Analyses for impact, efficiency, and sustainability of priority key population HIV services in Asia: Sri Lanka

2023

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Abbreviations

AEM	AIDS Epidemic Model
AIDS	Acquired immunodeficiency syndrome
ART	Antiretroviral therapy
ARV	Antiretroviral
CSO	Civil society organisation
FPA	Family Planning Association
FSW	Female sex worker
GAM	Global AIDS monitoring
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GoSL	Government of Sri Lanka
HIV	Human immunodeficiency virus
IBBS	Integrated Biological and Behavioural Surveillance
MSM	Men who have sex with men
NGO	Non-governmental organisation
NSACP	National STD/AIDS control program
NSP	National Strategic Plan
PLHIV	People living with HIV
PMTCT	Prevention of mother-to-child transmission
PrEP	Pre-exposure prophylaxis
PWID	People who inject drugs
SKPA	Sustainability of HIV Services for Key Populations in Asia
STI	Sexually transmitted infection
TGW	Transgender women
TSP	Tourist service providers (formerly known as beach boys)
UNAIDS	Joint United Nations Program on HIV/AIDS
VL	Viral load
WHO	World Health Organisation

Executive Summary

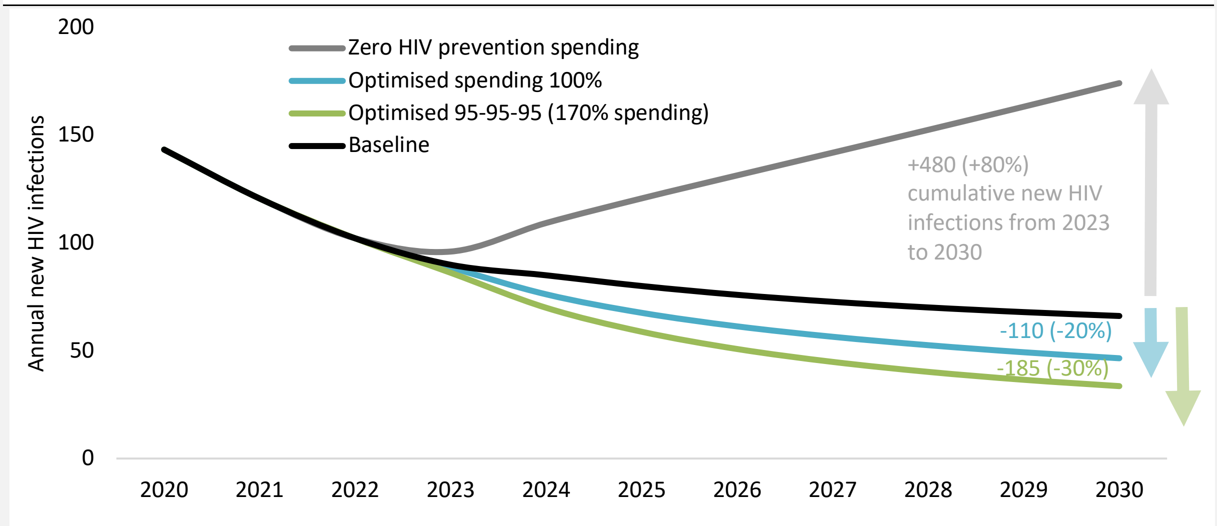
Sri Lanka has a low-level HIV epidemic with an HIV prevalence rate of less than 0.1%[1]among the general population, yet persistent new HIV infections in key populations, particularly among men who have sex with men. The ongoing political and economic crisis of 2022 may threaten the encouraging progress the Sri Lankan HIV response has made so far.

In 2022, an estimated total of US$11.7M was spent on HIV in Sri Lanka,[2] of which 31% was for ART and PMTCT. US$1.5M (13%) was for HIV targeted prevention, key population testing, ART retention and viral suppression programs included in this analysis. This analysis aimed to estimate resource needs and program priorities to minimise the number of new HIV infections and HIV-related deaths by 2030.

Key findings of this analysis were:

- **Achieving Fast Track 95-95-95 targets by 2030 may be within reach through investment of an additional US$1.1 million annually** (170% of current HIV prevention, testing and retention spending, resulting in a cumulative spending of US$8.8 million by 2030)**.** Priorities for spending include ART retention for all populations, scaling up viral load testing, and investing in key population HIV prevention and testing programs, specifically for men who have sex with men.
- **Optimisation of current spending** could reduce new HIV infections by at least 20% by 2030.
    1. **The first priority is to reallocate funding towards ART retention programs** (+US$80,000) and viral load testing (+US$62,500) through cost-efficiencies in key population programs, to ensure people living with HIV remain on treatment and achieve viral suppression. **ART resource needs** over 2022-2030 could be a cumulative US$30.5M if current spending allocations are maintained. An additional US$450,000 could be required for ART with optimised HIV prevention and retention spending due to increased diagnoses.
    2. **The second priority, with additional resources (+US$0.4M to $1.5M),** should be reaching additional MSM, including with pre-exposure prophylaxis (PrEP), through mixed modalities prioritising network-based approaches to reach people with the highest risk of acquiring HIV and people not previously tested.
- **Phasing out spending for HIV prevention, testing and retention support programs** may increase new HIV infections by 80%.

Projected change in annual new infections with different spending scenarios



[1] Annual report of National STD/AIDS Control Programme. 2020.

[2] Based on 2022 SKPA costing study, Global AIDS Monitoring, and the 2022 Investment Analysis of the HIV Response for Universal Health Coverage for Key Populations by 2030. Full spending is listed in Appendix E.

1. Introduction

1.1 Country context

Sri Lanka has maintained a low-level country HIV epidemic, with a stable HIV prevalence rate among key populations continuing to remain well below 2.0%. The estimated people living with HIV (PLHIV) was 3,700 in 2020, with 70% of PLHIV estimated to know their status, 83% of those diagnosed on treatment and 91% of those on treatment virally suppressed (1). The number of HIV cases reported at the end of 2022 was 609 and higher than 439 cases detected in 2019 (1). However this may be influenced by testing and a decreasing trend in *infections* has been noted since the peak of the HIV epidemic. The increasing share among men who have sex with men is a concern both in Sri Lanka and regionally. In 2019, 56% of new HIV infections in Sri Lanka were estimated to be transmitted among men who have sex with men, a more than ten-fold increase from 4.5% in 2000 (2).

The low-level HIV epidemic may be threatened by the on-going political and economic crisis of 2022. Fuel and food shortages, lengthy power cuts, and high inflation have resulted in difficult living conditions and challenges for delivering health care (3). The debt crisis the Sri Lankan government is currently facing may threaten to endanger the country's on-going HIV response due to rising costs of amenities, procurement issues and antiretroviral drug stockouts, and destabilising HIV prevention and care programs (4). From 2020 to 2022, the Global Fund has been the primary donor for HIV funding and has provided emergency funding for essential services in 2022 (5). Prior to the 2022 economic crisis, Sri Lanka entered a transition agreement to phase out Global Fund funding in the next ten years, but it is unclear if this will remain in place.

The Government of Sri Lanka received a Global Fund grant of US$6.6M for the period from 2019 to 2021, with the objective to support the Government of Sri Lanka to end AIDS by 2025 (6). This Global Fund funding is predominantly invested in the service delivery for HIV prevention for key populations while government funding finances the other components of HIV response including testing, treatment and viral load monitoring. HIV prevention and testing services for key populations are implemented through government-led STD clinics, civil society organisations (CSO) and non-governmental organisations (NGO). CSOs and NGOs use a variety of approaches to provide a range of sexual and reproductive health services including behaviour change information, HIV testing, provision of condoms and lubricants, and escorting to the STD clinic (7). However, current progress is threatened by the potential phasing out of international funding as well as a declining share in the proportion of expenditure for HIV by the National STD/AIDS Control Program (NSACP), from 0.44% in 2018 to 0.14% in 2020 (8).

1.2 Rationale for analysis

To maintain the HIV response in South-East Asia (SEA), national HIV programs must be sustainably financed. With eventual transition away from donor support, there will be increased demand on domestic HIV financing. Strengthened commitments by national governments is critical. It is more important than ever to invest available HIV resources cost-effectively to maximise impact.

Health Equit Matters is the Principal Recipient of the Sustainability of HIV Services for Key Populations in Asia (SKPA-2) Program. The program is a multi-country grant funded by the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) covering four (4) countries: Bhutan, Mongolia, the Philippines and Sri Lanka. It aims to promote sustainable services for key populations at higher risk of

HIV exposure including sex workers, men who have sex with men, transgender women and people who inject drugs, in the region. This analysis formed part of the SKPA contract, and the allocative efficiency analysis presented here can support the Government of Sri Lanka to prioritise investment decisions as part of developing action plans and budgets for the HIV response throughout the SKPA-2 grant period and beyond the life of the project.

1.3 Study objectives

The purpose of this study is to develop a sustainable HIV investment case tailored to the unique and specific investment needs in Sri Lanka. Specifically, the objectives of this study were to:

1. Estimate current spending on targeted HIV interventions in Sri Lanka;
2. For varying budget levels, determine how resource allocation for targeted HIV prevention and testing interventions can be optimised to minimize new infections and deaths over 2023-2030;
3. Determine the minimum level of resources required and optimised resource allocation to achieve 95-95-95 Fast Track targets by 2030; and
4. Assess the impact of optimised resource allocation on projected new HIV infections and HIV-related deaths compared to if current spending were fixed.

2. Methodology

An allocative efficiency analysis was conducted using Optima HIV, a mathematical model developed by the Optima Consortium for Decision Science in partnership with the World Bank. A detailed description of the Optima HIV model is available in Kerr et al (9) and Appendix A. In brief, Optima HIV is a population-based compartmental model of HIV transmission and disease progression integrated with an economic and program analysis framework. It applies an algorithm to estimate the optimised allocation of resources in a combination of HIV programs (9). Detailed epidemiological, behavioural, programmatic, and cost data collated through desk review were used to inform the Optima HIV model for Sri Lanka (Appendix A2). HIV epidemic patterns and projections were calibrated to align with existing and accepted output from the AIDS Epidemic Model, as incorporated into Spectrum and published by UNAIDS in AIDSinfo (7). Detailed calibration plots are shown in Appendix B.

This section further describes (2.1) an overview of the process (2.2) the populations and HIV programs included in this analysis, (2.3) baseline spending (2.4) a description of the scenarios modelled, (2.5) the model constraints applied to budget reallocations, and (2.6) the weighting applied to the model objectives.

2.1 Overview of modelling process

This efficiency analysis was conducted from February 2022 to May 2023. The analysis commenced with stakeholder consultations to identify relevant key populations, programs to reach these populations and their subsequent impacts. These consultations were conducted from February 2022 to March 2022 with relevant stakeholders from the National STD/AIDS Control Program (NSACP), Family Planning Association (FPA), health economists, community stakeholders, and key population representatives. A Technical Working Group (TWG) with a core set of local stakeholders was set-up to identify relevant modelling objectives and scenarios, validate the epidemiological situation, provide input on key population programs and their impacts and to provide feedback on results [Appendix C].

A costing study was conducted as part of the SKPA process to inform costing of key population programs.

2.2 Populations and HIV programs

Populations were disaggregated by risk and age and further defined in Appendix D. In brief, the populations considered in this analysis were:

- Key populations (aged 15-49)
  - Female sex workers (FSW)
  - Clients of female sex workers (Clients)
  - Tourism service providers (MSM), males
  - Hotspot based men who have sex with men (MSM 1), 15-19, 20-24, 25-49
  - Non-hotspot based men who have sex with men (MSM 2), 15-19, 20-24, 25-49
  - People who inject drugs (PWID), males*
  - Transgender women
  - Prisoners, males*
- General population
  - Females 0-14, 15-19, 20-24, 25-49, 50+
  - Males 0-14, 15-19, 20-24, 25-49, 50+

* The expected number of females in these groups are low and there was no data available at the time of this analysis to inform a female people who inject drug population or any data to inform HIV transmission among female prisoners.

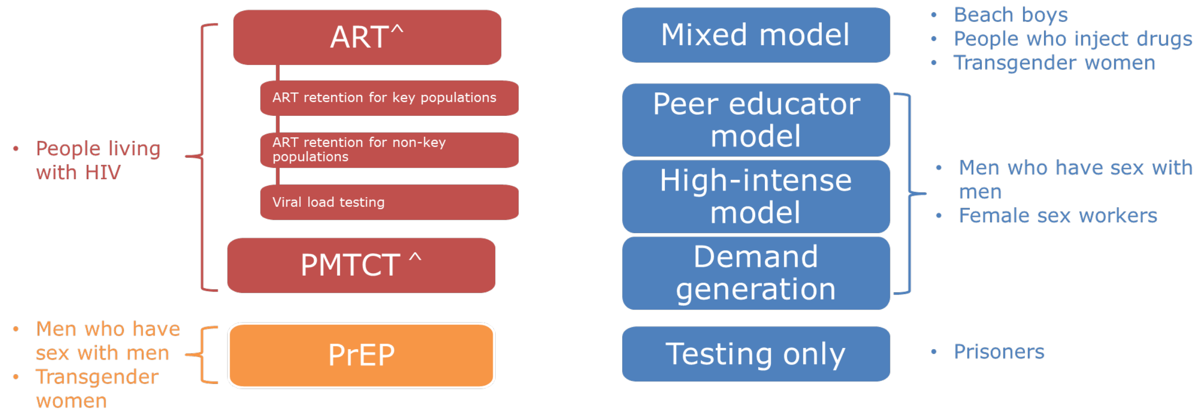
Risk disaggregation was aligned with Sri Lanka's AEM definitions for hotspot based (MSM 1) and non-hotspot based (MSM 2) men who have sex with men (2). MSM 1, hotspot based, are assumed to be reachable with traditional outreach programs for men who have sex with men and account for approximately 16% of all men who have sex with men. MSM 2 have a lower partner exchange rate, are assumed to also sexually interact with females in the general population, and therefore have a more heterogeneous risk profile of acquiring HIV and are harder to reach through hotspots (2).

Targeted HIV programs modelled in this study are illustrated in Figure 1, and program definitions are provided in Appendix E. HIV prevention and testing programs for female sex workers and men who have sex with men have detailed data available and are disaggregated by the service delivery modalities, 1) peer educator and 2) high-intense models. Peer educator models focus on outreach in known hotspots with repeat engagement for prevention and community empowerment. The high intense models aim to reach new people with high risk of HIV through a network-based approach utilising outreach workers. An additional demand generation program with virtual outreach was modelled as an extension of the high-intense model with the ability to reach additional young men who have sex with men (aged 15-24). Description of key modalities for reaching men who have sex with men is shown in Appendix E4. HIV prevention and testing programs for tourism service providers and transgender women were optimised through a mixed model, and the prisoner program included HIV testing only. The prevention component of the aforementioned key population programs was based on the delivery of condoms, lubricant, and social and behaviour change communication. A separate program was modelled for the implementation of pre-exposure prophylaxis (PrEP), reaching hotspot based men who have sex with men and transgender women.

Antiretroviral therapy (ART) and prevention of mother-to-child transmission (PMTCT) were assumed to be available to all diagnosed people living with HIV retained in care and were not included in the spending optimisation. Three treatment support programs were included in the model: ART retention for key populations, ART retention services for non-key populations, and viral load testing. ART retention services for key populations were assumed to be delivered through other outreach activities for key populations, requiring only marginal costs for additional social support. Implementing ART for non-key populations was assumed to require a new program and hence higher costs for logistics and delivery [Appendix E1].

STD clinic-based services were not modelled as a separate HIV program, but coverage through these clinics informed the baseline tested rates for all populations [Appendix E2].

Figure 1. Targeted HIV programs and focus populations modelled in the analysis.



^ART and PMTCT are considered to be available to all diagnosed people living with HIV retained in care, and spending is not part of the optimisation

2.3 Baseline spending

Baseline spending was based on bottom-up cost estimates, whereby $program\ spending = unit\ cost \times coverage$. Unit costs for key population programs were derived from the 2022 SKPA costing study (10), which included differentiated costs by program modality, including overhead costs. Coverage was based on latest reported coverage from country-provided program data for 2022 (Q4 2021 to Q3 2022). SKPA costing estimates were validated with the top-down spending from the 2022 HIV costed plan of the National HIV/STI Strategic Plan (NSP 2018-2022) (1). Spending on treatment and treatment support programs was derived from the Global AIDS Monitoring dataset (11), the 2022 Investment Analysis of the HIV Response for Universal Health Coverage for Key Populations by 2030 (8), and the SKPA costing study (10). The derived baseline spending is outlined by program in Appendix E1.

Budget optimisations were based on targeted HIV spending for HIV prevention, testing, and retention programs with a direct and quantifiable impact on HIV parameters included in the model. ART and PMTCT were excluded from the baseline optimisation budget, as it was assumed for the optimisation of HIV prevention, testing, and retention spending that independent funding would remain available to continue providing treatment for all diagnosed people living with HIV retained in care.

2.4 Scenario analyses

Based on input from stakeholders, a range of scenarios were identified for inclusion (Table 1). These incorporated the risk of reduced resource availability for HIV prevention, testing and retention programs for key populations in the future; the opportunity for increased funding through additional investments in HIV prevention; and the HIV resource allocation for progressing towards 95-95-95 targets. The modelled impact of optimisation scenarios on the HIV epidemic assumes that treatment coverage remains fixed at 2021 levels. Each optimisation assumes spending is reallocated in 2023 and the same amount of optimised spending for each program is allocated for each year up until 2030.

Table 1. Optimisation and scenario analyses for HIV prevention spending, including retention and viral load testing programs.

Scenario	Description
Zero HIV prevention, testing and retention spending	Considers the impact of new infections and HIV-related deaths if there was no spending on HIV prevention, testing and retention services from 2023-2030.
Reduced HIV treatment and viral load testing spending (10%, 25%)	Considers the impact of reduced focus on maintaining HIV treatment and viral load testing, resulting in reduced ART coverage of diagnosed people living with HIV and reduced viral suppression from 2023-2030.
Baseline scenario	Continued spending and fixed allocation of US$1.5M (100% HIV prevention, testing, and retention) reflecting 2021 distribution of funds.
Optimised spending 100%	Continued spending of US$1.5M (100%) for HIV prevention, HIV testing, retention and viral load testing programs with allocation optimised to reduce new infections and HIV-related deaths by 2030.
Reduced optimised spending (50%, 75%, 90%)	Considers if available resources for HIV prevention, HIV testing, retention and viral load testing programs were reduced. Percentages are relative to the most recent targeted prevention spending. Allocations are optimised to reduce new infections and HIV-related deaths by 2030.
Increased optimised spending (125%, 150%, 200%, 300%, 400%, 500%)	Considers if additional resources for HIV prevention, HIV testing, retention and viral load testing programs were made available. Percentages are relative to the most recent targeted prevention spending. Allocations are optimised to reduce new infections and HIV-related deaths by 2030.
95-95-95 targets	Explores the resources required and optimised resource allocation to reach 95% diagnosis, 95% treatment coverage among diagnosed people living with HIV, and 95% viral suppression among people on treatment and the projected impact if 95-95-95 targets were reached.

2.5 Model constraints

Each program was constrained to not reduce by more than 10% from 2022 spending, unless optimising a reduced budget where no constraints were applied. This constraint was informed by discussion with key stakeholders based on the potential harms of defunding key population programs (12) and was assumed to represent achievable “implementation efficiencies”. An additional scenario without any constraints was modelled, results are outlined in Appendix F1.

2.6 Model weightings

Budget optimisation weightings to minimise 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, consistent with previous analyses (13, 14).

Supplementary analyses were run with the objective weighting to (1) minimise new infections only and (2) minimise HIV-related deaths only. The results of these analyses are presented in Appendix F2.

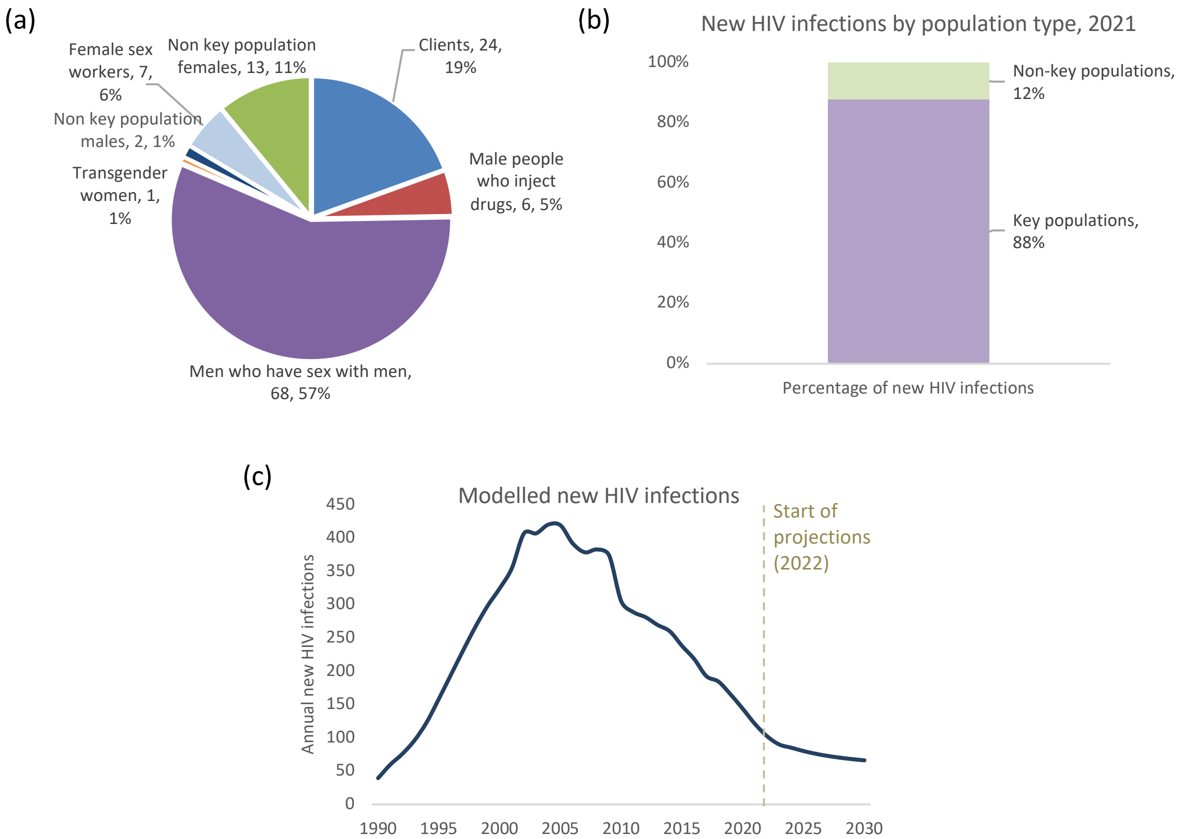
The 95-95-95 target scenario aims to reach 95% diagnosis, 95% treatment coverage among diagnosed people living with HIV and 95% viral suppression among those on treatment by 2030 with the minimal possible total spending as part of the UNAIDS Fast-Track strategy on ending the AIDS epidemic by 2030 (15).

3. Results

3.1 Baseline scenario of the HIV epidemic

New HIV infections are predicted to be occurring mainly among key populations in 2021 (106, 87% of all new HIV infections). The majority of these infections are estimated to be among men who have sex with men (72, 59% of all new HIV infections) (Figure 2a), as informed by and aligned with the AIDS Epidemic Model (16) that is used in-country for annual HIV projections.

Figure 2. Baseline new HIV infections based on Optima HIV model.



Panel shows: (a) Distribution of new HIV infections (121) by sub-population in 2021, (b) Percentage of new HIV infections among key populations; and (c) Historical and projected (dotted line) new HIV infections from 1990-2030 with baseline spending and allocation maintained.

Consistent with the AIDS Epidemic Model, new HIV infections have been declining in Sri Lanka since 2004. Maintaining 2022 spending on programs with fixed allocations would likely enable new HIV infections to continue gradually declining (Figure 2b). This baseline scenario could result in a cumulative 600 infections, 300 HIV-related deaths and 7,800 DALYs over the 2023 to 2030 period. In 2030, 93% of people living with HIV could be diagnosed, 86% of those diagnosed could be on treatment and 90% of those on treatment could be virally suppressed.

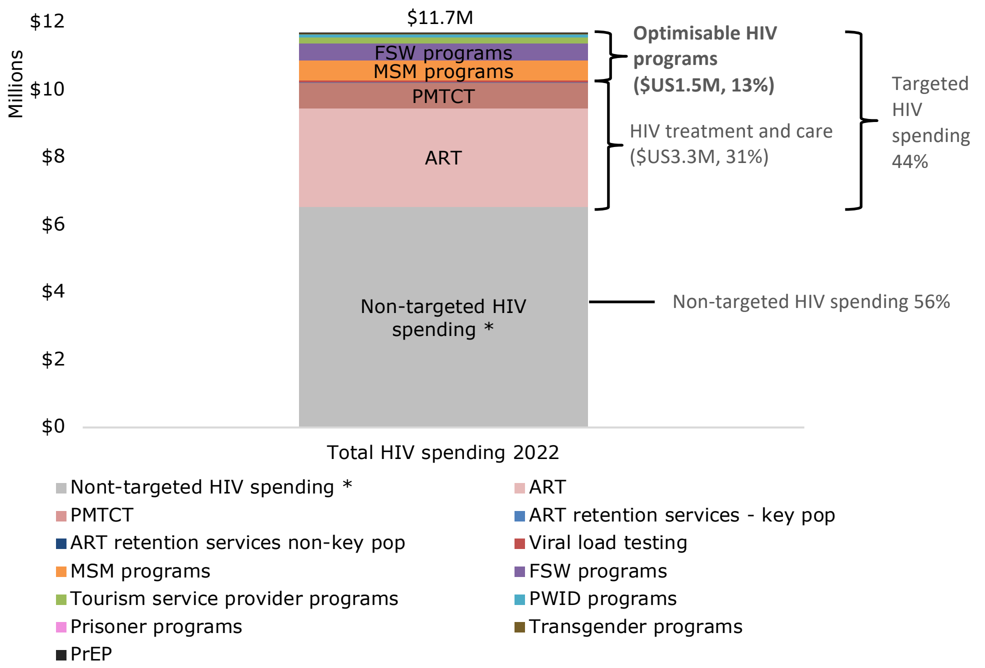
3.2 Baseline 2022 HIV spending

In 2022, a total of US$11.7M was spent on HIV in Sri Lanka based on the 2022 HIV costed plan of the National HIV/STI Strategic Plan (NSP 2018-2022) (17). This includes program implementation costs financed by the Government of Sri Lanka (GoSL) and supported by the Global Fund through national and regional grants. Over half of the total budget was allocated to non-targeted HIV spending, such as health system strengthening, strategic information and supportive environment, which were excluded from the optimisation (Figure 3). Over thirty percent of the total budget was allocated to ART and PMTCT.

Thirteen percent of the total budget**, US$1.5M, was spent on HIV targeted prevention and testing, ART retention and viral suppression programs, and these programs were included as the optimisable HIV programs in this analysis.**

Detailed spending on key population prevention and testing programs and treatment support programs included in the optimisation were derived from the 2022 SKPA costing study (10). Full program details are given in Appendix E1.

Figure 3. Overview of total spending for HIV in 2022



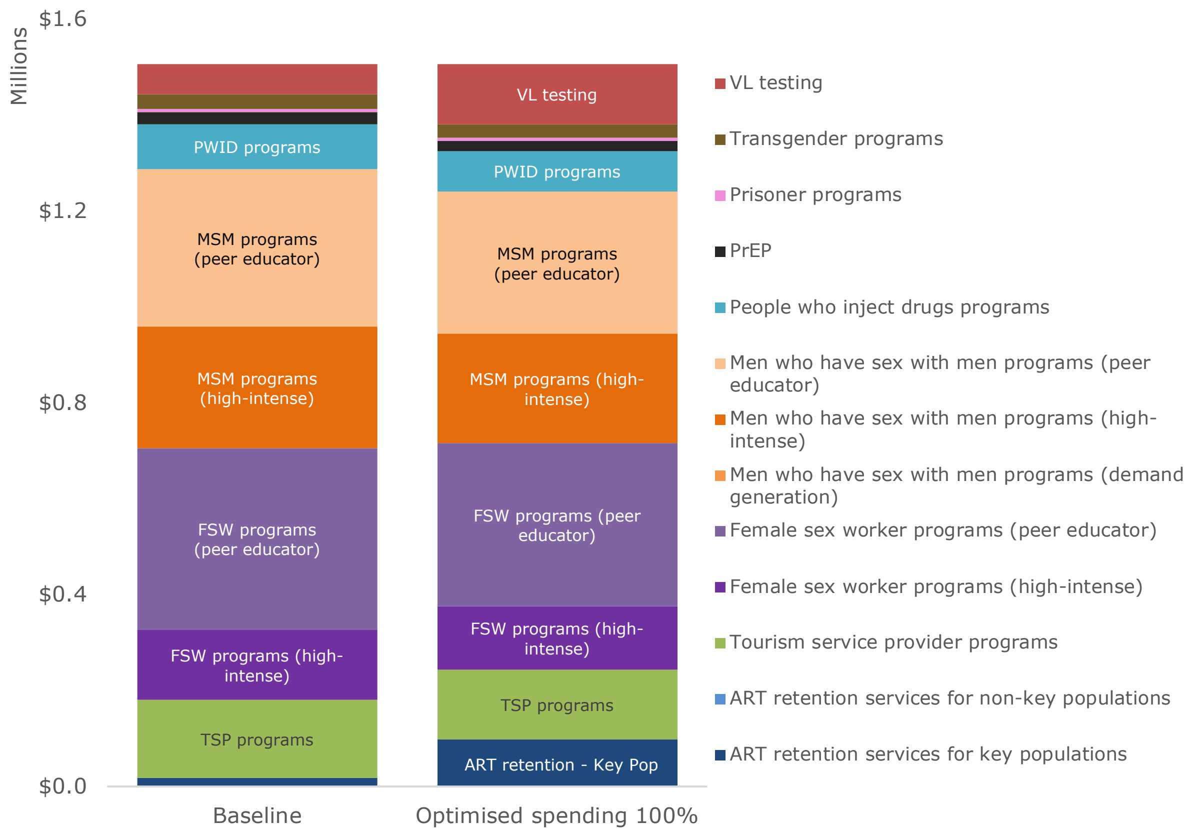
ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load

*Non-targeted HIV spending includes strategic information, management, health systems strengthening and supportive environment interventions.

3.3 Optimised resource allocation of current budget

Optimisation of 2022 spending for prevention, testing and retention was constrained to ensure no more than 10% of spending for one program can be re-allocated to another program to mirror real-world feasibility of reallocation of spending between programs. At 100% optimised spending, additional impact may be possible by prioritising scale-up of ART retention for key populations (433% increase) and viral load testing (100% increase) (Figure 4). These programs are prioritised ahead of key population testing programs because under the continuation of current conditions, by 2030 there are projected to be more people diagnosed and aware of their HIV status but not retained in care than undiagnosed people living with HIV. Improving ART retention and viral suppression relative to 2022 levels is central to advancing 95-95-95 progress in Sri Lanka.

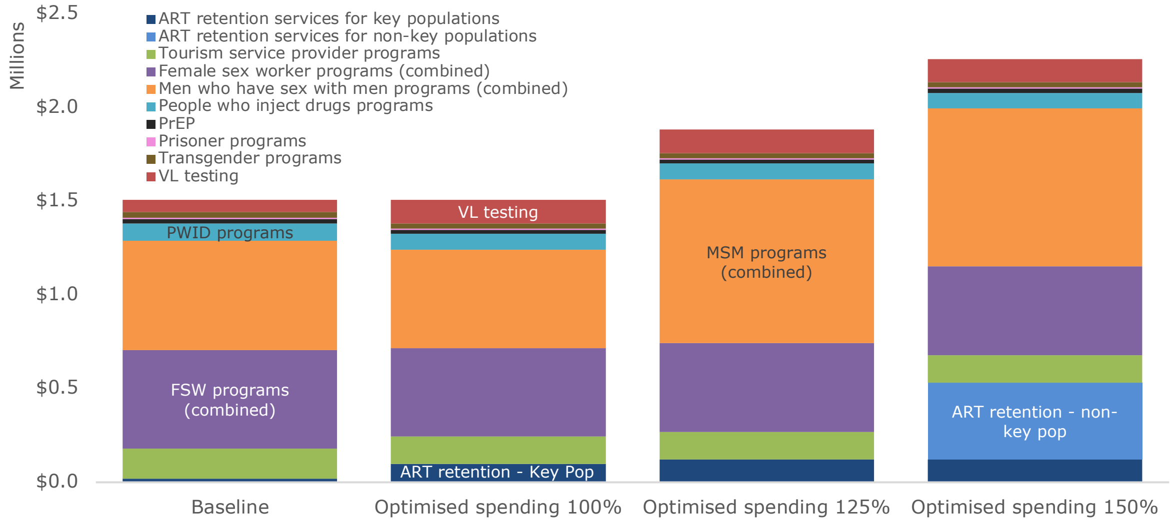
Figure 4. Optimised allocations under 100% budget levels of annual HIV prevention, testing and retention budgets for 2023 to 2030, to minimise new infections and HIV-related deaths by 2030.



3.4 Optimised resource allocation of **increased** budgets for 2022 prevention, testing and retention spending

We modelled optimised allocations for 100% (US$1.5M) to 500% (US$7.5M) of the current targeted prevention, testing and retention spending. The 500% optimisation represents an optimistic scenario, where additional funding may be complemented with potential efficiencies achieved within the spending of non-targeted programs – for example by reducing overhead costs – and reallocated to targeted prevention, testing and retention programs. As investments increase, programs for men who have sex with men are the next priority at 125% spending. ART retention for non-key populations is considered the fourth priority at 150% spending after ART retention services for key populations reach saturation.

Figure 5. Optimised allocations under 100% to 150% budget levels of annual HIV prevention, testing and retention budgets for 2023 to 2030, to minimise new infections and HIV-related deaths by 2030.



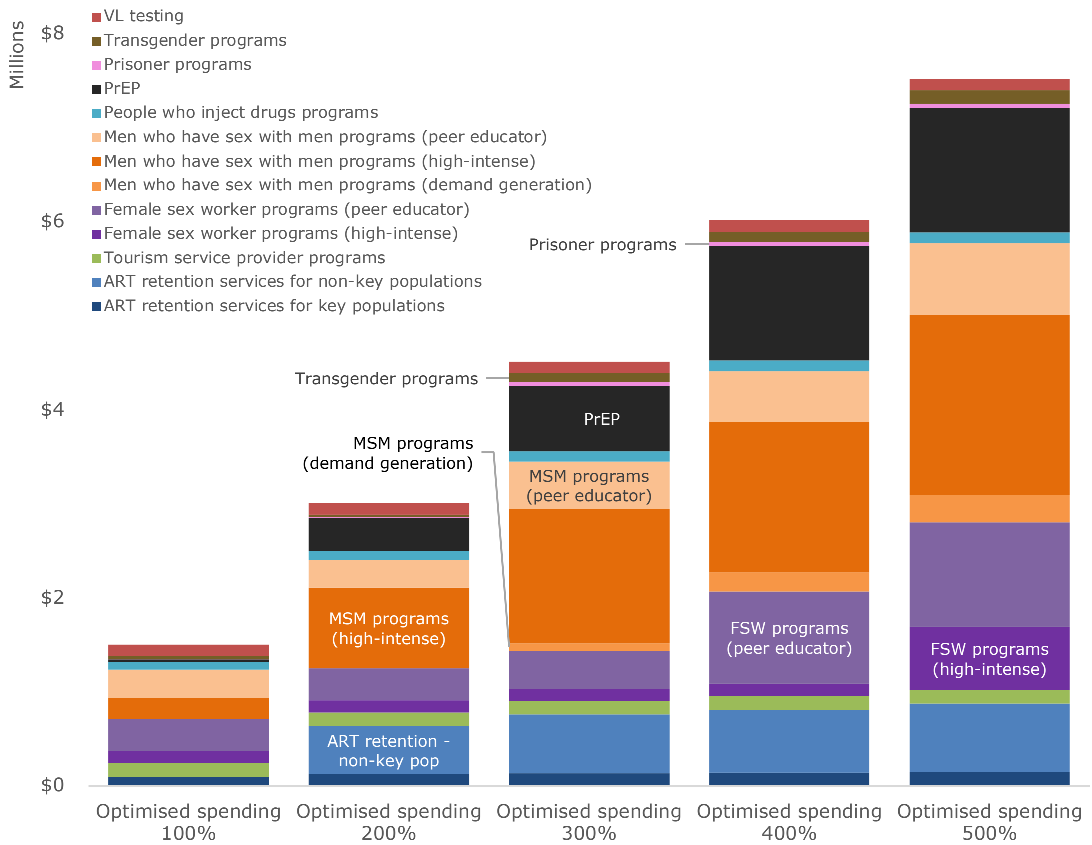
ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

As the optimisable HIV budget increases from 200% to 500% of current targeted spending (equivalent to up to 51% increase in *total* HIV spending), additional priorities are: (1) further scale-up of high-intense programs for men who have sex with men and ART retention; (2) PrEP for men who have sex with men and transgender women; (3) peer educator programs for men who have sex with men and expanding the high-intense model through demand generation to reach the younger age groups; and (4) expanding outreach for female sex workers (Figure 6, Appendix G). To note, a smaller proportion of spending is allocated to ART retention for key populations when comparing with the ART retention program for non-key populations. This is due to the lower unit cost of the key population retention program, as this is assumed to be an extension of the current key population programs, as well as lower maximum coverage. In contrast, the retention program for non-key populations would be novel and require higher costs per per person, but could reach a higher proportion of non-key populations in care. The key population retention program is the first priority until all accessible people are reached. The retention program for non-key populations will require a substantial increase in spending and is prioritised only at 150% of the current budget levels. Estimated optimised resource allocation by program at all budget levels is outlined in Appendix G.

Figure 6 highlights the different program modalities for key populations in more detail. All three modalities for reaching men who have sex with men are prioritised at higher budgets and are part of a balanced response for improving HIV epidemic outcomes in Sri Lanka. The high-intense program for men who have sex with men is prioritised before the peer educator modality because it is the most effective at reaching new networks at high risk of HIV, including men who have sex with men who cannot be reached through known hotspots.

PrEP is prioritised for expansion at 200% of current spending and above. Aligning National PrEP implementation protocol with the 2022 WHO updated guidelines for differentiated and simplified service delivery of PrEP may improve the cost-efficiency of PrEP (18).

Figure 6. Optimised allocations under 200% to 500% budget levels of annual HIV budgets for 2023 to 2030, to minimise new infections and HIV-related deaths by 2030.

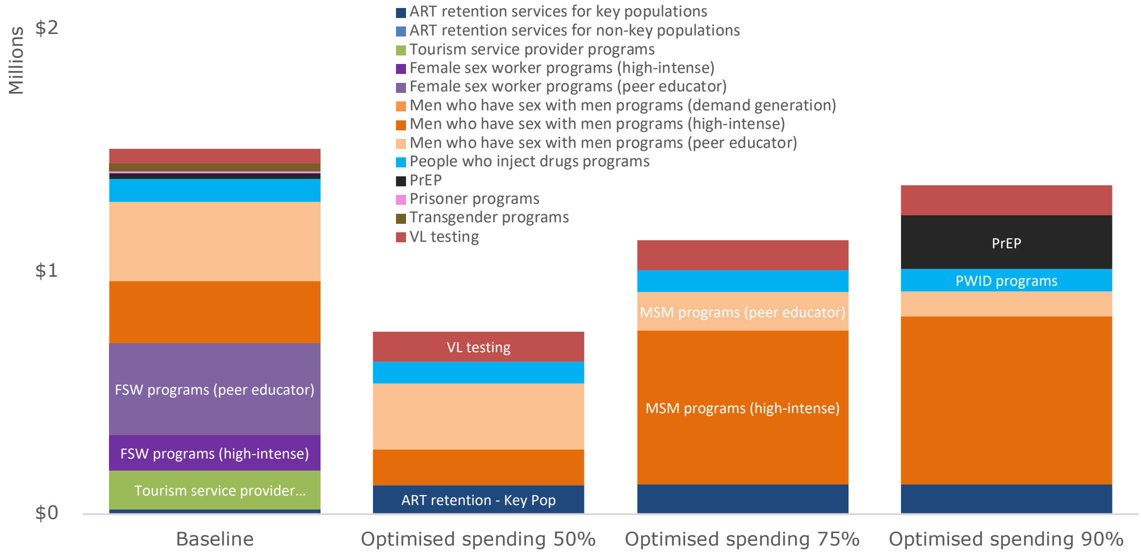


ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

3.5 Optimised resource allocation with **reduced** budgets for HIV prevention, testing, and retention

Compared with the baseline scenario, if less spending were available for direct HIV programs for prevention, testing and retention, priorities remain similar to the 100% optimised scenario, namely to scale up ART retention for key populations and viral load testing and maintain some spending for men who have sex with men programs. This is considered more effective at a reduced budget than maintaining programs for female sex workers and programs for tourist service providers. The second priority is to expand programs for men who have sex with men with a focus on scaling-up the high-intense model, in addition to maintaining some coverage of the peer educator model. Programs for people who inject drugs are also maintained to ensure continued surveillance despite low risk among this population. Figure 7 illustrates the priorities with reduced budget.

Figure 7. Optimised allocations with reduced budget of annual HIV budgets for prevention, testing and retention from 2023 to 2030, to minimise new infections and HIV-related deaths by 2030.



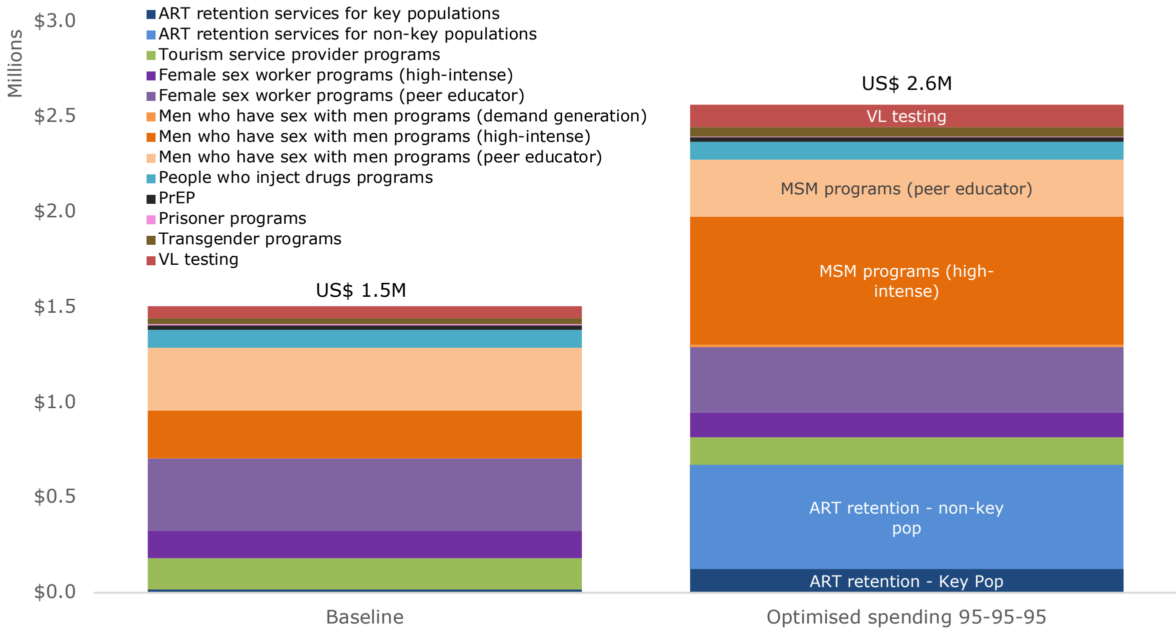
ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers VL, viral load.

3.6 Reaching 95-95-95 targets by 2030

We modelled an additional scenario to minimise resources needed to reach 95-95-95 targets, without considering new HIV infections and deaths. With this focused objective it may be possible to reach the UNAIDS 95-95-95 testing and treatment targets by 2030 if the spending for targeted HIV prevention programs is increased by 170%, meaning an additional $US1.1M per annum until 2030 (Figure 8). Priorities for expansion are ART retention for key populations (+US547,800) and non-key populations (+US$104,800), viral load testing (+US$53,100), and programs for men who have sex with men (+US$401,900). These programs are prioritized due to their impact on increasing diagnoses, maximizing treatment coverage and ensuring viral suppression.

PrEP is not prioritized to in the 95-95-95 scenario because its main impact is in reducing new infections, which is not a direct objective of the modelled scenario, and it does not diagnose, treat or lead to viral suppression among people living with HIV. However, PrEP is still a key component of the Fast-Track response (15) and can accelerate the reduction of new HIV infections (see section 3.8). The inclusion of PrEP would result in a similar allocation to the optimised spending 200% scenario and would give much higher confidence in reaching 95-95-95 if the underlying trend in new HIV infections is higher than estimated.

Figure 8. Optimised spending to meet 95-95-95 targets, requires $US2.6M (an additional US$1.1M, 170%) per annum.

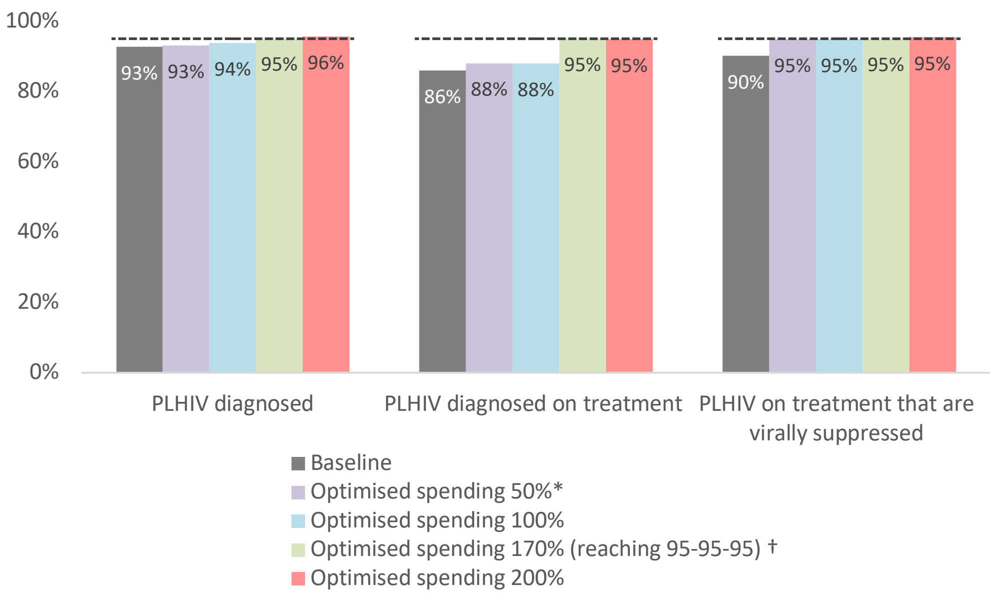


ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

3.7 Projected care cascade

If spending were optimised at 100%, the first 95 and third 95 target could be within reach, however diagnosed people living with HIV on treatment will remain at 88%. The 95-95-95 targets may be within reach with 170% budget optimised and more likely to be within reach with the 200% budget optimised to minimise new HIV infections and HIV-related deaths (Figure 9). 200% optimised spending may provide greater assurance of reaching the 95-95-95 targets and will have a greater impact on reducing new HIV infections (see Section 3.8).

Figure 9. Projected care cascade for 2030 in the (1) baseline scenario, (2) optimised spending 50%*, (3) optimised spending 100%, (4) optimised 95-95-95 scenarios (170% spending)† and (5) optimised spending 200%.



* Optimised spending 50% includes no constraints and is not directly comparable to optimisations at 100% spending and higher which were constrained to not reduce spending by more than 10% on any one program
† Optimised 95-95-95 scenario is modelled with the objective to reach 95% targets, whereas other budget optimisations are modelled with the objective to minimise new HIV infections and HIV-related deaths

3.8 Impact of the optimisation on the HIV epidemic

If there is no spending for HIV prevention, testing and retention programs, an additional 480 (80%) new HIV infections and 85 HIV-related deaths (30%) could occur over the 2023 to 2030 period compared with the baseline scenario. This could also reverse the decreasing trend in new HIV infections (Figure 10) and HIV-related deaths (Figure 11). If current spending for HIV were optimised, through retaining more people on treatment and monitoring their viral loads, this could avert 110 (20%) cumulative new HIV infections and 15 (5%) HIV-related deaths over the 2023 to 2030 period, compared with the baseline. At higher budget levels this impact increases, as more people are diagnosed and subsequently able to be linked and retained on treatment, while the scale-up of ART retention programs for non-key populations is prioritised (Table 2). PrEP, which is prioritised for expansion from 200% spending, has a direct impact on reducing HIV incidence, and may have a higher impact on reducing new infections (-40%) from baseline compared to when spending is optimised for achieving the 95 treatment targets alone (-30%).

Projected epidemic impacts of less than 100% spending should be interpreted with caution, as these optimisations did not include constraints and are thus not directly comparable to higher budget optimisations where only 10% of the budget could be reallocated. There may be negative consequences of fully defunding programs in unconstrained optimisations due to lack of surveillance as well as equity implications, and these are not captured in the projected epidemic impacts.

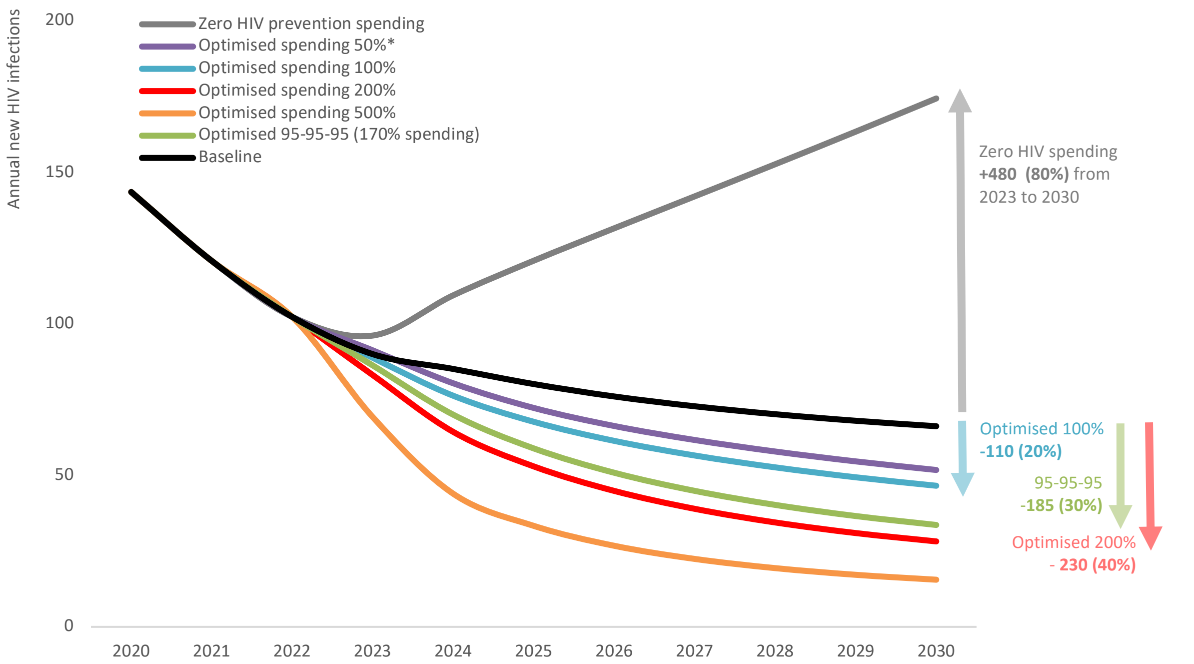
Table 2. Cumulative new HIV infections and HIV-related deaths between 2023-2030 under different scenarios, and differences in impacts compared to the baseline scenario of fixed 2022 spending on programs.

	Cumulative new HIV infections 2023-2030	Cumulative HIV-related deaths 2023-2030	Difference in infections from baseline	Difference in deaths from baseline
No HIV prevention* spending from 2023	1,090	385	480 (80%)	85 (30%)
50% optimised †	535	290	-70 (-10%)	-10 (-5%)
75% optimised †	490	285	-120 (-20%)	-15 (-5%)
90% optimised †	455	285	-155 (-25%)	-15 (-5%)
Baseline	610	300		
100% optimised	500	290	-110 (-20%)	-15 (-5%)
125% optimised	450	285	-160 (-25%)	-20 (-5%)
150% optimised	450	270	-160 (-25%)	-30 (-10%)
200% optimised	380	265	-230 (-40%)	-40 (-15%)
300% optimised	315	255	-295 (-50%)	-45 (-15%)
400% optimised	275	255	-335 (-55%)	-50 (-15%)
500% optimised	250	250	-360 (-60%)	-50 (-15%)
95-95-95	420	265	-185 (-30%)	-35 (-10%)

All numbers and percentages rounded to the nearest 5

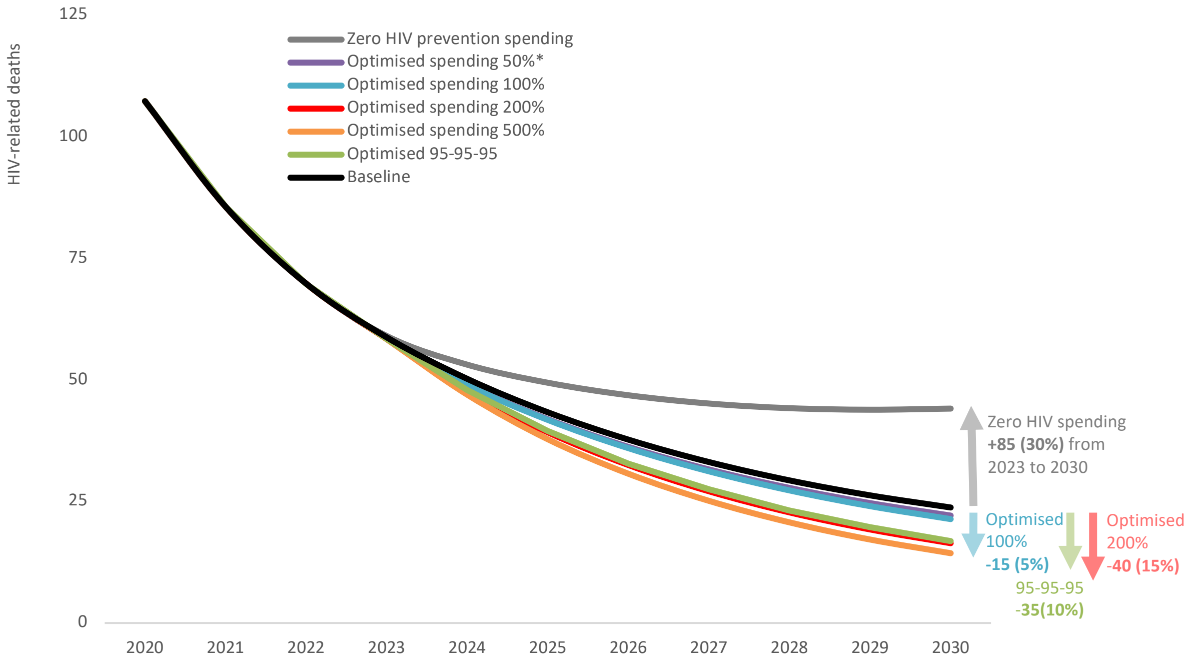
* Includes no spending on key population prevention, testing, ART retention or viral load testing.
† Optimisations below 100% spending included no constraints. Epidemic impacts are not directly comparable to optimisations at 100% spending and higher which were constrained to not reduce spending by more than 10% on any one program

Figure 10. Annual new HIV infections at varying budget levels (2020 to 2030) and projected change in cumulative new infections from 2023 to 2030.



* Optimised spending 50% includes no constraints and is not directly comparable to optimisations at 100% spending and higher which were constrained to not reduce spending by more than 10% on any one program

Figure 11. Annual HIV-related deaths at varying budget levels (2020 to 2030) and projected change in cumulative deaths from 2023 to 2030.



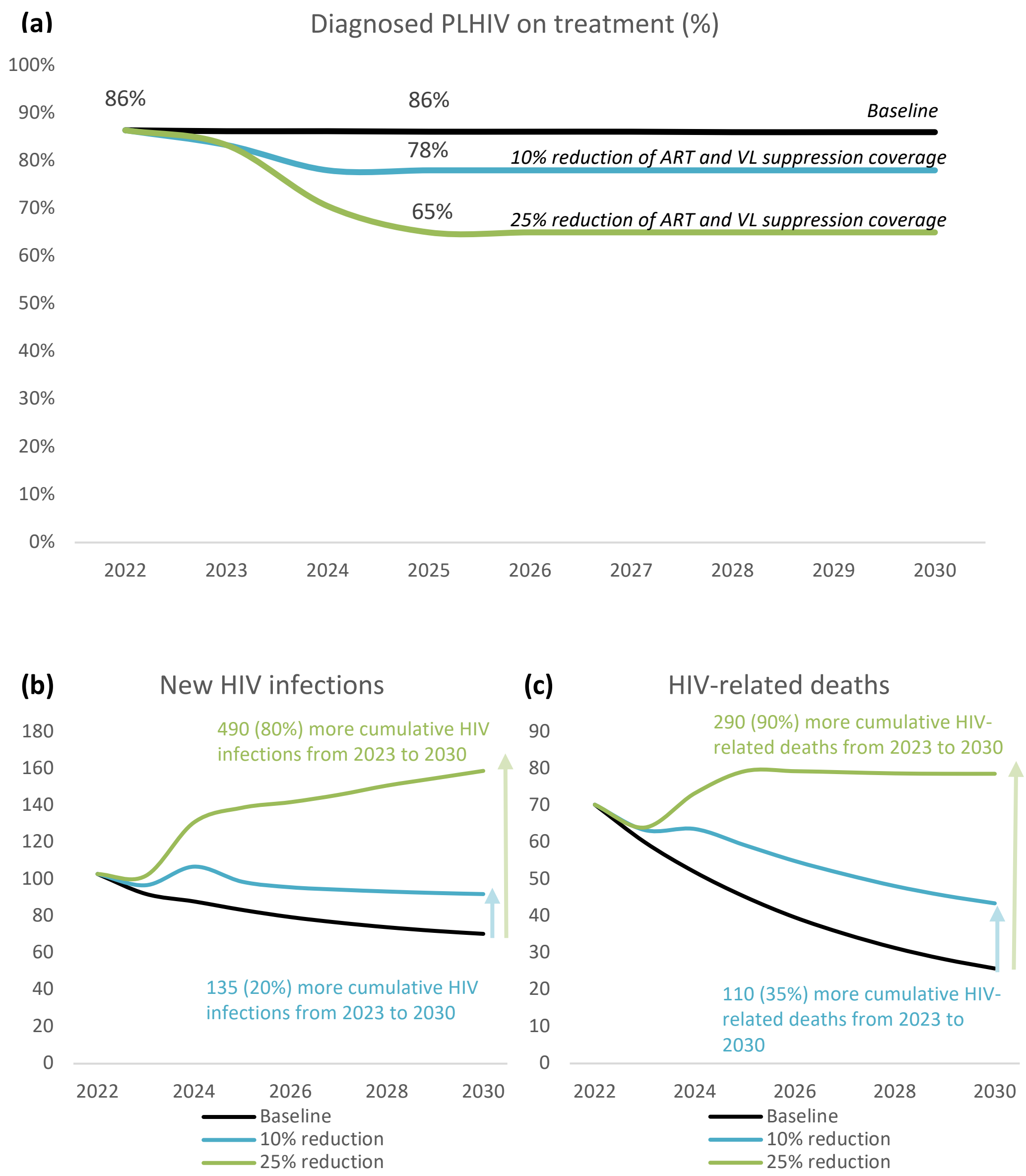
* Optimised spending 50% includes no constraints and is not directly comparable to optimisations at 100% spending and higher which were constrained to not reduce spending by more than 10% on any one program

3.9 Reduction in ART coverage and viral load monitoring

Should resources for ART and viral load monitoring or access to ART and viral load testing be limited in the future, this could have a significant impact on the HIV epidemic. In this scenario we assumed a 10% and 25% reduction in the proportion of diagnosed people living with HIV on treatment, as well as a 10% and 25% reduction in the proportion of those on ART who are virally suppressed. This reduction was assumed to take place in the grant cycle of 2023 to 2025, and impact was measured until 2030 (Figure 12).

The impact of only a 10% reduction in coverage of ART and viral suppression could result in a cumulative 95 (15%) more new HIV infections and 95 (30%) more HIV-related deaths from 2023 to 2030. A 25% reduction could reverse the declining trajectory of new HIV infections and HIV-related deaths entirely (Figure 12).

Figure 12. Impact of reducing coverage for ART and viral load testing coverage by 10 and 25% from 2023 to 2030. Panel shows: (a) Diagnosed people living with HIV on treatment for the baseline, 10%, and 25% reduction in coverage for ART and viral suppression scenario; (b) Impact on new HIV infections; and (c) Impact on HIV-related deaths.



ART, antiretroviral therapy; VL, viral load

3.10 ART resource needs

The model estimated that 2,300 people living with HIV were on treatment in 2021. Figure 13 illustrates the ART resource needs with varying levels of targeted HIV prevention spending. From 2022 onward, it was assumed that 100% of diagnosed people living with HIV who are retained in care would have access to ART (all diagnosed people who are not currently on ART were modelled as being lost to follow-up).

In the optimised scenarios, given the increase in number of people being diagnosed with HIV, in the short-term ART resource needs will increase. In the baseline scenario, a predicted US$30.5M could be necessary to ensure 2,870 people on treatment over the 2022 to 2030 period, assuming a unit cost of US$1,233 per person per year. In the 100% optimised scenario, an additional US$450,000 could be required over the 2022 to 2030 period to ensure +400 extra people who become diagnosed are on treatment, compared with the baseline scenario. In the optimised spending 500% scenario, an additional US$2.4M relative to baseline ART spending from 2022 to 2030 could allow for +2,000 additional people on treatment over that period. The longer-term projections show that the ART resource needs in optimised scenarios will eventually decrease due to overall HIV infections averted. In contrast, removing targeted HIV prevention spending would result in an eventual increase in ART resource needs in the longer-term.

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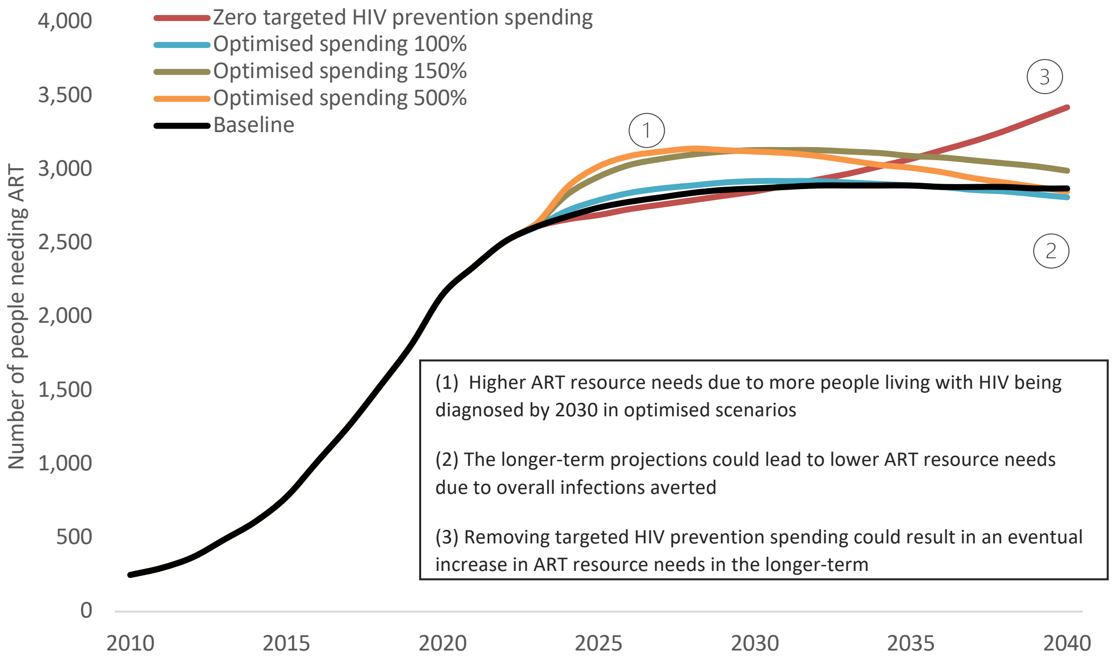
Figure 13. ART resource needs with varying levels of targeted HIV prevention spending.



4. Key limitations

As with any modelling study, there are limitations to consider when interpreting results and recommendations:

- **This study was initiated prior to the 2022 economic crisis and resulting political instability** in Sri Lanka, therefore the impacts of the crisis on the HIV epidemic as well as the costs and accessibility of interventions is not taken into account in this analysis.
- **Epidemiological indicators** and behavioural parameters come from population surveys and/or programmatic data that have varying degrees and types of biases and may be outdated. Uncertainty in these indicators combined with uncertainty in population sizes can lead to uncertainty in model calibration and projected baseline outcomes. The Optima HIV model aligns as best as possible with the national Sri Lankan AIDS Epidemic model to ensure consistency for number of people living with HIV, HIV-related deaths and new HIV infections. The recent increase in detected cases in Sri Lanka (609 in 2022 compared with 410 in 2021) could indicate an improvement in detection of existing HIV infections or alternatively that the underlying rate of new HIV infections is higher than previously estimated through AEM. This could further be evaluated through recency testing, which may already be in place. The uncertainty in projection of new HIV infections should be considered when interpreting the findings on PrEP prioritisation, as PrEP may be priortised at lower budget levels if there is a true increase in new HIV infections.
- **Attainable reach** of programs, for key populations in particular, is based on assumptions validated by country partners, however it may be much more difficult to reach these populations in practice.
- **Changes to allocations of spending** are applied immediately in the optimisation, whereas it is recognized that these changes will take time to implement in practice. At the same time, some re-allocations may not be logistically feasible.
- **Program definitions** for key population prevention and testing modalities were based on the high-intense and peer education models, as supported by the available data and according to current implementation. It is likely that these models will continue to evolve over time and for different geographical areas and populations. The prioritisation of specific modalities will require conversation between implementing partners, funders, and community. The findings from this analysis support increasing spending for programs for men who have sex with men and prioritising modalities to reach new men within networks with higher HIV risks.
- **Geographical heterogeneity** is not modelled, and outcomes represent national averages. For the high-intense program for men who have sex with men in particular, further data on potential costs and coverage is necessary to inform the expansion of the program beyond its current high-burden urban setting. There may also be opportunities for additional efficiency gains through appropriate geographical targeting in other programs.
- **ART resource needs** could be lower than estimated in this analysis if current conditions for loss to follow-up are primarily due to disruptions related to COVID-19 and economic conditions.
- **Effect (i.e. impact) sizes for interventions are informed from global literature**. Actual intervention impacts may vary depending on context or quality of implementation. This may also change over time, as programs are tailored to improve targeting of at-risk individuals, which may affect impact sizes locally.
- **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 and structural 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 optimisation but should be factored into programmatic and budgeting decisions.

5. Conclusion

This allocative efficiency analysis for HIV prevention and treatment support programs in Sri Lanka highlights the necessity to invest in ART retention and viral load monitoring at all budget levels. At the same time, more advances can be made by tailoring HIV services for key populations, with an emphasis on programs for men who have sex with men who are most at risk of acquiring HIV in Sri Lanka. Key recommendations include:

1. **Phasing out spending for HIV prevention and testing programs** will counteract encouraging progress in the HIV response and **may increase new HIV infections exponentially.** If the current spending levels for HIV cannot be sustained in the future, priority needs to be given to maintaining ART retention programs for key populations, viral load testing, and HIV prevention programs for men who have sex with men and people who inject drugs.
2. **Reduction of treatment and viral load monitoring coverage could have significant negative impact on HIV infections and HIV-related deaths**. Only a 10% reduction in treatment coverage and viral suppression could double the HIV-related deaths by 2030, while a 25% reduction could reverse the decreasing trend of both infections and deaths.
3. **Optimisation of 100% current spending** could lead to greater impact on the HIV epidemic, by averting 20% more HIV infections and 5% more HIV-related deaths over the 2023 to 2030 period. The first priority is to reallocate funding towards ART retention programs and viral load testing through cost-efficiencies in other programs, to ensure members of key populations remain on treatment and achieve viral suppression.
4. **With additional resources,** the second priority should be reaching additional men who have sex with men with HIV services, including with **pre-exposure prophylaxis (PrEP)**.
5. **All modalities of delivering HIV programs to men who have sex with men are part of a balanced response** for improving HIV epidemic outcomes in Sri Lanka. Approaches that are focused on reaching networks at higher risk of HIV transmission and people not previously tested are particularly important to reach the high proportion of men who have sex with men who are not accessible through known hotspots.
6. **Achieving 95-95-95 HIV testing and treatment targets by 2030 may be within reach**, though this will require an additional US$1.1M per year. Priorities for spending include ART retention for both key populations and the general population, scaling up viral load testing, and investing in HIV prevention and testing programs for men who have sex with men.

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Appendix A. Technical summary of the Optima HIV model

This model is informed by the latest evidence on HIV transmission, disease progression, and the impact of HIV programs on both. The following table lists all the assumptions on which this model is based. All references can be found in the Optima HIV Vol. VI. Parameter Data Sources.

The risks of transmitting, acquiring, and dying from HIV depend on a host of different factors that can vary across the population, across partnerships, and over time. In the Optima HIV epidemic model, the population is stratified in three different ways to reflect this variation: by demographic and/or risk group, by health/disease state (stratified by CD4 count category), and by stage of care. Optima HIV defines the different demographic/risk groups as *populations*, the different disease progression stages as *health states*, and the different care and treatment stages as *care states*. For example, a given person might be a female entertainment worker (their population) and be living with HIV with a CD4 count of 350–500 (their health state), and currently be linked to care but not on treatment (their care state).

To perform the optimisation, Optima HIV uses a global parameter search algorithm called adaptive stochastic descent (ASD) (19). Optima HIV version 2.11.3 updated November 2022, available at hiv.optimamodel.com was used for this analysis.

A.1 Model parameters

Three different types of HIV transmission are modelled: transmission between sexual partners, transmission via sharing injecting equipment, and mother-to-child transmission. The input data associated with populations, sexual partnerships, injecting partnerships, and births are outlined in Table A1 and Table A2.

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 behaviour 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

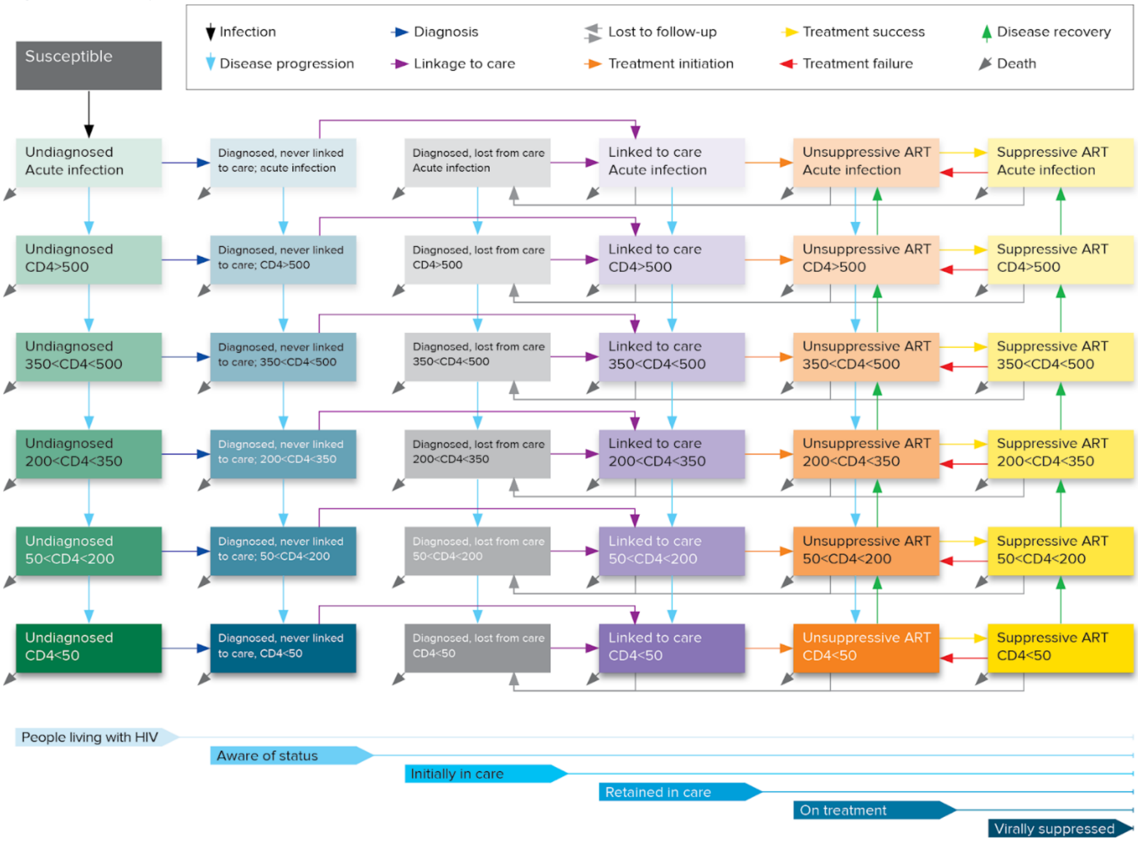
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates.

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

Optima HIV models seven states related to the care and treatment cascade (susceptible, undiagnosed, diagnosed and never linked to care, in care and not receiving ART, receiving ART and not virally suppressed, receiving ART and virally suppressed, and lost-to-follow-up). Among male populations, the susceptible compartment is further divided into those who have been circumcised versus those who have not been circumcised. All infected stages are further disaggregated into six CD4-related health states. Taken together, this gives 38 health and care states (Figure A1; circumcised compartments modelled for male populations only and not shown).

Figure A1. Optima HIV model structure.



A.2 Model inputs

Epidemiological, behavioural and programmatic data informing the Optima HIV model for Sri Lanka were sourced from national records, surveillance surveys, household surveys and other studies supplemented by expert advice from stakeholder consultations.

Table A2. Model inputs and their data sources.

Parameter	Source
Population size*	Age and gender stratified population sizes from the United Nations World Population Prospects 2019 (20). Consistent with AEM, key population sizes for higher risk populations are estimated from sources including (2, 8, 16, 21, 22).
HIV prevalence by population groups*	HIV prevalence data values are used as the primary point of reference during calibration. Values are taken from a combination of primary research including survey data, where available, and expert opinion/assumptions where no data exists. Sources include (1, 16, 23-27).
Other epidemiology* ▪ Percentage of people who die from non-HIV-related causes per year ▪ Prevalence of any ulcerative STIs ▪ Tuberculosis prevalence	Background mortality is taken from (20), with supplementary comorbidity information from (16, 17, 24, 25, 28, 29).
Testing and treatment* ▪ Percentage of population tested for HIV in the last 12 months ▪ Probability of a person with CD4<200 being tested per year ▪ Number of people on treatment ▪ Percentage of people covered by ARV-based prophylaxis ▪ Number of women on PMTCT (Option B/B+) ▪ Birth rate (births per woman per year) ▪ Percentage of HIV-positive women who breastfeed	The percentage of the population tested per year represents the likelihood that someone with an undiagnosed HIV infection will be diagnosed over the course of a year. As such inputs may be adjusted as part of calibration to match the proportion of HIV infections estimated to be diagnosed in each year, while maintaining trends in reported testing percentages. Sources include (1, 16, 17, 24, 25, 29-31).
Optional indicators* • Number of HIV tests per year • Number of HIV diagnoses per year • Modelled estimate of new HIV infections per year • Modelled estimate of HIV prevalence • Modelled estimate of number of PLHIV • Number of HIV-related deaths • Number of people initiating ART each year • PLHIV aware of their status (%) • Diagnosed PLHIV in care (%) • PLHIV in care on treatment (%) • Pregnant women on PMTCT (%) • People on ART with viral suppression (%)	Data entered in this section of the Optima HIV databook is not used by the model directly to generate output, but rather allows comparison points to be entered from other reliable sources or models in order to ensure consistency, in this case AEM and Spectrum output that has already being accepted nationally through a consultative process (16).
Cascade* • Average time taken to be linked to care (years) (by population groups) • Average time taken to be linked to care for people with CD4<200 (years) • Percentage of people in care who are lost to follow-up per year (%/year) • Percentage of people with CD4<200 lost to follow up (%/year)	Cascade parameters informed by programmatic data compiled through annual reports of NSACP (1, 7, 32-34).

Parameter	Source
• Viral load monitoring (number/year) • Proportion of those with VL failure who are provided with effective adherence support or a successful new regimen (%/year) • Treatment failure rate	
Sexual behaviour* ▪ Average number of acts with regular partners per person per year ▪ Average number of acts with casual partners per person per year ▪ Average number of acts with transactional partners per person per year ▪ % age of people who used a condom at last act with regular partners ▪ Percentage of people who used a condom at last act with casual partners ▪ Percentage of people who used a condom at last act with transactional partners ▪ Percentage of males who have been circumcised	Sources for sexual behaviour include (16, 24, 25, 31) with circumcision estimate was informed through global prevalence of male circumcision (35).
Injecting behaviours* ▪ Average number of injections per person per year ▪ Percentage of people who receptively shared a needle/syringe at last injection ▪ Number of people who inject drugs who are on opiate substitution therapy (OST)	Sources for injecting behaviour include (16, 24, 25).
Partnerships and transitions ▪ Interactions between regular partners ▪ Interactions between casual partners ▪ Interactions between transactional partners ▪ Interactions between people who inject drugs ▪ Birth ▪ Aging ▪ Risk-related population transitions (average number of years before movement)	Informed by population definitions, supplemented by details from AEM (16).
Constants • Interaction-related transmissibility (% per act) • Relative disease-related transmissibility • Disease progression (average years to move) • Treatment recovery due to suppressive ART (average years to move) • CD4 change due to non-suppressive ART (%/year) • Death rate (% mortality per year) • Changes in transmissibility (%) • Disutility weights	Source for constant values used for Optima HIV are given in the Optima HIV user guide available through the online tool http://hiv.optimamodel.com

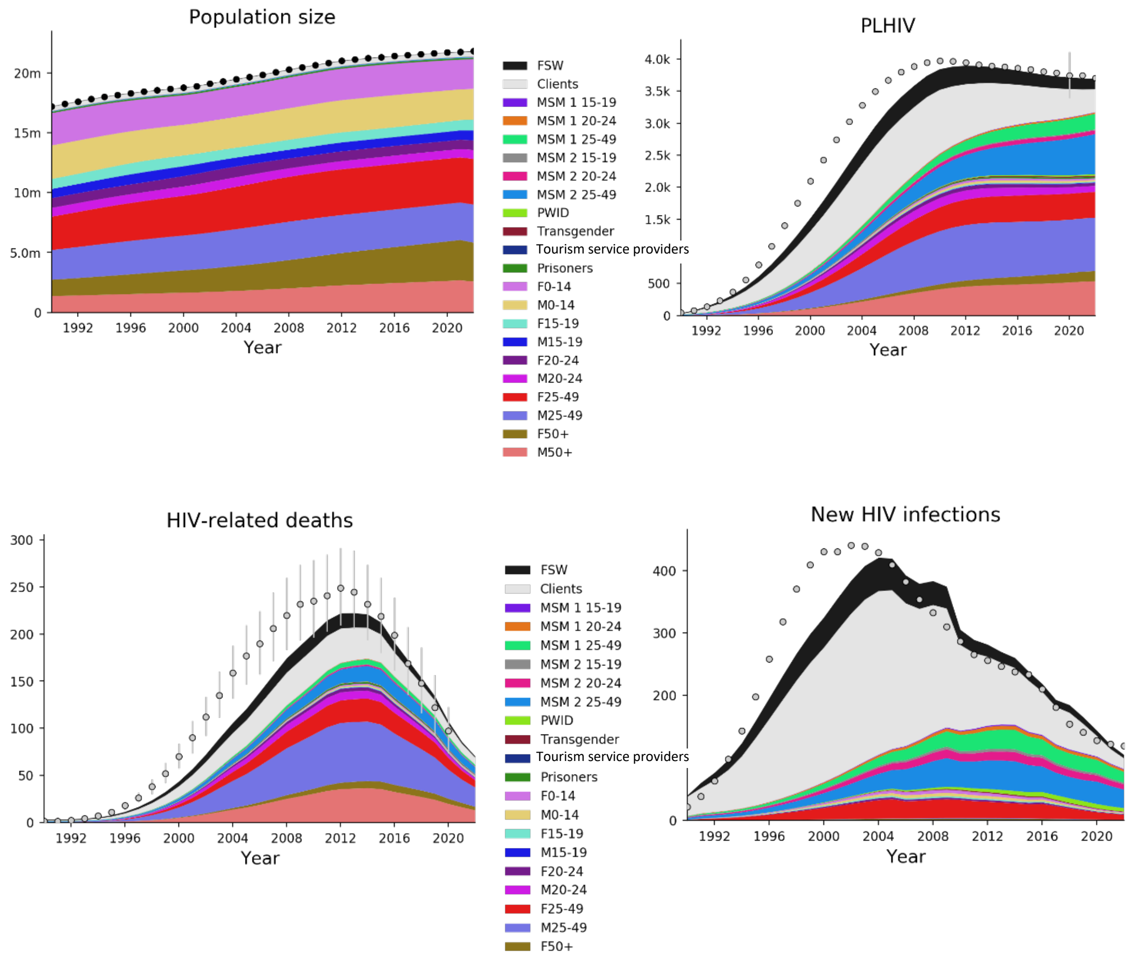
*Values can be defined annually from 1990 to 2022

Appendix B. Model calibration

The aim of calibration is to align model outputs to available epidemiological data and official country estimates based on other models (e.g. AIDS Epidemic Model [AEM]) as best as possible given the underlying model structure and assumptions. The main calibration parameters used for Optima HIV are ‘initial prevalence’ (the percentage of each population with HIV in the first-time step of the model, January 1, 1990), and ‘force of infection’ which represents all factors which are not modelled explicitly but which impact on the likelihood of each population becoming infected relative to other populations. Individual population prevalence estimates are calibrated to prevalence survey data relating to each population, and secondarily to match existing country estimates including new HIV infections and HIV-related deaths from AEM and other Spectrum modelling to provide consistency with an agreed baseline. While the epidemic in Sri Lanka has remained concentrated in key populations, there has significantly been a shift in incidence from primarily through transactional sex (both clients and female sex workers) at the peak of the epidemic between the late 1990s and early 2000s, to rising infection rates among men who have sex with men.

Calibration outputs in relation to official country estimates based on World Population Prospects, Spectrum model, surveillance surveys, program data and UNAIDS are presented below. The shaded area represent the Optima estimate by subpopulation and the data points are the original data with which the model is aligning.

Figure B1. Main calibration outputs for population size, number of people living with HIV, HIV-related deaths, new HIV infections and HIV diagnoses for 1990 to 2022.



Please note that estimates for people living with HIV, HIV-related deaths and new HIV infections are aligned with 2022 AEM estimates (grey data points)

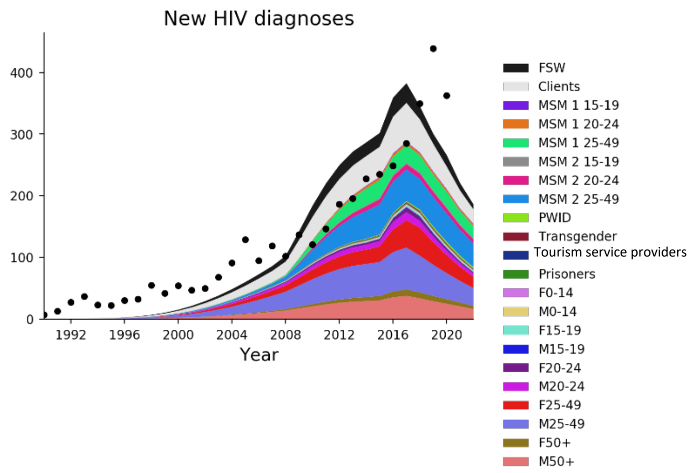


Figure B2. Calibration output for HIV treatment cascade parameters.

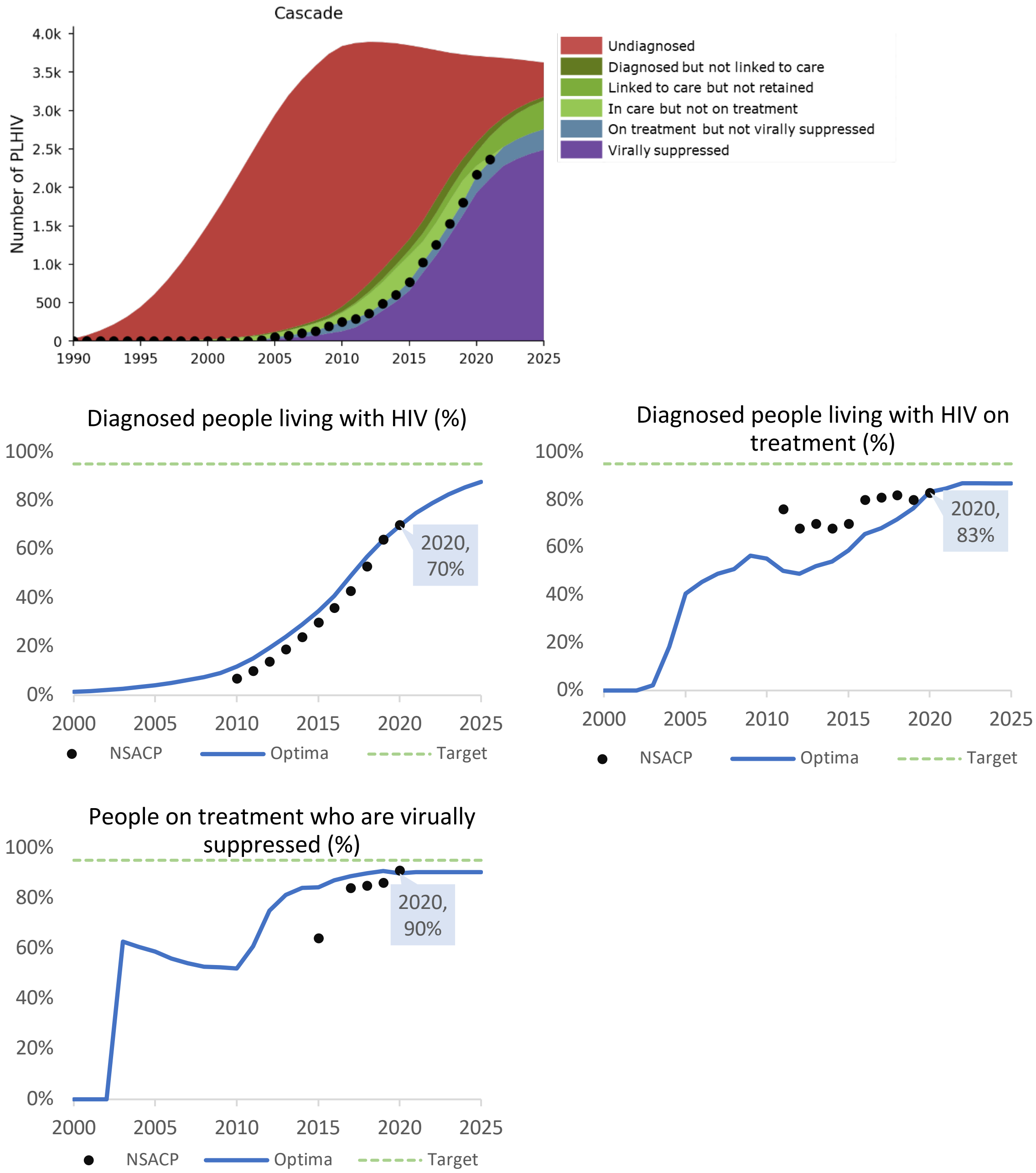
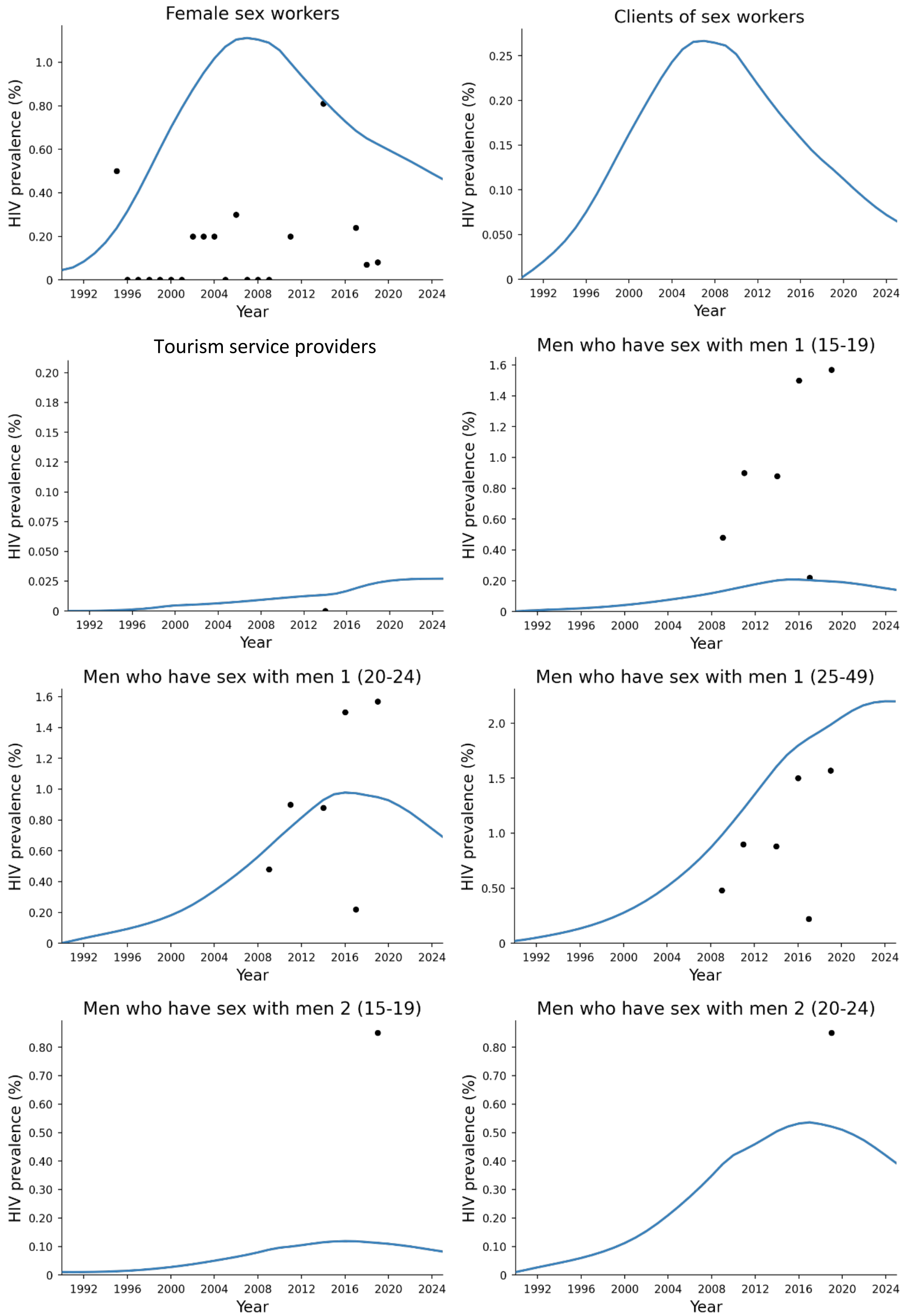
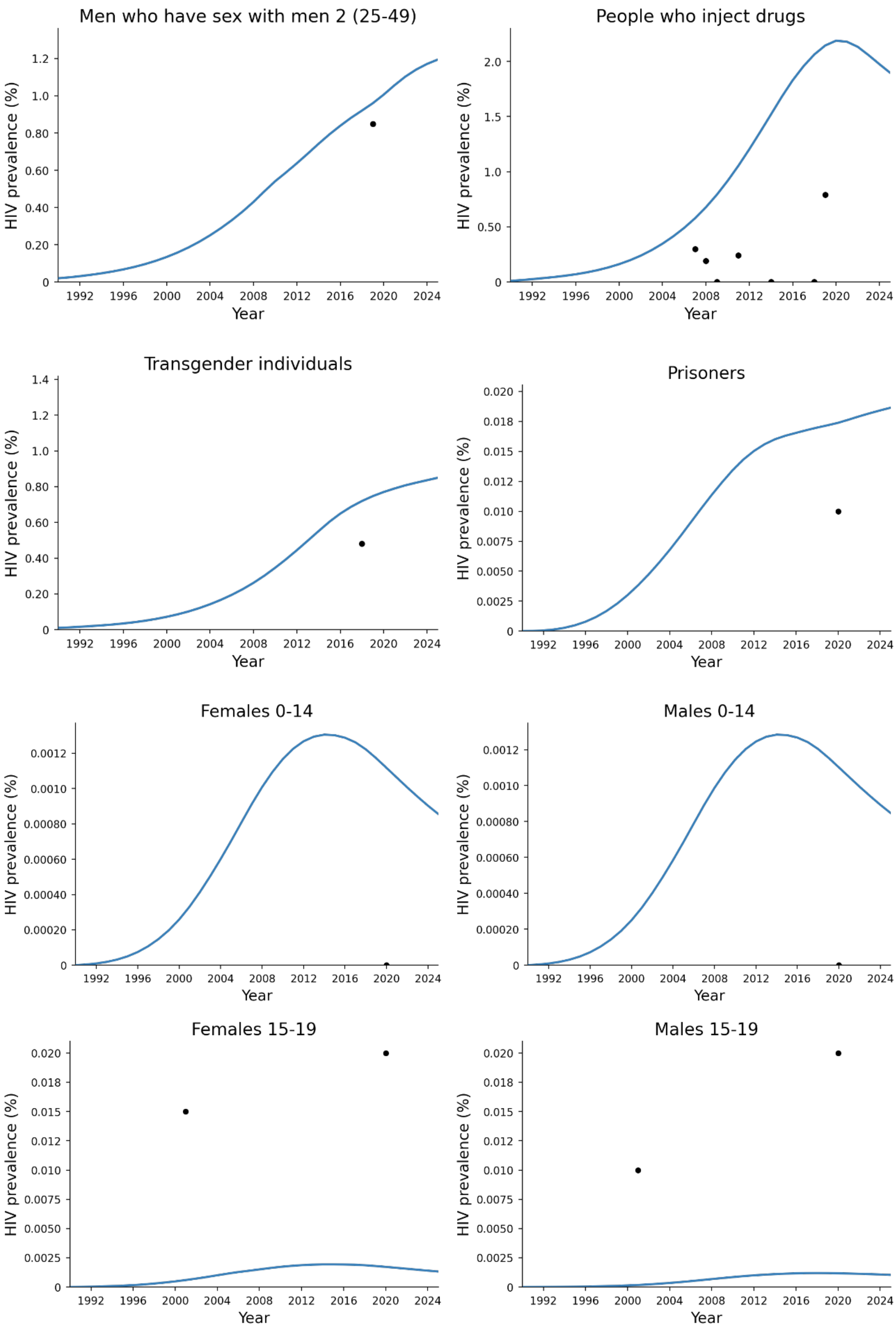
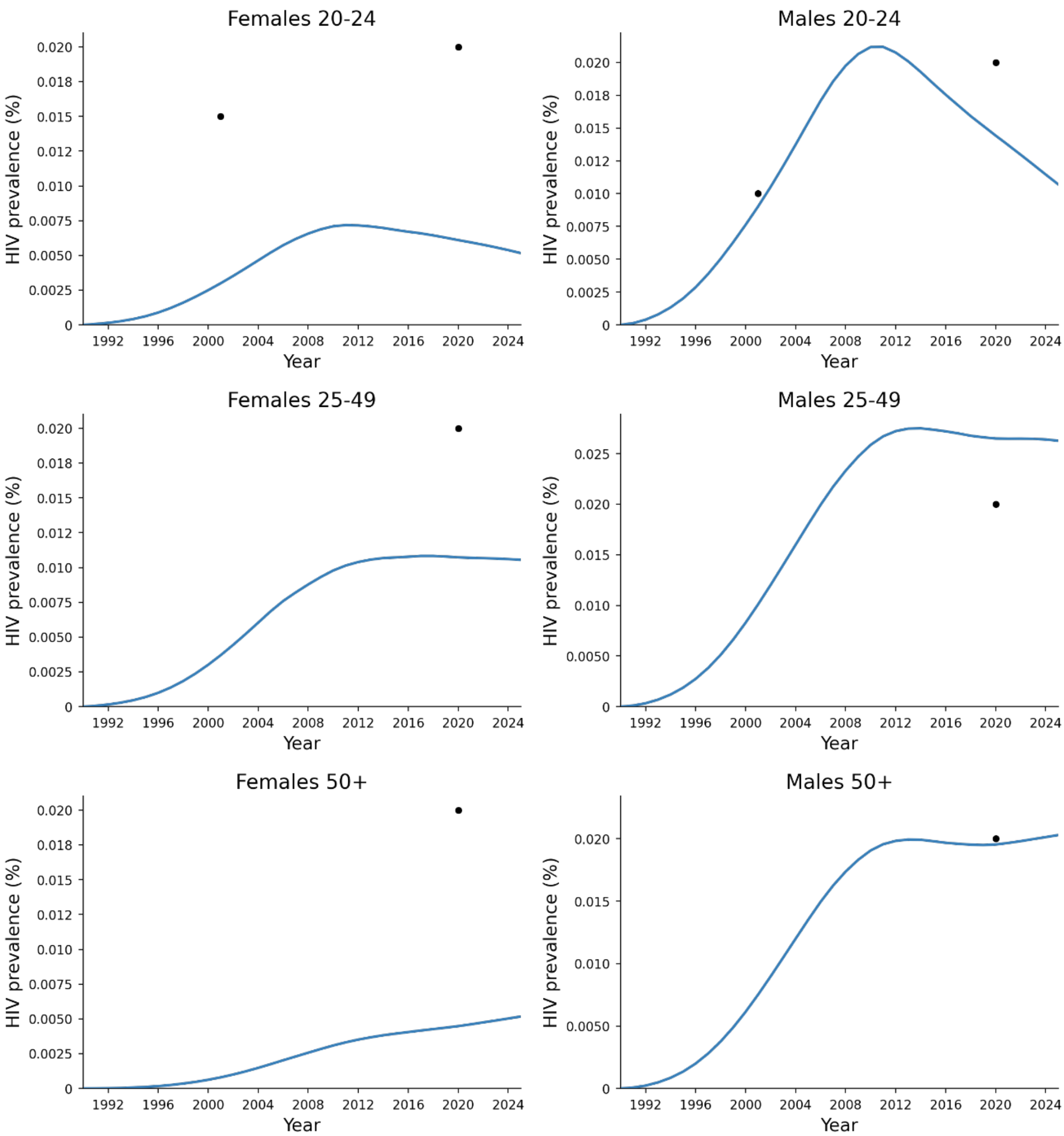


Figure B3. Calibration outputs for HIV prevalence by population for 1990 to 2025.




Men who have sex with men 2 (25-49)
People who inject drugs
Transgender individuals
Prisoners
Females 0-14
Males 0-14
Females 15-19
Males 15-19
HIV prevalence (%)
Year
1992
1996
2000
2004
2008
2012
2016
2020
2024


Females 20-24
Males 20-24
Females 25-49
Males 25-49
Females 50+
Males 50+
HIV prevalence (%)
Year
0
0.0025
0.0050
0.0075
0.010
0.012
0.015
0.018
0.020
0.025
1992
1996
2000
2004
2008
2012
2016
2020
2024

Appendix C. Stakeholder consultations

To meet stakeholder needs, the flexibility of Optima HIV to model context-specific subpopulations and programs was leveraged to answer policy questions through scenario and optimisation analyses. This study was conducted in consultation with stakeholder groups through a series of technical group meetings (Table C2) and individual discussions that were held from 28th of January 2022 to 28 February 2023 as listed in Table C1.

Table C1. Stakeholder consultation discussions

Stakeholder	Key topics
Technical Working Group 1 (Jan 2022)	Provided introduction to Optima, reviewed key analysis inputs, discussed key policy questions, program and population inclusion, and discussed analysis timelines and TWG membership.
Technical Working Group 2 (Feb 2022)	Discussion to address concerns regarding the differences between Optima and AEM. Discussed the added value of an allocative efficiency analysis.
Health Equity Matters	Ongoing discussions regarding the upcoming key population investment case, consultants and key population representatives to speak to, key population service delivery as it stands and priorities for key population services, review and interpretation of preliminary results.
UNAIDS	Ongoing discussions with regional experts to review epidemiological inputs and ensure alignment with AEM, a model that is reviewed annually by the country team with support from UNAIDS. Reviewed expected impact of programs, targeting of key populations, and preliminary results and interpretation.
Key population investment case consultants	Discussed Global Fund transition, stigma-related issues, virtual platforms and the potential for these in service delivery (delivery of self-testing for example), linkage to care and adherence issues, critical recommendations; especially concerns around civil society organisations when Global Fund funding is no longer in place.
National STD/AIDS Control Program (NSACP) – HIV financing experts	Discussed the implementation of PrEP, Global Fund transition and the ability of government funding to fill this gap, and key service delivery issues.
National STD/AIDS Control Program (NSACP) – epidemiological experts	Discussed epidemiological data, latest AEM file and its outputs, the MSM risk groups and ability of Optima to subdivide into age categories, lack of behavioural data for transgender populations or tourist service providers, agreed on key population size estimates and HIV prevalence estimates, and provided input on preliminary findings.
Family Planning Association (FPA)	Reviewed key policy questions for Sri Lanka, the potential for PrEP implementation and key barriers to access for key populations. Further information on young men who have sex with men engaging in high-risk behaviour who may be accessible via online platforms, review of key population programs and their potential implementation efficiencies, review and interpretation of preliminary results.
National AIDS Council	Sustainability of funding, viral load testing and potential for data collation for costing.

Stakeholder	Key topics
Technical Working Group 3 (Mar 2022)	Reviewed summary of the key findings form stakeholder interviews; discussed policy questions that the efficiency analysis will respond to, cost and coverage of direct HIV programs, and population size estimates.
Community consultation with key populations representatives from PLHIV organisations	Discussed the delivery of key population programs; barriers to condom ise, testing, PrEP uptake and treatment among key population; and the potential maximum reachable coverage of services.
Technical Working Group 4 (Oct 2022)	Reviewed regional costing study methods and preliminary results for Sri Lanka and discussed costing inputs for Optima modelling.
Technical Working Group 5 (Feb 2023)	Reviewed preliminary findings of the budget optimisation analysis.

Table C2. Technical Working Group members

Name	Designation	Institution
Dr Rasanjalee Hettiarachchi	Director	National STD & AIDS Control Program (NSACP)
Dr K.A.M Ariyarathne	Head of Strategic Information Unit	NSACP
Dr Shanmuganathan Muraliharan	Medical Officer	NSACP, Strategic Information Management (SIM) Unit
Dr Sathya Herath	GFATM Project Lead	NSACP
Dr Sriyakanthi Beneragama	Head of Epidemiological Unit	NSACP
Dr Himali Perera	Persons Living with HIV Coordinator	NSACP
Dr Darshani Mallikarathne	Leads the Key Population Programs Venereologist	NSACP
Dr L.S Lakshan	SI Officer	NSACP, Strategic Information Management Unit
Dr Ajith Karawita	Consultant Venereologist	NSACP
Dr Nimali Jayasuriya	HIV Testing Coordinator	NSACP
Dr Chandrika Jayakody	Currently in charge of the Main STI Clinic in Colombo	NSACP
Dr Geethani Samaraweera	In charge of trainings	NSACP
Dr Sujatha Samarakoon	Head	National AIDS Council

Sriyal Nilanka		FPA Sri Lanka
Nadika Fernandopulle	Programme Manager for the Global Fund Grant	FPA Sri Lanka
Amal Bandara	Assistant Director M&E	FPA Sri Lanka, Focal point GF
Imasha Perera	KP Focal Point – Transgender persons	KP Taskforce – CCM
Palitha Wijayabandra	KP Focal Point – Persons Living with HIV	KP Taskforce – CCM
Manju Hemal	KP Focal Point – MSM	KP Taskforce – CCM
Mahesh Nissanka	KP Focal Point – Persons Who Inject Drugs	KP Taskforce – CCM
Ranjith Wickramasinghe	KP Focal Point – Beach Boys	KP Taskforce – CCM
Kanthi Abeykoon	KP Taskforce Vice Chair representing Female Sex Workers	KP Taskforce – CCM
Priskila Arulpragasam	Innovation assistant	UNFPA
Sarah Soysa	National Programme Analyst - SRHR	UNFPA
Heather-Marie Schmidt	Technical Advisor	UNAIDS Regional Office for Asia Pacific / WHO Thailand
Ye Yu Shwe	Technical Advisor	UNAIDS Regional Office for Asia Pacific
Preshila Samraweera		WHO
Dr Janakan Navaratnasingam		WHO
Niluka Perera	Independent Consultant	Diversity and Solidarity Trust (CSO)

Appendix D. Populations

Population definitions are consistent with NSACP on HIV estimation in Sri Lanka using the AEM tool, however with additional key populations of tourist service providers and prisoners included due to stakeholder concerns on the significance of those populations to the HIV epidemics, as well as additional age stratification in key populations and general population of low-risk males and females (Table D1).

Key assumptions:

- AEM 2021 did not include prisoners as a separate population, and data for prisoners are limited. The prisoner population is included using behavioural assumptions and separate population estimates based on data from the Department of Prisons Sri Lanka and programmatic data for those reached with interventions.
- Without primary data on behaviour of MSM 2, assumptions around behaviours for MSM 2 are closely similar to MSM 1, initial prevalence and force of infection were calibrated at to match overall epidemic trends.

Table D1. Definitions of population groups included in the analysis.

Abbreviation	Population group	Definition
Clients	Clients of female sex workers	Clients of female sex workers, who have paid money or goods in exchange for sex in the last 12 months.
TGW	Transgender women	Biological male at birth, 15-49 years old, self-identified as female or third gender.
PWID	People who inject drugs	Biological males, 15-49 years old who injected drug(s) one or more time(s) in the last month.
FSW	Female sex workers	Biological females, 15-49 years old, who sell sex in exchange of money or goods in the last 12 months.
MSM 1 15-19	Hotspot based men who have sex with men, 15-19	Biological males, 15-19, 20-24 and 25-49 years old respectively, who have had anal sex with another male in last 12 months including those who find and meet male sex partners though online applications. MSM 1 are those go, work, or visit at hotspot, sauna, spa, beer garden who can be reached through venue-based outreach. Also referred to as "reachable" men who have sex with men (2, 8).
MSM 1 20-24	Hotspot based men who have sex with men, 20-24	
MSM 1 25-49	Hotspot based men who have sex with men, 25-49	
MSM 2 15-19	Non-hotspot based men who have sex with men, 15-19	Biological males, 15 to 24 and 25-49 years old, respectively, who have had anal sex with another male in last 12 months including those who find and meet male sex partners though online applications. MSM 2 have a lower partner exchange rate, are assumed to also sexually interact with females in the general population, and may therefore be at lower risk of acquiring HIV (2). It is assumed that MSM2 cannot readily be reached with location-based physical outreach programs. Also referred to as "unreachable" or "hidden" men who have sex with men (2, 8).
MSM 2 20-24	Non-hotspot based men who have sex with men, 20-24	
MSM 2 25-49	Non-hotspot based men who have sex with men, 25-49	
Prisoners	Prisoners	Male prisoners who have been convicted of offences under the law by various courts in the Island and sentenced to a term of imprisonment, and unconvicted prisoners awaiting trial.
TSP	Tourist service providers	Biological males, 15 to 49 years old who cruise in and around beach areas and associate with tourists as guides, animators or providers of any form of gratification including insertive and receptive sex (homosexual, heterosexual or bisexual orientation) during the last 12 months (formerly known as beach boys).
F0-14 M0-14 F15-19 M15-19 F20-24 M20-24 F25-49 M25-49 F50+ M50+	Females (0-14) Males (0-14) Females (15-19) Males (15-19) Females (20-24) Males (20-24) Females (25-49) Males (25-49) Females (50+) Males (50+)	Age stratified general population 0-14, 15-19, 20-24, 25-49, and 50 years and older, analogous to low-risk males and low-risk females in AEM.

Appendix E. HIV Program definitions

The key assumptions of resource optimisation are the relationships between (1) the cost of HIV programs for specific target populations, (2) the resulting coverage levels of targeted populations with these HIV programs, and (3) how these coverage levels of HIV programs for targeted populations influence behavioural and clinical outcomes. The data to inform these relationships are listed in Table E1.

E.1 Overview of HIV program inputs

Table E1. HIV programs included in the model; budget and unit costs (in US dollars), annual coverage, target populations, saturation value and population factor.

Category	Program	Spending 2022[1]	Unit cost 2022	Coverage 2022, n (%)[6]	Target population(s)	Saturation value[7]	Population factor[8]
Treatment	1. Antiretroviral therapy (ART)[2,3]	$2,915,853	$1,233.96	2,363 (63%)	People living with HIV	100%	1.0
	2. Prevention of mother-to-child transmission (PMTCT)[2,3]	$740,667	$46,291.68	16 (76%)	Pregnant women living with HIV	100%	1.0
	3. ART retention services for non-key populations	$0	$244.96	0 (0%)	People living with HIV	100%	0.00009
	4. ART retention services for key populations	$18,453	$122.48	151 (14%)	People living with HIV	75%	0.005-0.01
	5. Viral load testing	$62,505	$22.50	2,351 (0%)	People living with HIV	100%	1.0
HIV prevention in key populations	6. HIV testing and prevention programs for men who have sex with men						
	a. Peer educator	$253,522	$77.71	4232 (25%)	Hotspot based men who have sex with men (MSM1)	90%	1.0
	b. High intense	$328,875	$114.24	3,702 (7%)	Hotspot based men who have sex with men (MSM1). Non-hotspot based men who have sex with men (MSM2)	45%[9]	0.5
	c. Demand generation (virtual outreach)	$0	$70.72	0 (0%)	Non-hotspot based men who have sex with men (MSM2) aged 15-24	45%[9]	0.5

Category	Program	Spending 2022[1]	Unit cost 2022	Coverage 2022, n (%) [6]	Target population(s)	Saturation value [7]	Population factor [8]
	7. HIV testing and prevention programs for female sex workers						
	a. High intense	$146,565	$67.05	2,186 (7%)	Female sex workers	45%[9]	1.0
	b. Peer educator	$377,905	$75.67	4,994 (16%)	Female sex workers	50%	1.0
	8. HIV testing and prevention programs for people who inject drugs	$93,793	$114.24	821 (87%)	People who inject drugs	95%	1.0
	9. HIV testing and prevention programs for tourist service providers	$161,795	$76.21	2123 (46%)	Tourist service providers	90%	1.0
	10. HIV testing program among prisoners	$6,938	$1.00	6,938 (6%)	Prisoners	30%	1.0
	11. HIV testing and prevention programs for transgender people	$30,673	$102.93	298 (13%)	Transgender women	78%	1.0
	12. Pre-exposure prophylaxis (PrEP)[4]	$24,349	$121.74	200 (2%)	Hotspot based men who have sex with men (MSM1), transgender women	30%	0.5
						20%	0.75
						30%	1
Non-targeted HIV programs[2,5]	Strategic information, management, health systems strengthening and supportive environment interventions	$6,536,125	N/A	N/A	N/A		
Total		$11,697,748					

1 Source 2022 SKPA cost study unless indicated

2 Not included in the optimisation

3 Spending and coverage based on 2020 values, calculated from the Global AIDS Monitoring Reports 2020 (PMTCT) and 2021 (ART) spending and NSACP coverage to derive unit costs;

4 PrEP modelled as three programs with different population factors representing uptake among individuals at lower risk as overall coverage of PrEP increases with maximum coverage achievable overall 80%;

5 Spending on non-targeted programs include spending classified as strategic information, health systems strengthening, and supportive environment in the NSP costed work plan as well as unclassified spending that could not be categorised as direct HIV spending within prevention, diagnosis and treatment programs;

6 Proportional coverage is based on target population size specific to each program;

7 Saturation value represents *maximum* achievable coverage accounting for geographical, social and implementation constraints in accessibility and uptake;

8 Population factor represents the proportion of the population actually being targeted by model parameters (that is for whom the model parameter is relevant)
Generally: 1-1, however program service delivery modalities, e.g. pre-exposure prophylaxis, may have a population factor 0.5, thereby targeting half of the key population, but thereby targeting those at highest risk;

9 Maximum coverage is informed by the distribution of key population groups in high burden districts where it is feasible to implement the high intense program and where there are data to inform unit costs and effectiveness.

E.2 Program impacts

For each HIV program, it is necessary to derive one set of logistic curves that relate funding to program coverage levels and another set of curves (generally linear relationships) between coverage levels and clinical or behavioural outcomes (i.e., the impacts that HIV strategies aim to achieve). Outcomes expected from changes in program funding are assumed by interpolating and extrapolating available data using a fitted logistic curve. A limitation of this approach is that all changes in behaviour are assumed to be because of changes in program funding.

Table E2. Data inputs of impact of each parameter by intervention.

HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
MSM programs (demand generation)	Average time taken to be linked to care (years)	MSM 2 15-19	0.45	0.45	0.20	0.20
MSM programs (demand generation)	Average time taken to be linked to care (years)	MSM 2 20-24	0.45	0.45	0.20	0.20
FSW programs (high-intense)	Average time taken to be linked to care (years)	FSW	0.45	0.45	0.20	0.20
FSW programs (peer educator)	Average time taken to be linked to care (years)	FSW	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 1 15-19	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 1 20-24	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 1 25-49	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 2 15-19	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 2 20-24	0.45	0.45	0.20	0.20
MSM programs (high-intense)	Average time taken to be linked to care (years)	MSM 2 25-49	0.45	0.45	0.20	0.20
PWID programs	Average time taken to be linked to care (years)	PWID	0.75	0.75	0.30	0.30
TSP programs	Average time taken to be linked to care (years)	Tourist service providers	0.60	0.60	0.20	0.20
Transgender programs	Average time taken to be linked to care (years)	Transgender women	0.45	0.45	0.20	0.20
MSM programs (demand generation)	Condom use for casual acts	MSM 1 15-19, MSM 2 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 15-19, MSM 2 20-24	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 20-24, MSM 2 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 20-24, MSM 2 20-24	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 1 25-49, MSM 2 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 1 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 1 20-24	61%	61%	80%	80%

MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 1 25-49	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 2 15-19	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 2 20-24	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, MSM 2 25-49	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 15-19, Transgender	30%	30%	70%	70%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 1 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 1 20-24	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 1 25-49	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 2 15-19	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 2 20-24	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, MSM 2 25-49	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 20-24, Transgender women	30%	30%	70%	70%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 25-49, MSM 2 15-19	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	MSM 2 25-49, MSM 2 20-24	65%	65%	80%	80%
MSM programs (demand generation)	Condom use for casual acts	Transgender women, MSM 2 15-19	30%	30%	70%	70%
MSM programs (demand generation)	Condom use for casual acts	Transgender women, MSM 2 20-24	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 2 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 2 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, MSM 2 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 15-19, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 2 15-19	61%	61%	80%	80%

MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 2 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, MSM 2 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 20-24, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 2 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 2 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, MSM 2 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 1 25-49, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 2 15-19	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 2 20-24	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, MSM 2 25-49	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 15-19, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 2 15-19	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 2 20-24	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, MSM 2 25-49	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 20-24, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 1 25-49	61%	61%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 2 15-19	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 2 20-24	65%	65%	80%	80%

MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, MSM 2 25-49	65%	65%	80%	80%
MSM programs (high-intense)	Condom use for casual acts	MSM 2 25-49, Transgender women	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 1 15-19	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 1 20-24	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 1 25-49	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 2 15-19	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 2 20-24	30%	30%	70%	70%
MSM programs (high-intense)	Condom use for casual acts	Transgender women, MSM 2 25-49	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 2 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 2 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, MSM 2 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 15-19, Transgender women	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 2 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 2 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, MSM 2 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 20-24, Transgender women	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 2 15-19	61%	61%	80%	80%

MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 2 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, MSM 2 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 1 25-49, Transgender women	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 15-19, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 15-19, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 15-19, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 20-24, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 20-24, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 20-24, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 25-49, MSM 1 15-19	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 25-49, MSM 1 20-24	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	MSM 2 25-49, MSM 1 25-49	61%	61%	80%	80%
MSM programs (peer educator)	Condom use for casual acts	Transgender women, MSM 1 15-19	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	Transgender women, MSM 1 20-24	30%	30%	70%	70%
MSM programs (peer educator)	Condom use for casual acts	Transgender women, MSM 1 25-49	30%	30%	70%	70%
PWID programs	Condom use for casual acts	PWID, F15-19	0%	0%	50%	50%
PWID programs	Condom use for casual acts	PWID, F20-24	0%	0%	50%	50%
PWID programs	Condom use for casual acts	PWID, F25-49	0%	0%	50%	50%
TSP programs	Condom use for casual acts	TSP, F15-19	60%	60%	90%	90%
TSP programs	Condom use for casual acts	TSP, F20-24	60%	60%	90%	90%
TSP programs	Condom use for casual acts	TSP, F25-49	60%	60%	90%	90%
TSP programs	Condom use for casual acts	TSP, F50+	60%	60%	90%	90%
Transgender women programs	Condom use for casual acts	MSM 1 15-19, Transgender women	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	MSM 1 20-24, Transgender women	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	MSM 1 25-49, Transgender women	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	MSM 2 15-19, Transgender women	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	MSM 2 20-24, Transgender women	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	MSM 2 25-49, Transgender women	30%	30%	70%	70%

Transgender women programs	Condom use for casual acts	Transgender women, MSM 1 15-19	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, MSM 1 20-24	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, MSM 1 25-49	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, MSM 2 15-19	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, MSM 2 20-24	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, MSM 2 25-49	30%	30%	70%	70%
Transgender women programs	Condom use for casual acts	Transgender women, Transgender women	0%	0%	50%	50%
FSW programs (high-intense)	Condom use for commercial acts	Clients, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 1 15-19, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 1 20-24, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 1 25-49, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 2 15-19, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 2 20-24, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	MSM 2 25-49, FSW	71%	71%	90%	90%
FSW programs (high-intense)	Condom use for commercial acts	PWID, FSW	71%	71%	90%	90%
FSW programs (peer educator)	Condom use for commercial acts	Clients, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 1 15-19, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 1 20-24, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 1 25-49, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 2 15-19, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 2 20-24, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	MSM 2 25-49, FSW	71%	71%	95%	95%
FSW programs (peer educator)	Condom use for commercial acts	PWID, FSW	71%	71%	95%	95%
TSP programs	Condom use for commercial acts	TSP, F15-19	48%	48%	95%	95%
TSP programs	Condom use for commercial acts	TSP, F20-24	48%	48%	95%	95%
TSP programs	Condom use for commercial acts	TSP, F25-49	48%	48%	95%	95%
TSP programs	Condom use for commercial acts	TSP, F50+	48%	48%	95%	95%
MSM programs (demand generation)	HIV testing (average tests per year)	MSM 2 15-19	0.16	0.16	0.78	0.78

MSM programs (demand generation)	HIV testing (average tests per year)	MSM 2 20-24	0.16	0.16	0.78	0.78
FSW programs (high-intense)	HIV testing (average tests per year)	FSW	0.30	0.30	1.26	1.26
FSW programs (peer educator)	HIV testing (average tests per year)	FSW	0.30	0.30	1.91	1.91
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 1 15-19	0.16	0.16	0.80	0.80
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 1 20-24	0.16	0.16	0.80	0.80
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 1 25-49	0.16	0.16	0.80	0.80
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 2 15-19	0.16	0.16	0.78	0.78
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 2 20-24	0.16	0.16	0.78	0.78
MSM programs (high-intense)	HIV testing (average tests per year)	MSM 2 25-49	0.16	0.16	0.78	0.78
MSM programs (peer educator)	HIV testing (average tests per year)	MSM 1 15-19	0.16	0.16	1.05	1.05
MSM programs (peer educator)	HIV testing (average tests per year)	MSM 1 20-24	0.16	0.16	1.05	1.05
MSM programs (peer educator)	HIV testing (average tests per year)	MSM 1 25-49	0.16	0.16	1.05	1.05
PWID programs	HIV testing (average tests per year)	PWID	0.02	0.02	0.38	0.38
TSP programs	HIV testing (average tests per year)	TSP	0.05	0.05	0.50	0.50
Prisoner programs	HIV testing (average tests per year)	Prisoners	0.0	0.0	1	1
Transgender women programs	HIV testing (average tests per year)	Transgender women	0.1	0.1	0.78	0.78
ART retention services for general population	Loss to follow-up rate (per year)	Clients	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	F0-14	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	M0-14	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	F15-19	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	M15-19	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	F20-24	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	M20-24	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	F25-49	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	M25-49	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	F50+	13%	13%	2%	2%
ART retention services for general population	Loss to follow-up rate (per year)	M50+	13%	13%	2%	2%
ART retention services	Loss to follow-up rate (per year)	FSW	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 1 15-19	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 1 20-24	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 1 25-49	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 2 15-19	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 2 20-24	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	MSM 2 25-49	15%	15%	3%	3%

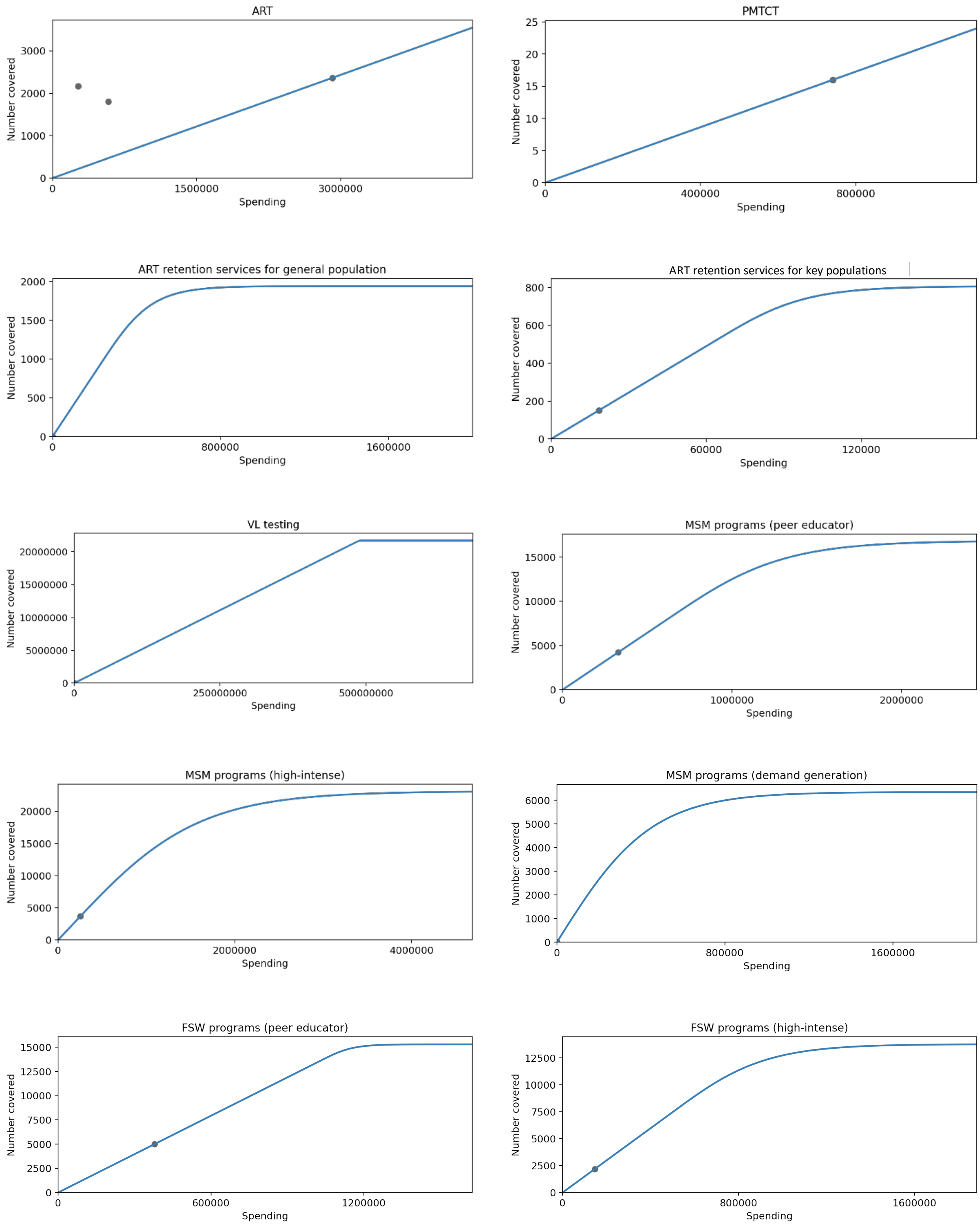
ART retention services	Loss to follow-up rate (per year)	PWID	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	Transgender women	15%	15%	3%	3%
ART retention services	Loss to follow-up rate (per year)	TSP	15%	15%	3%	3%
PrEP 1-3	Proportion of exposure events covered by PrEP	MSM 1 15-19	0%	0%	100%	100%
PrEP 1-3	Proportion of exposure events covered by PrEP	MSM 1 20-24	0%	0%	100%	100%
PrEP 1-3	Proportion of exposure events covered by PrEP	MSM 1 25-49	0%	0%	100%	100%
PrEP 1-3	Proportion of exposure events covered by PrEP	Transgender women	0%	0%	100%	100%
VL testing	Viral load monitoring (number/year)	Total	0	0	-	-

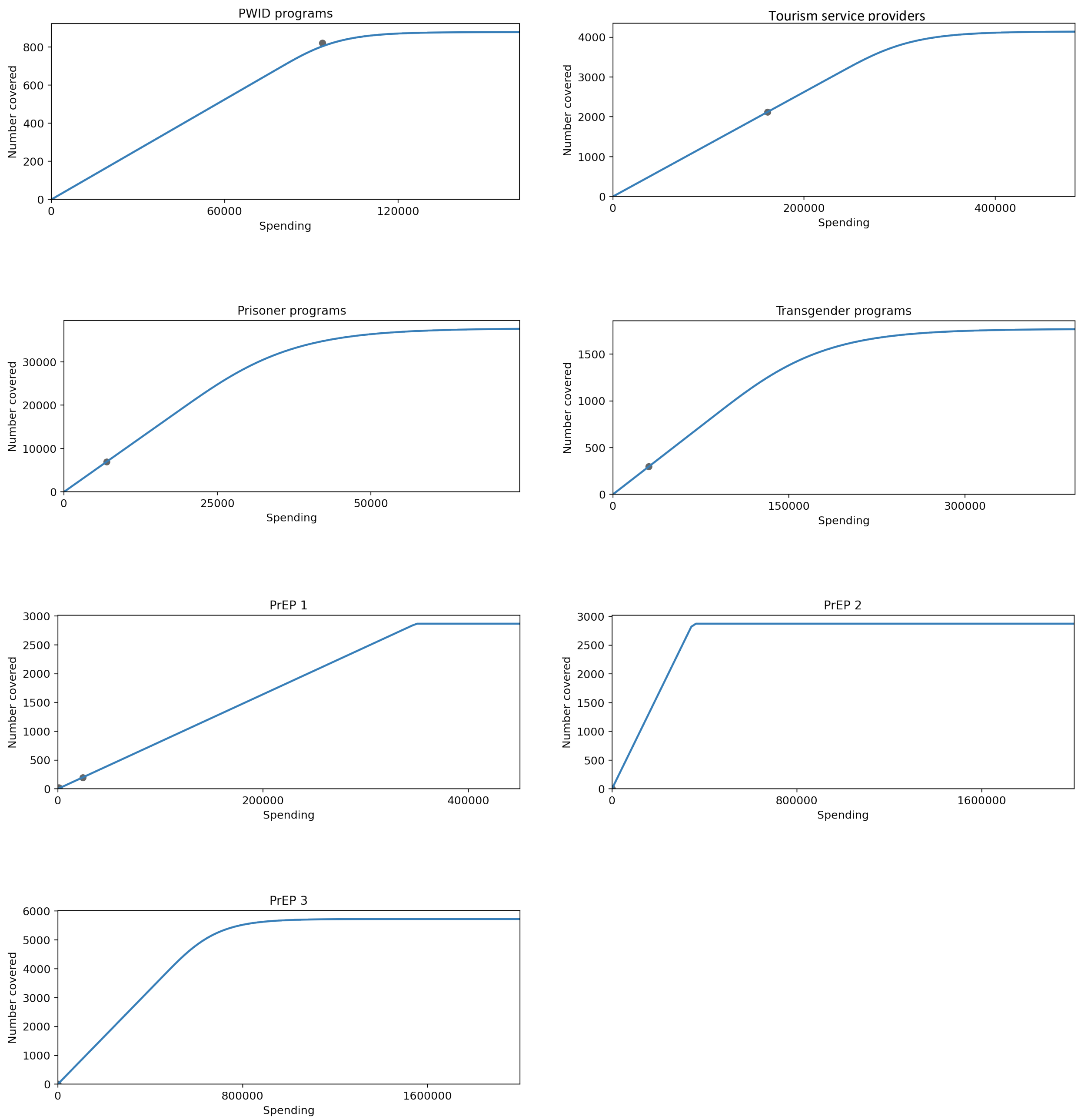
- The number of people modelled as receiving ART and PMTCT and VL tests is equal to the coverage of the respective programs. ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; TSP: tourist service providers; VL, viral load

E.3 Cost functions

The following figures show the relationship between total spending and number of individuals covered among targeting population(s) of each program.

Figure E1. Cost functions for HIV programs in Sri Lanka.





E.4 Modalities for reaching men who have sex with men

The definitions, target populations, method of delivery, impact, cost, and maximum reach of outreach modalities for men who have sex with men were developed in consultation with key stakeholders. All modalities involve a combination of physical and virtual outreach and have a combined potential maximum reach of 43,000 people, aligning with Ministry of Health targets for 2024. A comparative overview of the modality characteristics and impacts are provided in Table E3, with a description of each program below.

Peer educator programs rely on repeated engagement with existing beneficiaries in known hotspots for prevention and community empowerment, covering a maximum of 14,400 people.

High-intense programs are effective at reaching new clients at highest risk of HIV acquisition by focusing outreach within networks with identified people living with HIV. To represent this, the program is modelled to capture a disproportionately higher amount of risk such that with 22.5% program coverage (up to ~22,275 people) it effectively reaches people associated with 45% of the risk by covering twice the number of sexual acts as people covered. This was informed by the distribution of risk acts among the population of men who have sex with men (25). Currently, high-intense outreach is only implemented in high-burden districts in Sri Lanka. Given that higher risk acts are not evenly distributed in the population of men who have sex with men in Sri Lanka, the high-intense model cannot be further expanded without decreasing effectiveness, i.e. reaching a smaller amount of people at lower risk of acquiring HIV due to fewer risk acts in a wider geographical area. The relative cost per person reached would likely also increase with higher coverage levels and expansion outside of high-burden districts, as outlined in the 2020 Transition Readiness Assessment (6).

Demand creation strategies utilising virtual outreach are being newly implemented as an add-on to the high-intense model to extend the reach of these services to young men who have sex with men not reached through other modalities. This focuses mainly on young men who have sex with men aged 15-24 among the non-hotspot based population, up to an additional 12,000 people. The estimated cost per reach of demand creation assumes the same costs as high-intense programs plus marginal costs to account for the courier delivery of consumables as part of online to offline engagement.

Table E3. Description of key outreach modalities for reaching men who have sex with men.

PEER EDUCATOR	**HIGH-INTENSE**	**DEMAND CREATION (VIRTUAL OUTREACH)**
Peer educator-led outreach in known hotspots, including education, HIV prevention and testing	Outreach worker-led, with focus on HIV prevention and testing among networks with high risk (hybrid model)	Demand generation focused on further expanding the reach of high-intense
Predominantly physical outreach with some virtual outreach	Mixed physical and virtual outreach	Predominantly virtual outreach
Reaches only **hotspot-based** MSM	Reaches a proportion of **all** MSM	Reaches an additional proportion of **young, non-hotspot based MSM**
Ability to reach up to ~14,400 people (90% of hotspot based MSM)	Ability to reach up to ~22,275 people associated with 45% of risk acts	Ability to reach an additional ~12,000 people
Focuses on regular contact with existing clients for prevention and community empowerment	Effective at reaching new clients and men at **highest risk** of HIV acquisition	Effective at reaching young MSM not reached through other modalities
$77.71 / person / year	$68.48 / person / year	$70.72 / person / year
Assumes 6 contacts / person / year	Assumes 5 contacts / person / year	Assumes 5 contacts / person / year
Increases testing by +89% points	Increases testing by +62% points	Increases testing by +62% points
Increases casual condom use from 61% baseline to 80% with full coverage	Increases casual condom use from 61% baseline to 80% with full coverage	Increases condom use for casual partnerships from 61% baseline to 80% with full coverage

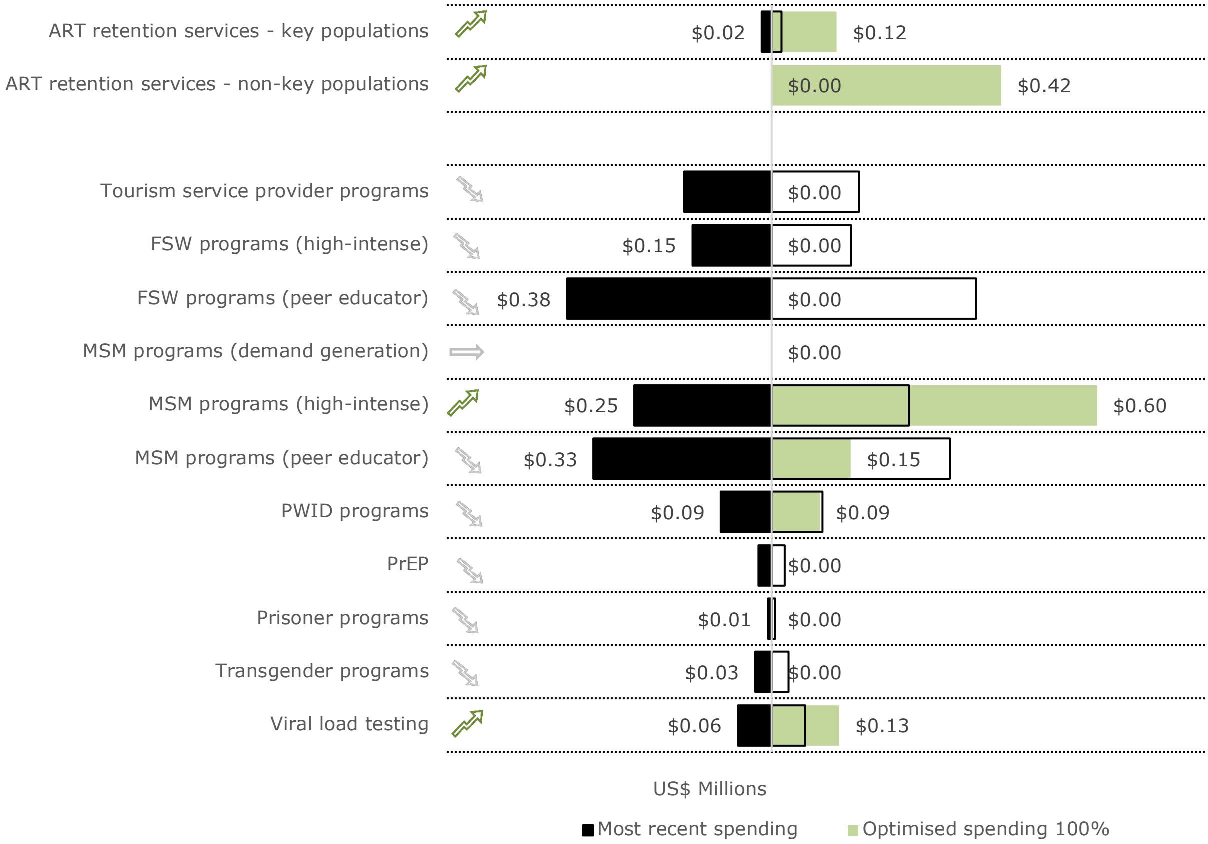
Appendix F. Supplementary analysis

F.1 Optimised allocations without constraints

A supplementary analysis was run to assess the optimisation priorities if there were no constraints on reducing budget allocation for any program.

At 100% spending optimised, high-intense programs for men who have sex with men, ART retention services for both key and non-key populations, and viral load test are prioritised for scale-up (Figure F1). Programs for people who inject drugs and peer education for men who have sex with men are partially maintained in the optimisation.

Figure F1. Change in resource allocation with 100% spending optimised and no constraints on budget reallocation.

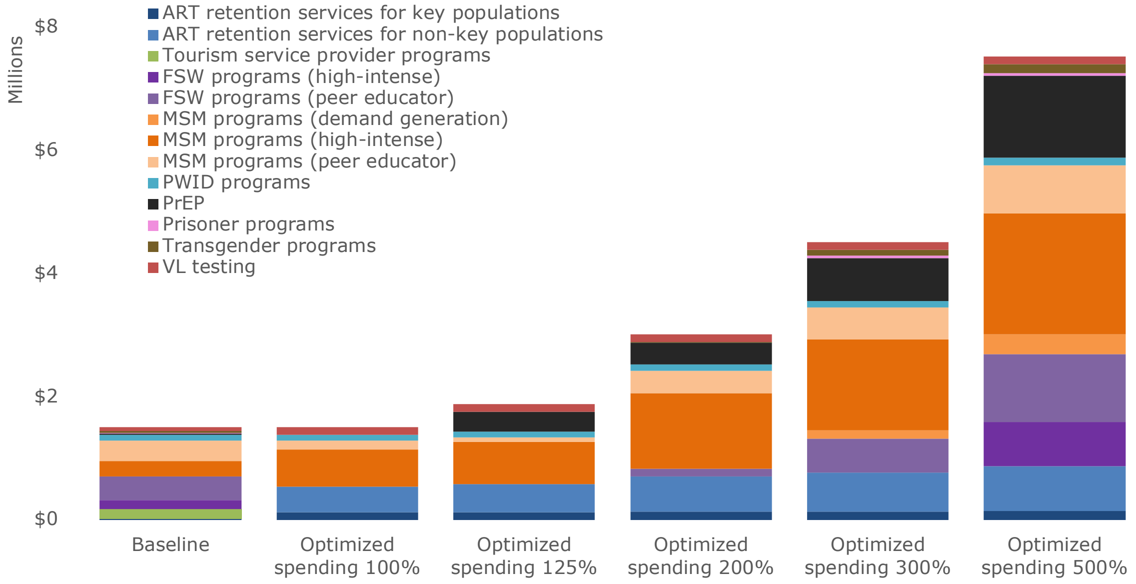


ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

As the budget increases, PrEP is also prioritised, while programs for female sex workers are only introduced at 200% spending and higher (Figure F2).

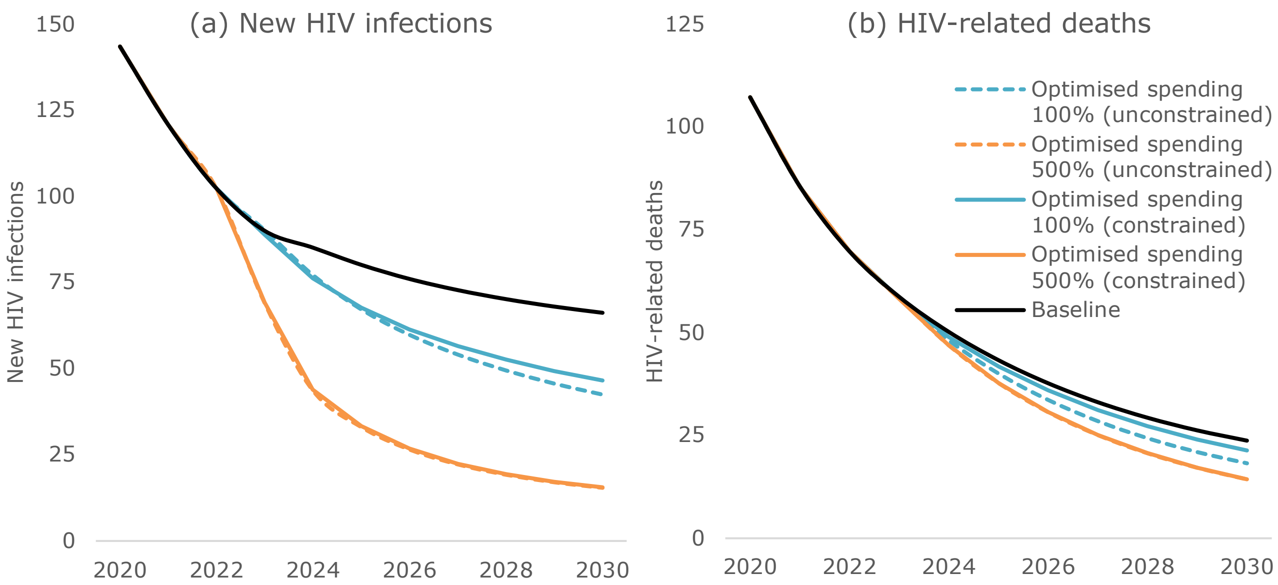
The projected impact of budget optimisations is similar with and without constraints applied, particularly at higher budget levels (Figure F3). Any additional marginal epidemic gains projected from the unconstrained allocation would need to be considered alongside the substantial risks of reduced HIV surveillance for some key populations, especially female sex workers. Subsequently, the risks and implications of defunding programs as per the unconstrained optimisation outweigh the potential benefits.

Figure F2. Optimised allocations under 100% to 500% budget levels of annual HIV budgets for 2023 to 2030 without constraints on reallocation.



ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

Figure F3. Projected change in (a) annual new infections and (b) HIV-related deaths from 2020 to 2030 with 100% and 500% optimised spending with and without allocation constraints.

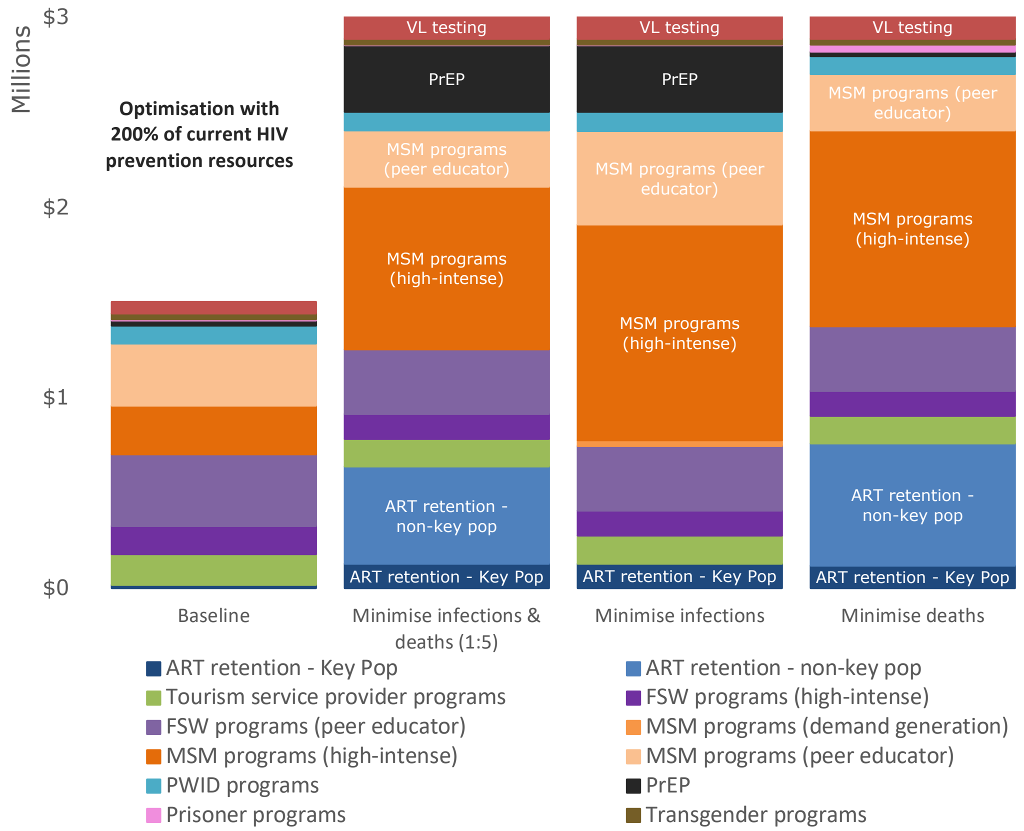


F.2 Optimised allocations under different objectives

The decision on which programs to prioritise may change depending on the objectives. The objective function for the primary budget optimisation was weighed 1:5 for minimising new HIV infections and HIV-related deaths to present a balanced optimisation (see Section 2.6). A supplementary analysis considered the optimised allocation if the model was instead prioritised to minimise new HIV infections only or minimise HIV-related deaths only. The findings are shown for 200% budget levels (Figure F4).

At 200% budget, ART retention services for key populations, viral load testing, and high-intense programs for men who have sex with men are prioritised regardless of the objective. Shifting the focus to minimising new HIV infections would lead to additional funding allocated to high-intense programs for men who have sex with men and PrEP being prioritised ahead of expanding ART retention services for non-key populations. Conversely, with a focus on minimising HIV-related deaths, ART retention services for non-key populations are prioritised ahead of PrEP. All outreach modalities for men who have sex with men create a balanced epidemic response.

Figure F4. Optimised allocations under 200% budget levels under different objective assumptions.

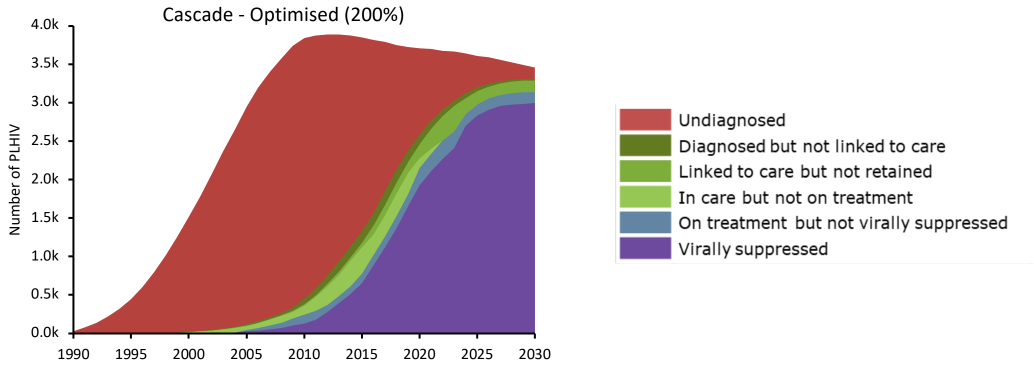


ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

With at least 200% of current spending, all priorities can be scaled up effectively in 1:5 optimisation and 95-95-95 cascade targets could be met. Projected cascade achievements are similar with objectives to minimise infections and deaths (1:5) and to minimise deaths only, with the cascade projected to reach 96-95-95 by 2030 with 200% budget optimised (Figure F5). Given a lower focus on ART retention services, ART coverage among diagnosed people living with HIV is expected to be lower, at 88%, when optimised for minimising infections only at 200% budget (Figure F5).

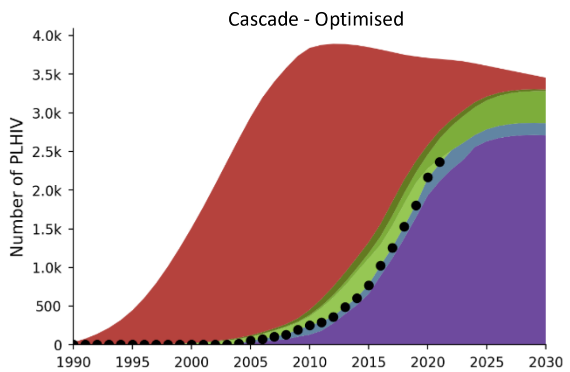
Figure F5. HIV treatment cascade outcomes for 200% budget optimisations with different objective weightings. Panels show number of people living with HIV (PLHIV) by treatment status according to 200% budget optimisation.

(a) Minimise infections and deaths (1:5)



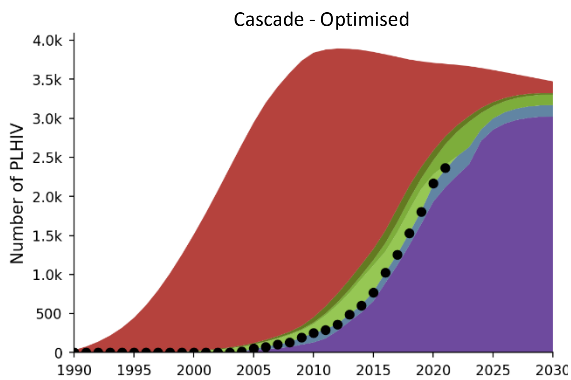
Reaches 96-95-95 by 2030

(b) Minimise infections



Reaches 96-88-95 by 2030

(c) Minimise deaths



Reaches 96-95-95 by 2030

Appendix G. Optimisation results - annual HIV budget allocations at varying budget levels

Table G1 lists estimated optimised resource allocations for each program by spending level. These outputs are not suggested future budgets, as they assume changes can be made immediately in 2023 and do not take into account external factors that are not modelled, such as workforce mobilization, adequate time for scale-up of the program, procurement of commodities and adaptation of facilities. Table G1 shows the percentage change in spending relative to baseline budget allocation.

Table G1. Modelled output of annual budget allocations optimised to minimise new HIV infections and HIV-related deaths from 2023 to 2030.

Programs	Baseline	Optimised spending 50%	Optimised spending 75%	Optimised spending 90%	Optimised spending 100%	Optimised spending 125%	Optimised spending 150%	Optimised spending 200%	Optimised spending 300%	Optimised spending 400%	Optimised spending 500%	95-95-95 scenario
ART retention services for key populations	$18,453	$119,900	$121,200	$122,300	$98,400	$123,400	$120,600	$127,500	$138,800	$142,200	$149,100	$123,200
ART retention services for general population	$0	$0	$0	$0	$0	$0	$412,100	$511,300	$623,300	$671,100	$731,400	$547,800
VL testing	$62,505	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$115,600
MSM programs (peer educator)	$328,875	$270,400	$157,300	$103,100	$296,000	$296,000	$296,000	$296,000	$507,600	$532,300	$759,300	$296,000
MSM programs (high-intense)	$253,522	$148,200	$635,400	$691,900	$228,200	$579,500	$546,500	$853,800	$1,425,600	$1,602,400	$1,914,400	$672,600
MSM programs (demand generation)	$0	$0	$0	$0	$0	$0	$0	$0	$82,200	$201,300	$295,100	$15,700
FSW programs (peer educator)	$377,905	$0	$0	$0	$340,100	$340,100	$340,100	$340,200	$401,200	$983,100	$1,108,700	$340,100
FSW programs (high-intense)	$146,565	$0	$0	$0	$131,900	$131,900	$131,900	$131,900	$131,900	$131,900	$669,700	$131,900
PWID programs	$93,793	$89,200	$90,100	$92,300	$84,400	$84,400	$84,400	$97,100	$107,000	$115,700	$117,300	$95,900
TSP programs	$161,795	$0	$0	$0	$145,600	$145,600	$145,600	$145,600	$145,600	$145,700	$145,700	$145,600
Prisoner programs	$6,938	$0	$0	$0	$6,200	$6,200	$6,200	$6,200	$37,900	$41,200	$45,700	$6,200
Transgender programs	$30,673	$0	$0	$0	$27,600	$27,600	$27,600	$27,600	$94,100	$110,500	$144,600	$50,200
PrEP	$24,349	$0	$0	$220,300	$21,900	$21,900	$21,900	$348,500	$696,000	$1,219,000	$1,320,900	$21,900
Total	$1,505,373	$ 752,700	$1,129,000	$1,354,900	$1,505,300	$1,881,700	$2,258,100	$3,010,700	$4,516,100	$6,021,500	$7,526,900	$2,562,700

Except for baseline spending, all values rounded to nearest 100; ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs, including needle-syringe programs; TSP, tourist service providers; VL, viral load.

Table G2. Modelled output of percent change in spending relative to baseline budget allocation

% change table	Optimised spending 50%	Optimised spending 75%	Optimised spending 90%	Optimised spending 100%	Optimised spending 125%	Optimised spending 150%	Optimised spending 200%	Optimised spending 300%	Optimised spending 400%	Optimised spending 500%	95-95-95 scenario
ART retention services for key populations	550%	557%	563%	433%	569%	554%	591%	652%	671%	708%	568%
ART retention services for non-key populations	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
VL testing	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	85%
Men who have sex with men programs (peer educator)	-18%	-52%	-69%	-10%	-10%	-10%	-10%	54%	62%	131%	-10%
Men who have sex with men programs (high-intense)	-42%	151%	173%	-10%	129%	116%	237%	462%	532%	655%	165%
Men who have sex with men programs (demand generation)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Female sex worker programs (peer educator)	-100%	-100%	-100%	-10%	-10%	-10%	-10%	6%	160%	193%	-10%
Female sex worker programs (high-intense)	-100%	-100%	-100%	-10%	-10%	-10%	-10%	-10%	-10%	357%	-10%
People who inject drugs programs	-5%	-4%	-2%	-10%	-10%	-10%	3%	14%	23%	25%	2%
Tourism service provider programs	-100%	-100%	-100%	-10%	-10%	-10%	-10%	-10%	-10%	-10%	-10%
Prisoner programs	-100%	-100%	-100%	-10%	-10%	-10%	-10%	447%	494%	559%	-10%
Transgender programs	-100%	-100%	-100%	-10%	-10%	-10%	-10%	207%	260%	371%	64%
PrEP	-100%	-100%	805%	-10%	-10%	-10%	1331%	2758%	4906%	5325%	-10%

ART, antiretroviral therapy; PrEP, pre-exposure prophylaxis; VL, viral load.