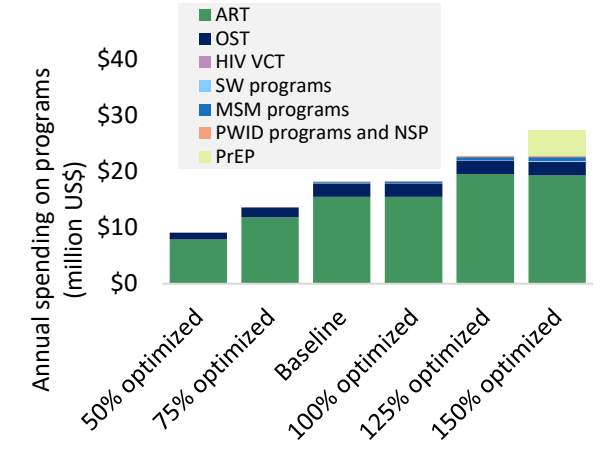
	Cumulative new HIV infections 2023-2030	*Cumulative HIV deaths 2023-2030*	*Cumulative HIV DALYs 2023-2030*	*Difference in infections from baseline*	*Difference in deaths from baseline*	*Difference in DALYs from baseline*
50% optimized	4,486	919	24,673	122%	204%	168%
75% optimized	3,439	593	16,599	70%	96%	80%
Baseline	2,020	302	9,207			
100% optimized	1,998	302	9,186	-1%	-	-
125% optimized	1,087	220	7,165	-46%	-27%	-22%
150% optimized	851	217	7,036	-58%	-28%	-24%

Percentage optimized refers to percentage of baseline spending.

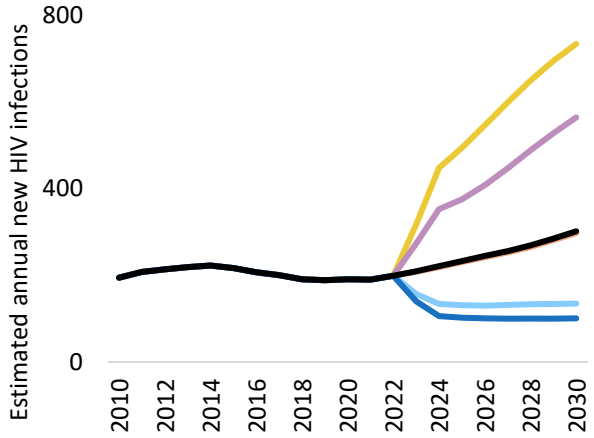
SERBIA

Allocation of HIV resources towards maximizing the impact of funding

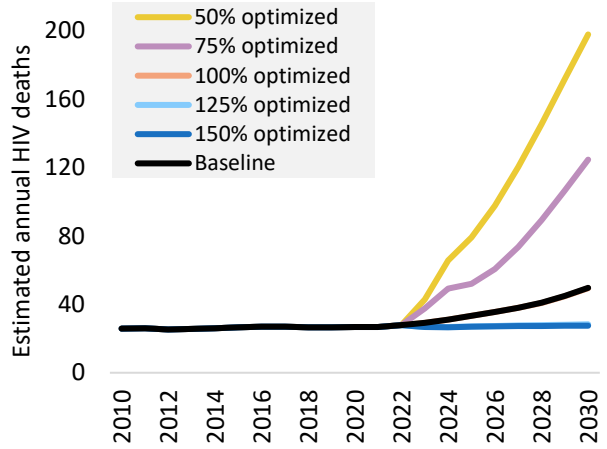
(a) Serbia: budget optimizations (all programs)



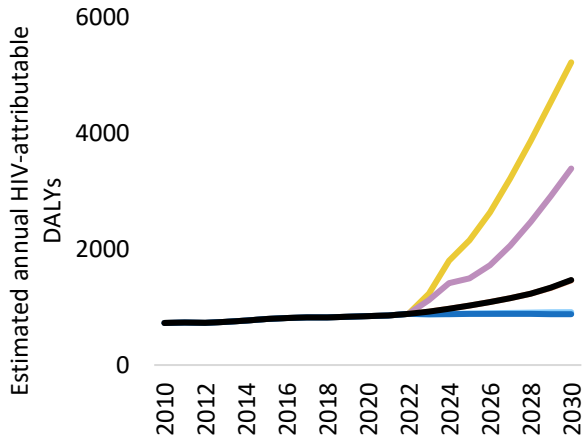
(b) Serbia: annual new HIV infections in budget optimizations



(c) Serbia: annual HIV deaths in budget optimizations



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



(e) Serbia: projected care cascade in 2030

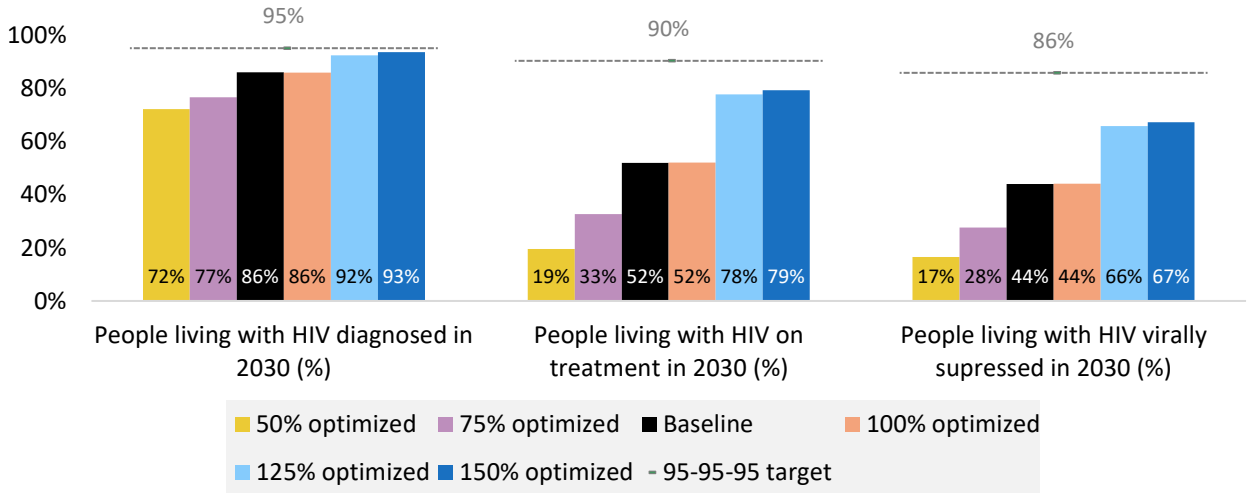


Figure A4 Model outcomes from budget optimization scenarios aiming to minimize infections and deaths: Combined funding sources. Panels show (a) optimal budget allocations under varying levels of annual HIV budgets according to percentage of estimated 2021 spending; (b) estimated annual new HIV infections; (c) HIV-related deaths; (d) HIV-related disability-adjusted life years; and (e) projected care cascade for the year 2030. ART, antiretroviral therapy; DALY, disability-adjusted life year; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, needle-syringe program; OST, opioid substitution therapy; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.

Table A10. Annual HIV budget (US$) allocations among targeted HIV programs funded from all sources at varying budgets for 2023 to 2030

	100% latest reported (2021)	50% optimized	75% optimized	100% optimized	125% optimized	150% optimized
Antiretroviral therapy (ART)	15,514,976	7,882,179	11,823,268	15,514,976	19,622,789	19,326,739
Opioid substitution therapy (OST)	2,384,990	1,211,663	1,817,494	2,384,990	2,384,990	2,384,990
PrEP	-	-	-	-	-	4,503,487
HIV voluntary counselling and testing services (VCT) (general population and key population)	68,105	34,600	51,900	68,105	68,105	68,105
HIV testing and prevention targeting MSM	196,948	-	-	242,880	571,109	711,466
HIV testing and prevention targeting PWID and NSP	65,560	-	-	32,780	222,716	302,587
HIV testing and prevention targeting SW	26,304	-	-	13,152	13,152	77,606
Total	18,256,883	9,128,442	13,692,662	18,256,883	22,821,104	27,385,325

FSW, female sex workers; HIV VCT, HIV voluntary counseling and testing for the general population and key population through the network of public health institutions; MSM, men who have sex with men; NSP, Needle-syringe program; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SW, sex workers.

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