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

2023

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Acknowledgements

This Optima HIV modelling analysis was conducted as a collaboration between the Mongolia country partners, Health Equity Matters, Burnet Institute and UNAIDS and funded through the Global Fund to Fight AIDS, Tuberculosis and Malaria *Sustainability of HIV Services for Key Populations in Asia Program* multi-country grant.

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UNAIDS: Heather-Marie Schmidt, Purvi Shah, Ye Yu Shwe and the UNAIDS Asia Pacific Regional Support Team.

Other persons to acknowledge: Sergelen Munkhbaatar, Guy Morineau, Sjoerd Postma, Anastasia Nitsoy and all members of the National technical working group (TWG) to manage the research and assessment on STIs, HIV, AIDS and TB. In addition, the study partners acknowledge the contributions from communities and civil society living with, affected by and/or vulnerable to HIV as part of the TWG and thorough consultations.

Suggested citation:

National Centre for Communicable Diseases, Youth For Health, Burnet Institute, Health Equity Matters. Analyses for impact, efficiency, and sustainability of priority key population HIV services in Asia: Mongolia. Melbourne: Burnet Institute; 2023.

Abbreviations

AEM	AIDS Epidemic Model
AIDS	Acquired immunodeficiency syndrome
ART	Antiretroviral therapy
ARV	Antiretroviral
FSW	Female sex worker
GAM	Global AIDS monitoring
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
GoM	Government of Mongolia
HIV	Human immunodeficiency virus
HTS	HIV testing services
HSS	HIV sentinel surveillance
IBBS	Integrated Biological and Behavioural Surveillance
MICS	Multiple Indicator Cluster Survey
MSM	Men who have sex with men
NASA	National AIDS Spending Assessment
NCCD	National Centre for Communicable Diseases
NGO	Non-governmental organization
NSP	National Strategic Plan
PLHIV	People living with HIV
PMTCT	Prevention of mother-to-child transmission
PrEP	Pre-exposure prophylaxis
PSE	Population size estimate
SGS	Second generation HIV and STI Surveillance
STI	Sexually transmitted infection
TGW	Transgender women
TWG	Technical working group
UNAIDS	Joint United Nations Programme on HIV/AIDS
VL	Viral load
WHO	World Health Organization
WPP	World Population Prospects
YFH	Youth For Health

Executive Summary

Mongolia has a low-level HIV epidemic with a national HIV prevalence less than 0.1%.[1] However, there are persistent new HIV infections in key populations, particularly among men who have sex with men, as well as disproportionate burden among transgender women.[2] Significant progress has been made, with an estimated 87% of diagnosed people living with HIV on treatment, and 96% of those on treatment achieving HIV viral suppression in 2021.[1] However, there remains a substantial gap in reaching diagnosis targets, with only an estimated 44% of people living with HIV aware of their status.[1]

Using the Optima HIV modelling tool, this analysis aimed to estimate resource needs for optimised HIV outcomes and program priorities to minimise the number of new HIV infections and HIV-related deaths by 2030 and progress towards 95-95-95 Fast-Track targets. In 2021, an estimated US$2.5 million was spent on HIV in Mongolia.[3] Of this, US$1.15 million (46%) was targeted spending on HIV prevention and testing programs and included as the optimisable budget in this analysis.

Key findings of this analysis were:

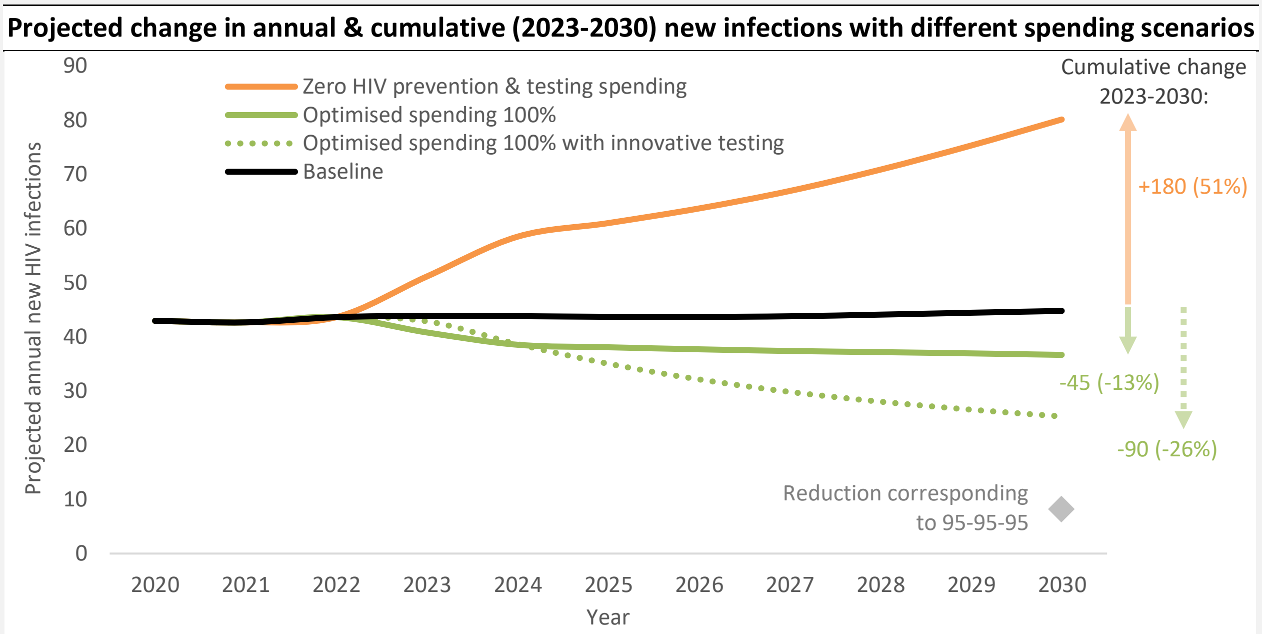
- It may be possible to reduce cumulative new HIV infections over 2023 to 2030 by 13% with current resources for HIV prevention and testing by:
  - Expanding funding for **pre-exposure prophylaxis for men who have sex with men and transgender women** (US$+117,000) to reduce high incidence in these populations, as it was estimated they accounted for 65% of new HIV infections in 2022. This will require regulatory changes to approve antiretrovirals for prevention.
  - Increasing investment in existing HIV prevention and testing[4] programs for men who have sex with men (+US$72,000) and female sex workers (+US$98,000), given disproportionate burden of HIV and other STIs in these populations[2] and the importance of tailored services for key populations in concentrated epidemics.
  - Reducing emphasis on facility-based testing (-US$277,000), as this program is less effective in reaching undiagnosed people living with HIV.
- **95% diagnosis targets will remain out of reach with current spending and programs continued.** With 100% prevention and testing spending optimised, 56% of people living with HIV may know their status by 2030.
- **Innovative testing modalities could better reach people living with undiagnosed HIV,** increasing diagnosis rates to 73% by 2030 and reducing cumulative new HIV infections by 26% with optimised spending.
  - The most recent behavioural survey data indicates high reported testing rates among key populations (54%-90%),[2] however diagnosis rates remain well under 50%.
  - The implementation of innovative testing strategies such as self-testing, community-based testing and index testing could improve HIV detection through better targeted approaches.
- **Phasing out of spending for HIV prevention and testing programs** could expand the epidemic, increasing new infections by 51% by 2030 and increasing HIV disease burden, and therefore it is essential to maintain spending in this area.

[1] UNAIDS. AIDSInfo: HIV estimates with uncertainty bounds 1990-present 2021 [cited 2022 August 27]. Available from: https://aidsinfo.unaids.org/

[2] HIV and syphilis surveillance survey report, 2019; Biological-behavioral assessment and population size estimation among transgender person in Ulaanbaatar, Mongolia-2021

[3] 2022 NASA

[4] Includes condom distribution, social and behaviour change communication and rapid testing through key population-focused community-based services


Projected change in annual & cumulative (2023-2030) new infections with different spending scenarios
Zero HIV prevention & testing spending
Optimised spending 100%
Optimised spending 100% with innovative testing
Baseline
Cumulative change 2023-2030:
+180 (51%)
-45 (-13%)
-90 (-26%)
Reduction corresponding to 95-95-95
Projected annual new HIV infections
Year
0
10
20
30
40
50
60
70
80
90
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030

1. Introduction

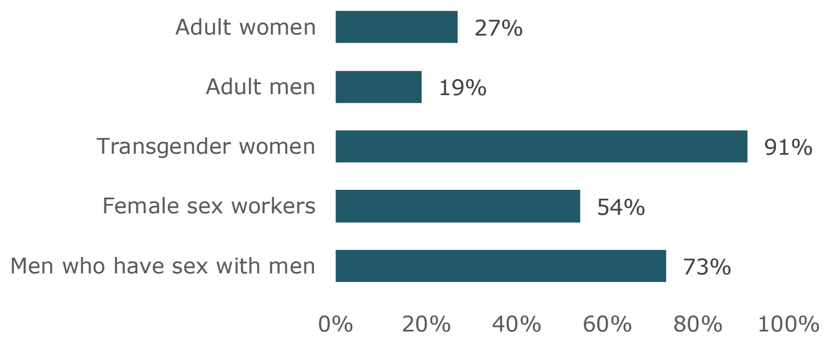
1.1 Country context

Since the first case of HIV was notified in Mongolia in 1992, the country has successfully maintained a low-level HIV epidemic, with an estimated 650 people living with HIV in 2020, representing an HIV prevalence of <0.1% (1). Although HIV infections in Mongolia are low, the majority of people living with HIV remain undiagnosed, with only an estimated 44% of people living with HIV in 2021 knowing their status (1). As of the end of 2019, the cumulative number of people diagnosed and registered with HIV in Mongolia was 286, and the total number of registered HIV-related deaths was 47 (2). Mongolia has achieved greater progress in pillars two and three of the HIV care cascade, with an estimated 87% of diagnosed people with HIV on treatment, and of those, 96% with viral suppression (1).

All registered cases of HIV in Mongolia are attributed to sexual transmission, and as of 2020, 68% of registered cases of HIV in Mongolia have been recorded among men who have sex with men (3). Since 2005, Second-Generation HIV/STI Surveillance (SGS) surveys have been used to monitor trends in HIV and sexually transmitted infections (STI) among key and priority populations. Gay, bisexual and other men who have sex with men are disproportionately affected by HIV, with the 2019 survey indicating HIV prevalence of 6.2% (4). Until recently there have been no data on HIV among transgender women. A focused integrated biological and behavioural surveillance (IBBS) survey conducted in Ulaanbatar in 2021 estimated HIV prevalence was 5.4% among transgender women (5), and a second IBBS is under analysis (6). However, both surveys were affected by sampling bias (5, 6) and reported uptake of HIV-related services within the survey was higher than expected based on overall program data; it is unclear how this may have impacted prevalence estimates. Estimated prevalence of HIV has remained at 0% among female sex workers based on serial surveys (4, 7-10) and there have been no reports of HIV among women selling sex domestically (2). However, almost one-quarter of registered cases of HIV among women have been classified as likely having sold sex abroad (11), and sex work may be underreported due to criminalization, stigma and discrimination (2, 11, 12). The prevalence of syphilis and other STIs remains high among key populations (4, 5) in Mongolia as well as more broadly in the general population (13). High prevalence of STIs coupled with frequent condomless sex (4) and unmet sexual and reproductive health needs (11) pose potential implications for HIV transmissibility and acquisition in these populations (14).

Mongolia has a combined strategy for communicable disease prevention and control, integrating HIV, STIs and TB management, which was last updated for 2021-2023 (3). HIV programming is implemented through the National Centre for Communicable Diseases (NCCD) under the Ministry of Health (MOH). HIV treatment and support services are provided nearly exclusively through the NCCD (2). Approximately half of HIV testing in Mongolia is done in the context of antenatal care (15), when guidelines require that women are tested twice for HIV and syphilis. Mandatory testing for the purposes of employment or marriage is also common (11, 16). Despite the majority of people living with HIV estimated to not be diagnosed, reported HIV testing rates from surveys among key populations and non-key populations suggest relatively high levels of testing in Mongolia, although this may be affected by sampling and respondent bias (Figure 1). Community-based services focusing on key populations are delivered by Youth for Health (YFH) for men who have sex with men and transgender women, and Perfect Ladies for female sex workers and are exclusively funded through external funds, primarily via Global Fund support (2). These services focus on rapid HIV and syphilis testing and outreach–encompassing behaviour change information, condom and lubricant distribution, and referrals–delivered both in the community and online. Through demonstration projects, pre-exposure prophylaxis (PrEP) has been available to key populations in Mongolia since mid-2021 and HIV self-testing since mid-2021 (17, 18).

Figure 1. Proportion of surveyed population that has taken an HIV test in the past year



Source: MICS 2018 (adult men and women) (13), IBBS 2021 (transgender women, Ulaanbaatar only) (5), IBBS 2019 (MSM, FSW)(4)

Mongolia is classified as a lower-middle income country. In 2019, nearly two million USD was spent on HIV in Mongolia, of which 54% was financed through international donor support (15). The main international donor is the Global Fund, accounting for 91% of international financing. Since 2016, HIV funding has decreased due to a reduction in Global Fund contributions (19), which saw a reduction in prevention programming such as condom distribution (personal communication 17/5/2022). Programs focusing on prevention and testing among key populations are exclusively funded through external funds, while domestic funding finances HIV treatment and care as well as the procurement and distribution of HIV-syphilis dual test kits for government health clinics (2).

Recent assessments of the HIV services for key populations in Mongolia and readiness to transition from Global Fund support have identified several gaps in current programming and areas for improvement. These have included missed opportunities for community-based testing, including testing by lay persons; a need for specialised health care services for transgender women; more effective outreach, harm reduction services and mental health care; inadequate standardisation of comprehensive service package for key populations; and opportunities to strengthen referrals to friendly, acceptable and voluntary sexual and reproductive health services for key populations (2, 11, 12). Further, these assessments have highlighted the role of criminalisation, stigma and discrimination, and violence in driving risks for HIV and limiting access to health care services as well as outreach (2, 11, 12). There is also an increasing interest in using innovative strategies in Mongolia to engage key populations in HIV services and narrow the gap in prevention and diagnosis (3).

1.2 Rationale for analysis

To maintain the HIV response in South-East Asia, national HIV programs must be sustainably financed. With planned 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 efficiently to maximise impact.

Health Equity Matters is the Principal Recipient of the Sustainability of HIV Services for Key Populations in Asia (SKPA) Program. The program is a multi-country grant funded by the Global Fund covering eight (8) countries: Bhutan, Laos, Malaysia, Mongolia, Papua New Guinea, Philippines, Sri Lanka and Timor-

Leste. 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 people and people who use drugs, in the region. This analysis formed part of the SKPA contract, and the allocative efficiency analysis presented here can support the Government of Mongolia to prioritise investment decisions as part of developing action plans and budgets for the HIV response throughout the follow-on SKPA-2 grant period.

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 Mongolia. Specifically, the objectives of this study were to:

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

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 (20) 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 (20). Detailed epidemiological, behavioural, programmatic, and cost data were collated through desk review to inform the Optima HIV model for Mongolia. HIV epidemic patterns and projections were calibrated to align with existing and nationally accepted estimates from the AIDS Epidemic Model (21, 22) and Spectrum (1). 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 Centre for Communicable Diseases (NCCD), Youth For Health (YFH), health economists, community stakeholders, and key population representatives. Representatives from these groups participated in periodic working sessions 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 (0). 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 0. In brief, the populations considered in this analysis were:

- Key populations (aged 15-49)
  - Female sex workers (FSW)
  - Clients of female sex workers (Clients)
  - Men who have sex with men reachable through hotspots (MSM 1), 15-19, 20-24, 25-49
  - Men who have sex with men not reachable through hotspots (MSM 2), 15-19 15-19, 20-24, 25-49
  - 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+

Risk disaggregation was aligned with AEM definitions for MSM1 and MSM2, which assumes MSM1 are more easily reachable through traditional outreach programs for men who have sex with men and account for approximately 54% of all men who have sex with men. According to the AEM definition, the remaining 46% are MSM2, assumed to be more likely to be behaviourally bisexual, have fewer anal sex acts with men, and be less likely to access prevention interventions (23).

Targeted HIV programs modelled in this study are listed below, and program definitions are provided in Appendix E.

- Facility-based HIV testing services (HTS)
- HIV testing and prevention programs for men who have sex with men (MSM programs)
- HIV testing and prevention programs for female sex workers (FSW programs)
- Online outreach for men who have sex with men and transgender women (online outreach)
- Pre-exposure prophylaxis (PrEP) for men who have sex with men and transgender women

Standard HIV testing and prevention programs for key populations incorporate rapid HIV testing, condom distribution and social and behaviour change communication delivered through key-population focused community-based organisations. These are differentiated from newer or novel modalities for reaching men who have sex with men and transgender women through online outreach and innovative testing strategies.

To align with the AEM, it was assumed that programs for men who have sex with men could reach both MSM1 and MSM2 at a ratio of 2:1. Based on program reports and IBBS data (5, 12), it was also assumed that small numbers of transgender women could be reached through the program for men who have sex with men (see Appendix E1).

In addition to standard programs, a separate optimisation scenario considered the prospective program innovative testing services incorporating the planned scale-up of HIV self-testing, community-based testing and index testing (assisted partner notification) for men who have sex with men and transgender women (Appendix E2).

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.

2.3 Baseline spending

Baseline spending was from the year 2021 and derived from the 2021 National AIDS Spending Assessment (NASA) (21). Unit costs per individual reached were based on top-down estimates whereby $unit\ cost\ = total\ spending\ \div coverage$. Spending data for online outreach for men who have sex with men and transgender women was based on country-provided program spending estimates. Coverage was based on latest reported in the NASA, Global AIDS Monitoring (GAM), and country-provided program data. The weighted cost of innovative testing, incorporating a differentiated package of testing services, was informed by the SKPA costing study (24) and stakeholder input (Appendix E2).

Budget optimisations were based on targeted HIV spending for HIV prevention and testing programs with a direct and quantifiable impact on modelled HIV parameters. Non-targeted spending, including HIV care for coinfections and opportunistic infections, enabling environment, systems strengthening, administration, management, strategic information and research were excluded from the optimisation budget. ART and PMTCT were excluded from the optimisation budget, as it was assumed 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 and testing programs in the future, maintaining current spending for HIV testing and prevention, and the opportunity for increased funding through additional investments in HIV prevention and testing. The optimised spending scenarios determine the most cost-effective distribution of spending across HIV prevention and testing programs to maximise the reduction of new HIV infections and AIDS-related deaths by 2030. 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. Impact was assessed in terms of change (annual and cumulative) in new HIV infections and HIV-related deaths from 2023 to 2030 and progress towards Fast-Track 95-95-95 targets. The modelled impact of optimisation scenarios on the HIV epidemic assumes that proportional treatment coverage remains fixed at 2021 levels.

2.1 Model constraints

Each program was constrained to not reduce by more than 50% from 2022 spending, unless optimising a 50% reduced budget where no constraints were applied. This constraint was informed by discussion with key stakeholders based on feasibility and the potential harms of defunding any program.

2.1 Model weightings

Budget optimisations to minimise new HIV infections and HIV-related deaths by 2030 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 (25, 26).

Table 1. Optimisation and scenario analyses for HIV prevention and testing spending

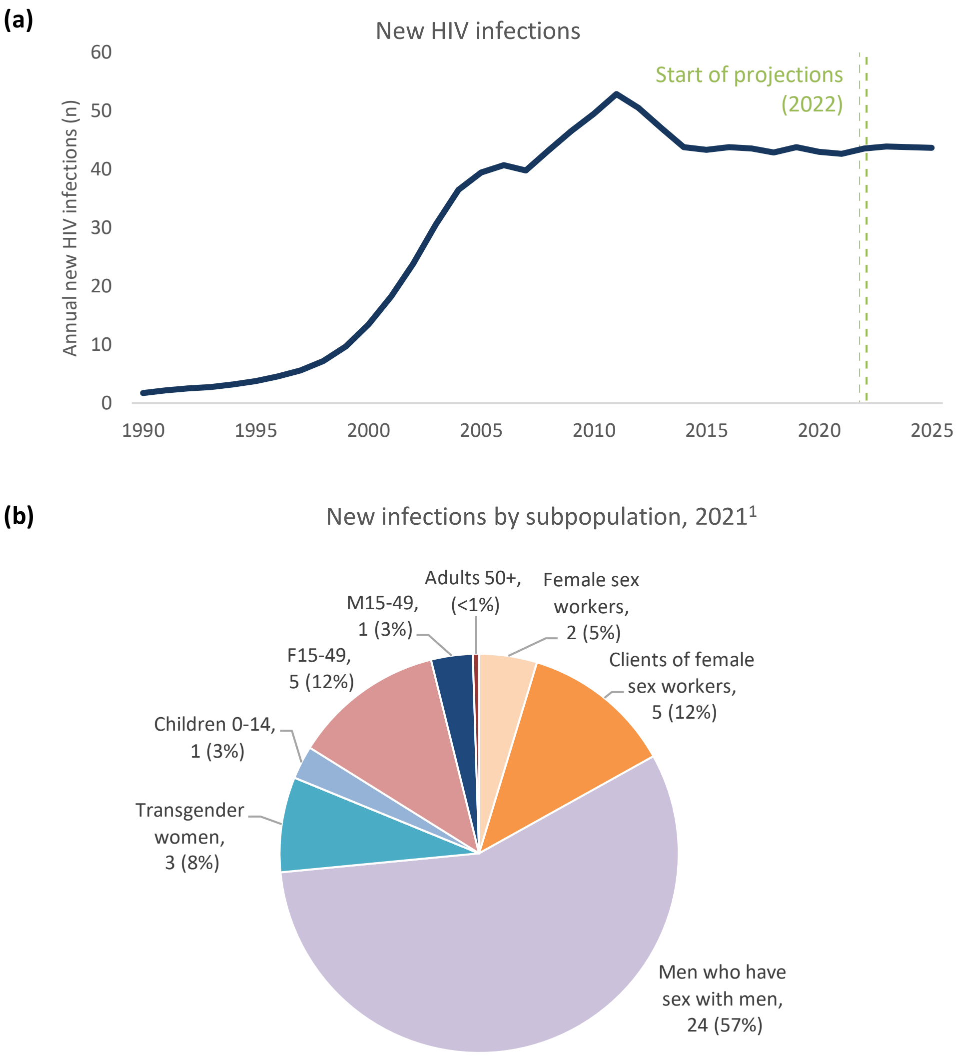
Scenario	Description
Zero HIV prevention and testing spending	Considers the impact on new infections and HIV-related deaths if there was no spending on HIV prevention and testing services from 2023-2030.
Baseline scenario	Continued spending and fixed allocation of US$1.15M (100% HIV prevention and testing) reflecting 2021 distribution of funds.
Optimised spending 100%	Continued spending of US$1.15M (100%) for HIV prevention and testing with allocation optimised to reduce new infections and HIV-related deaths by 2030. Each program is constrained not to decrease below 50% of the current spending.
Reduced optimised spending (50%, 90%)	Considers if available resources for HIV prevention and 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. Each program is constrained not to decrease below 50% of the current spending in the 90% spending optimisations, but no constraints for spending reductions are applied to 50% spending optimisations.
Increased optimised spending (125%, 150%, 200%)	Considers if additional resources for HIV prevention and 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. Each program is constrained not to decrease below 50% of the current spending.
Addition of innovative testing strategies	This scenario estimates the impact of incorporating innovative testing strategies, including self-testing, community-based testing and index testing for men who have sex with men and transgender women, to advance progress in reaching 95% diagnosis. Considers the optimised resource allocation at varying budgets and epidemic impact if the prospective innovative testing program is available. Allocations are optimised to reduce new infections and HIV-related deaths by 2030. Each program is constrained not to decrease below 50% of the current spending.
Reaching 95-95-95 targets	Explores the impact on new HIV infections and HIV-related deaths if 95% diagnosis, 95% treatment coverage among diagnosed people living with HIV, and 95% viral suppression among people on ART could be reached by 2030. Does not consider the programs to achieve this, just the potential impact of doing so.

3. Results

3.1 Baseline scenario of the HIV epidemic

The total number of new HIV infections has remained low in Mongolia and been relatively stable between 2014 and 2021, estimated at 43 new infections in 2021, of which 34 (80%) occurred among key populations. However, maintaining 2021 spending on programs with fixed allocations may enable new HIV infections to gradually increase (Figure 2a). Over half of new HIV infections were estimated to be occurring among men who have sex (24, 57% of all new HIV infections), as informed by and aligned with the AEM that is used in-country for annual HIV projections (Figure 2b).

Figure 2. Baseline new HIV infections based on Optima HIV model. Panel shows: (a) Projected annual new HIV infections from 1990 to 2025, and (b) New infections by sub-population in 2021.



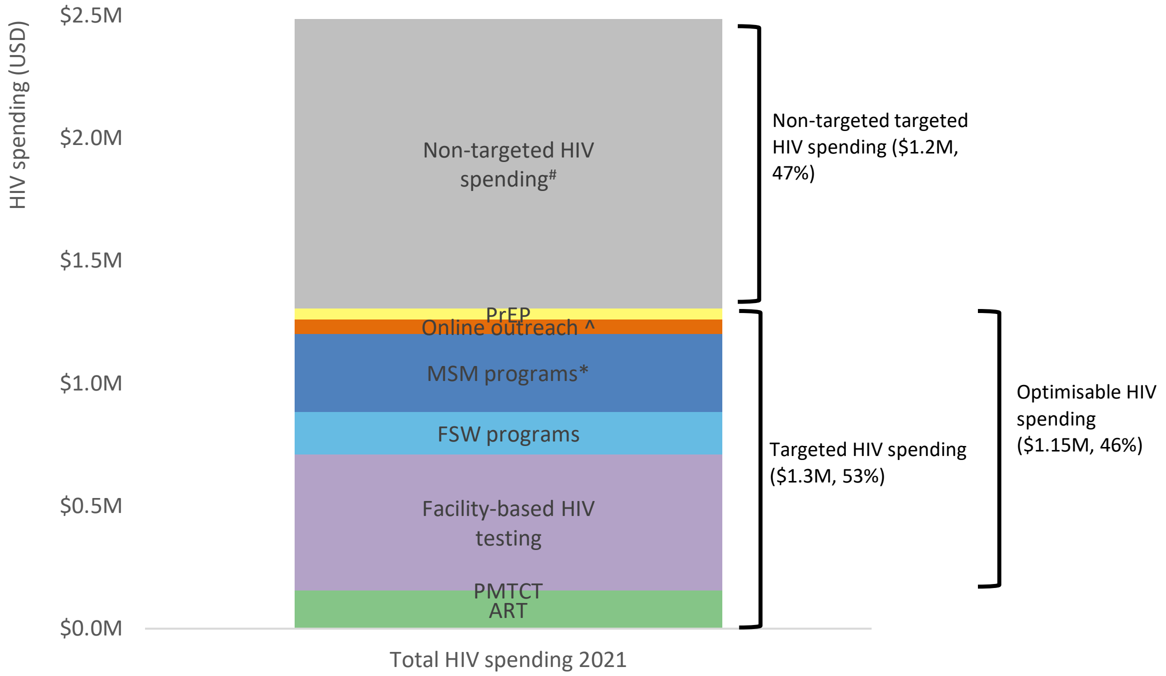
Source: Optima HIV Mongolia analysis, 2023

3.2 Baseline 2021 HIV spending

In 2021, US$2.5 million in total was spent on HIV based on the 2022 NASA (21). This includes program implementation costs financed by the Government of Mongolia (GoM) and supported by the Global

Fund through national and regional grants. Of this, nearly half was for indirect HIV spending (47%) including non-targeted HIV programs such as HIV care (detection and treatment of opportunistic infections and coinfections), enabling environment, systems strengthening, administration, management, strategic information and research. Of the remaining 53%, the HIV prevention and testing budget accounted for 46% and antiretroviral treatment accounted for 6%.[1] The **US$1.15M (46%) spent on targeted HIV prevention and testing programs were included in the optimisation analysis** (Figure 3). Full program details are given in Appendix E1.

Figure 3. Overview of total spending for HIV in 2021



Source: 2022 NASA and program data, Optima HIV Mongolia analysis 2023
Notes: # Non-targeted spending, including HIV care for coinfections or opportunistic infections, enabling environment, systems strengthening, administration, management, strategic information and research were excluded because they do not have a direct nor quantifiable impact on modelled parameters; * Standard HIV testing and prevention program focused on men who have sex with men but also reaching some transgender women; ^ Focused on men who have sex with men and transgender women; ART, antiretroviral therapy; FSW, female sex worker; MSM, men who have sex with men; PrEP, pre-exposure prophylaxis

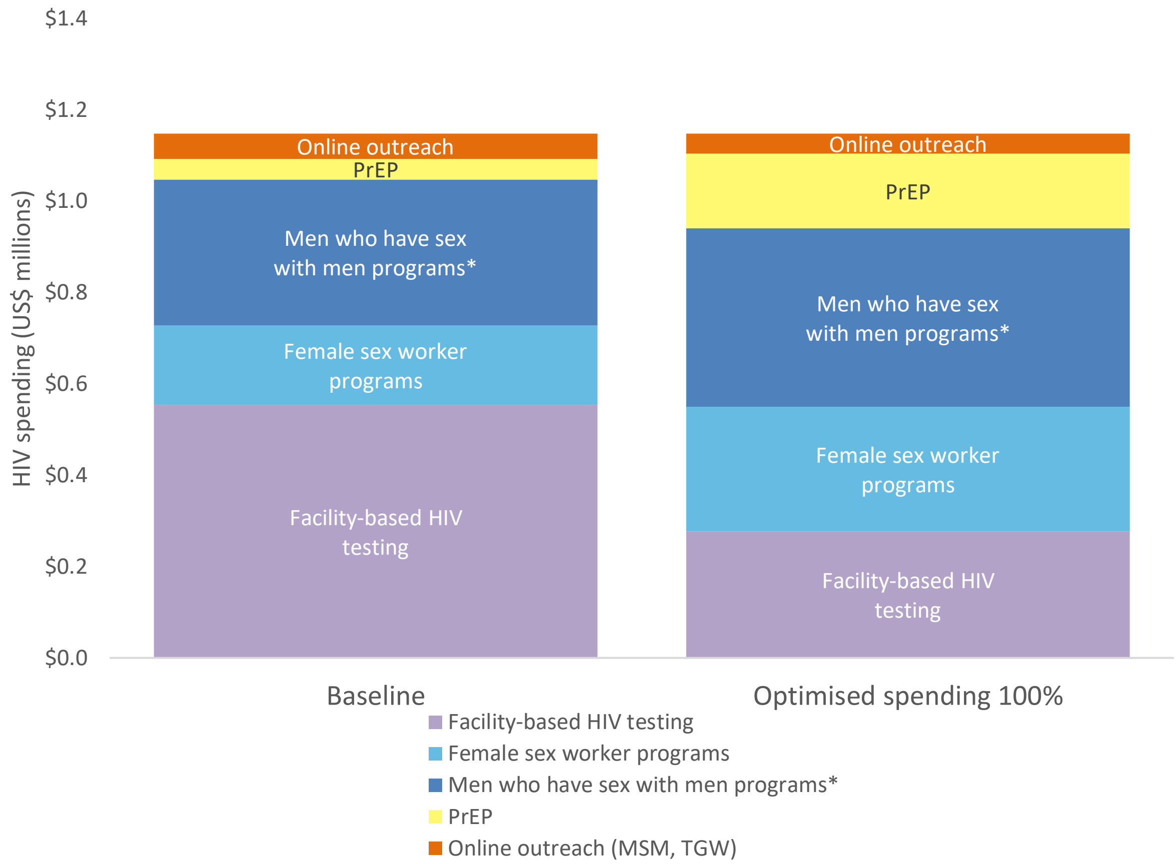
3.3 Optimised resource allocation for current budget

When optimising the current HIV prevention and testing spending for 2023 to 2030, infections and deaths are reduced if spending is increased for PrEP for men who have sex with men and transgender women (+US$117,000), programs for female sex workers (+US$98,000) and standard prevention and testing programs for men who have sex with men (+US$72,000). This is achieved in the model by decreasing spending for facility-based testing by 50% (-US$277,000) (Figure 4, Appendix F), which could be realised by limiting mandatory testing, reducing the number of tests required in antenatal care, and through better targeting of existing testing programs. Targeted testing among key

[1] Values do not add up to 100% due to rounding

populations is recommended over generalised testing through facility-based services to reach undiagnosed people living with HIV.

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



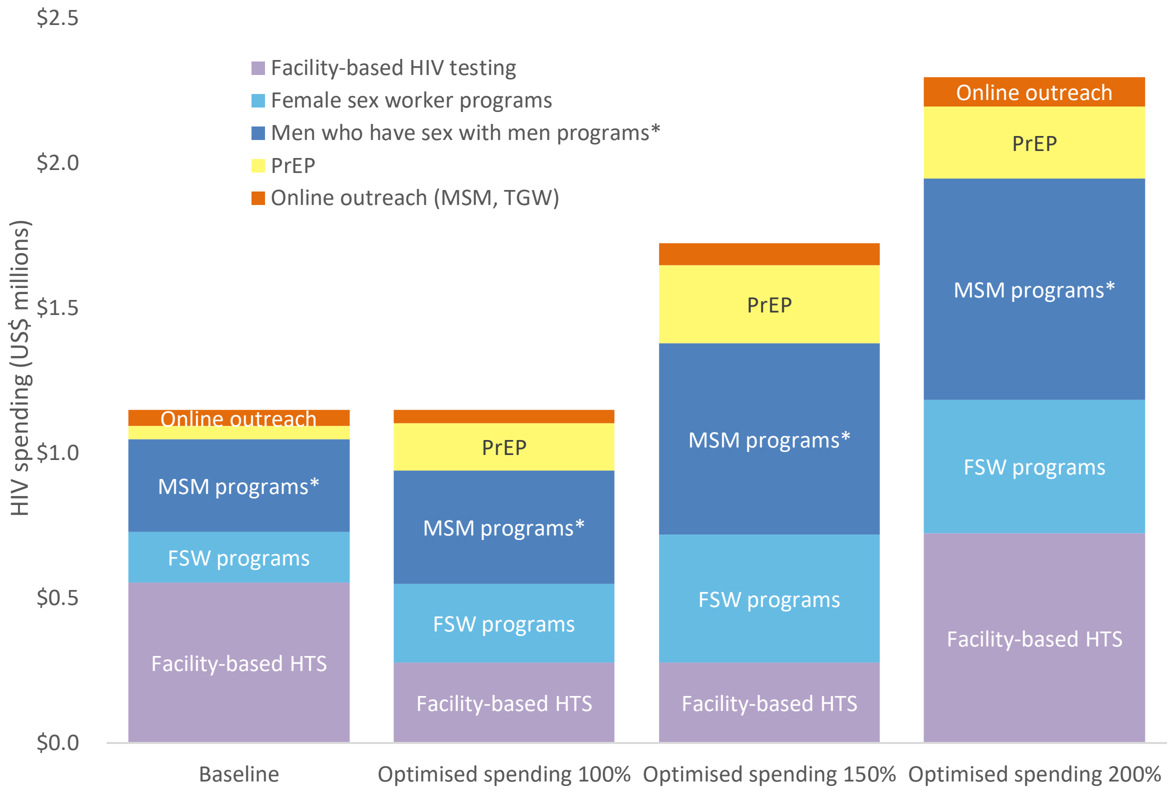
Source: Optima HIV Mongolia, 2023
Notes: MSM, men who have sex with men, PrEP, Pre-exposure prophylaxis; TGW, transgender women; * Men who have sex with men programs also reach small numbers of transgender women.

3.4 Optimised resource allocation of increased budgets

Should the optimisable HIV budget for prevention and testing increase from 100% to 200% of current targeted spending (equivalent to up to 46% increase in *total* HIV spending), additional priorities are:

1) Further expansion of standard programs for men who have sex with men (+$443,000 relative to baseline);
2) Scale-up of programs for female sex workers (+$286,000) given high effectiveness in maintaining very low HIV prevalence in this population; and
3) Further scale-up of pre-exposure prophylaxis (+$204,000) and online outreach for men who have sex with men and transgender women (+$46,000) to reduce incidence among these populations. Facility-based testing is suggested to be scaled-up only after the other programs because a limited yield is expected from this testing program, and at 200% total budget available it receives +$170,000 relative to baseline (Figure 5, Appendix F).

Figure 5. Optimised allocations with increased budgets for 100% to 200% budget levels of annual HIV prevention and testing for 2023 to 2030, to minimise new infections and HIV-related deaths by 2030

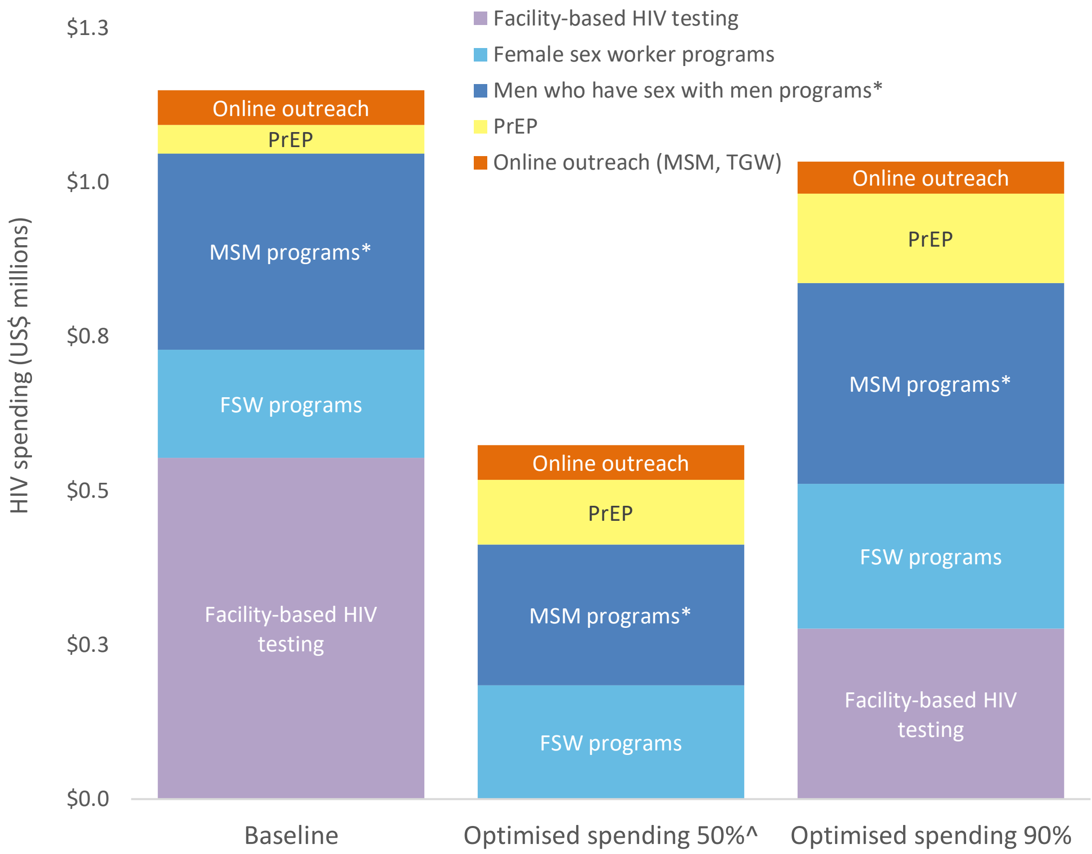


Source: Optima HIV Mongolia, 2023
Notes: FSW, female sex worker; MSM, men who have sex with men, PrEP, pre-exposure prophylaxis; TGW, transgender women; * Men who have sex with men programs also reach small numbers of transgender women.

3.5 Optimised resource allocation of reduced budgets

Should the optimisable HIV budget for prevention and testing decrease in coming years by 50%, the main priority would be to ensure that key population programs are maintained as much as possible, with a shift from standard prevention programs for men who have sex with men to PrEP. While continued availability of facility-based testing will remain important in practice, prioritizing testing through key population-focused services are expected to have a higher impact. At 90% of the current HIV prevention and testing spending, further scaling up PrEP for men who have sex with men and transgender women (+$99,000) and increased investment in female sex worker programs (+$60,000) are prioritised.

Figure 6. Optimised allocations with reduced budget levels under 50%^ and 90% of annual HIV budgets for prevention and testing from 2023 to 2030, to minimise new infections and HIV-related deaths by 2030



Source: Optima HIV Mongolia, 2023

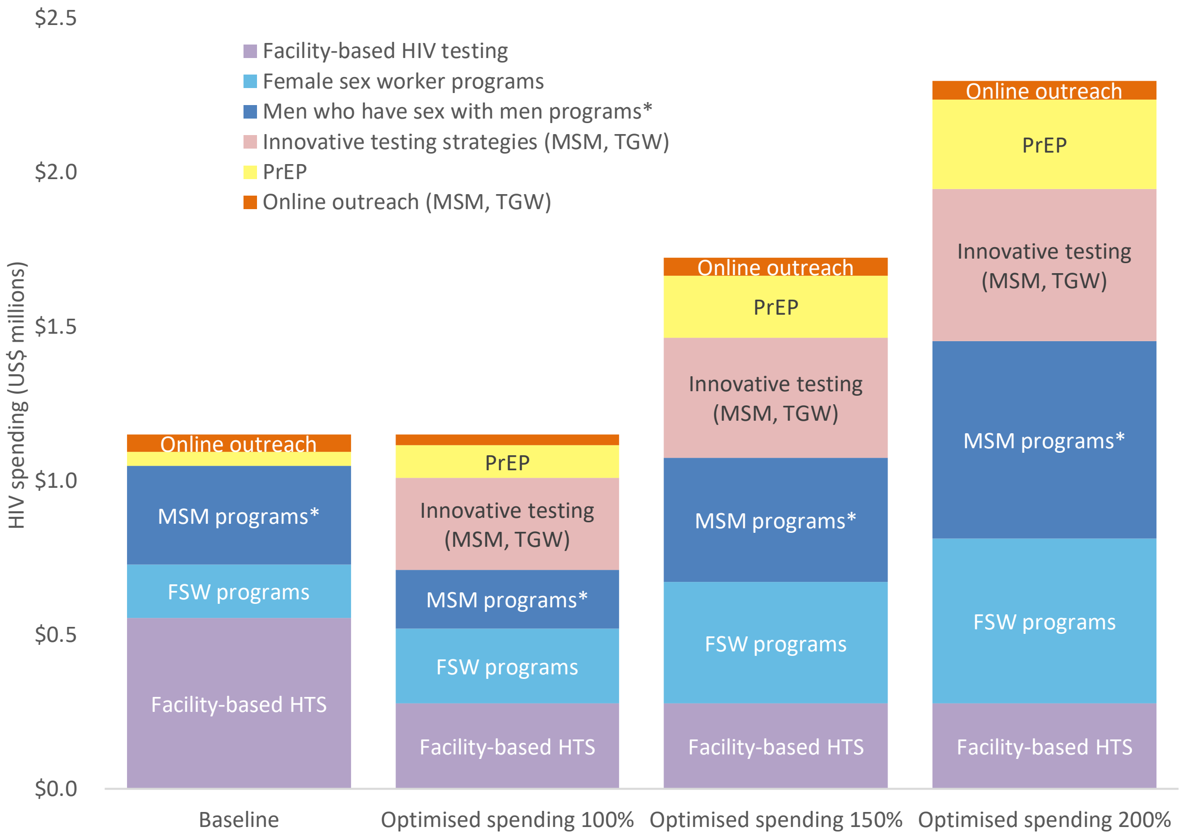
Notes: FSW, female sex worker; MSM, men who have sex with men, PrEP, pre-exposure prophylaxis; TGW, transgender women; * Men who have sex with men programs also reach small numbers of transgender women; ^ No spending constraints were applied in the 50% spending optimisation

3.6 Reaching 95-95-95 targets by 2030–increasing diagnosis rates through innovative testing

Despite testing rates among key populations being estimated to be relatively high based on behavioural surveys (Figure 1), diagnosis rates are low, with an estimated 44% of all people living with HIV aware of their status in 2022. High testing rates may be subject to sampling bias and respondent bias as well as be indicative of testing not effectively reaching those living with undiagnosed HIV. Annually around 400,000 HIV tests are conducted (27), while only 25 people living with HIV were newly diagnosed in 2020 and 16 in 2021 (28), demonstrating low detection rates.

Improving diagnosis rates may not be feasible with the current testing programs and current targeting approaches. However, innovative testing approaches that may reach previously unreached people living with HIV are becoming available. Self-testing and community-based testing have undergone pilot testing (18), and implementation guidelines are being developed for scale-up. To estimate the impact of the implementation of these testing modalities alongside index testing, a prospective innovative testing program for men who have sex with men and transgender women was costed and defined (Appendix E) and added to the optimisable programs. In the subsequent 100% spending optimisation, innovative testing is highly prioritised (+US$298,000) alongside PrEP (+US$60,000) and programs for female sex workers (+$68,000) in favour of other key population prevention and testing programs and facility-based HIV testing. As budget levels increase, more spending is made available to expand other key population prevention and testing programs. The impact of the innovative testing strategy on the HIV epidemic is outlined in sections 3.7 and 3.8.

Figure 7. Optimised allocations under increasing budget levels of annual HIV prevention and testing budget with innovative testing strategies for 2023 to 2030, to minimise new infections and HIV-related deaths by 2030



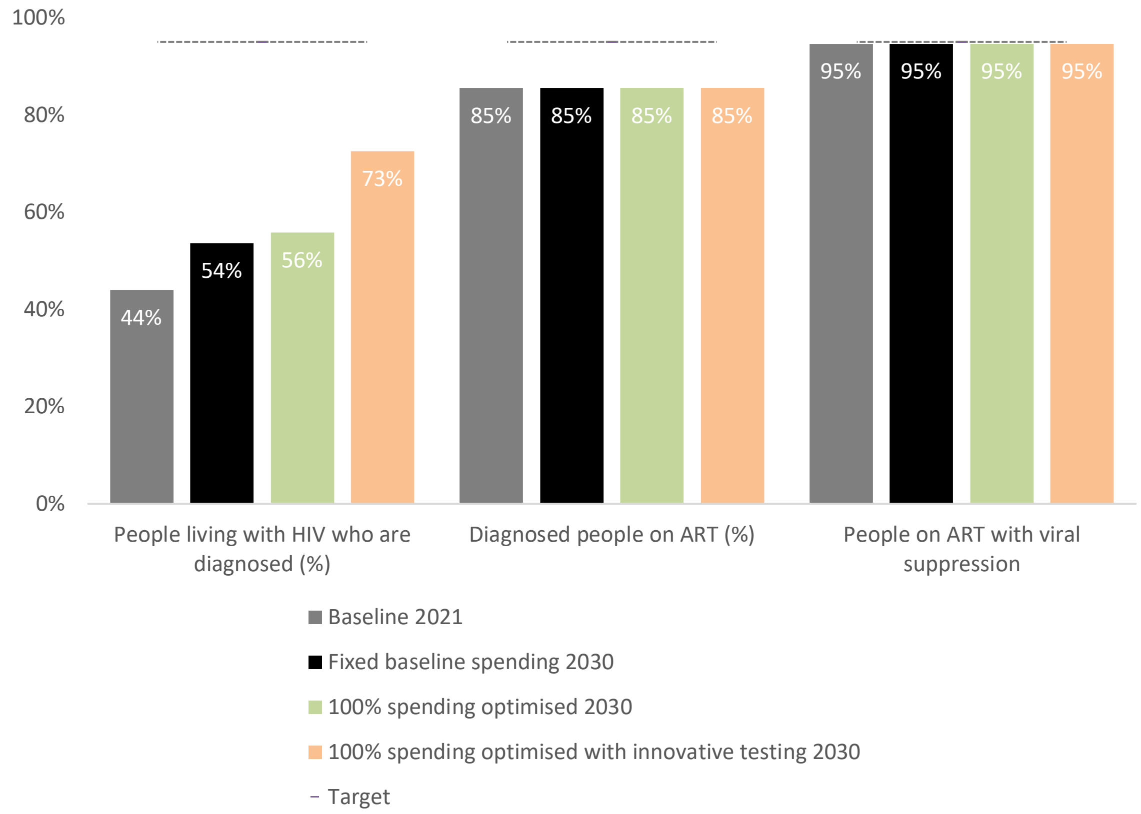
Source: Optima HIV Mongolia, 2023

Notes: FSW, female sex worker; HTS, HIV testing services; MSM, men who have sex with men, PrEP, pre-exposure prophylaxis; TGW, transgender women; * Men who have sex with men programs also reach small numbers of transgender women;

3.7 Projected care cascade

Progress towards the 95-95-95 Fast Track targets by 2030 are outlined in Figure 8. Optimising current spending and incorporating innovative testing could lead to incremental gains in diagnosis rates. However, there is still expected to be a gap in diagnosis in 2030, even with the inclusion of innovative testing strategies (73% diagnosis projected). Opportunities to advance the second and third pillars were not assessed, as there were no programs included that target linkage to care, retention on treatment, or viral load monitoring. Budget optimisations assumed treatment would continue to be available to diagnosed people living with HIV at existing coverage level (85%) and that viral suppression could be maintained at current levels (95%).

Figure 8. Projected care cascade in the (1) baseline scenario in 2021, (2) baseline scenario to 2030, (3) optimised spending 100% in 2030, (4) optimised spending 100% with innovative testing in 2030



Source: Optima HIV Mongolia, 2023
Notes: ART, antiretroviral therapy

3.8 Impact of the optimisation on the HIV epidemic

With baseline spending maintained, it is projected that there could be 350 new HIV infections and 185 HIV-related deaths from 2023 to 2030. If there is no spending for HIV prevention and testing programs, an additional 180 (51%) new HIV infections (Figure 9) and 15 (8%) HIV-related deaths could occur over the 2023 to 2030 period compared with the baseline scenario, thus potentially reversing the decreasing trend in HIV-related deaths (Figure 10). If current spending for HIV were optimised through more targeted prevention and testing for key populations, this could avert 45 (13%) cumulative new HIV infections and five (3%) 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 to treatment. However, the impact plateaus above 150% budget because the main difference is increased spending on facility-based HIV testing (Table 2), which has a low yield.

The inclusion of an innovative testing program may have a higher impact on reducing new infections (-26%) from baseline compared to when current spending is optimised without innovative testing available (-13%). The lag in impact with 100% spending optimised including innovative testing is due to relatively less emphasis on PrEP when innovative testing is available and the need for time for people newly diagnosed to go on treatment and achieve viral suppression (assumed approximately 90 days total; Table A2 and Appendix A2). However, with 200% spending available both PrEP and innovative testing are prioritized for faster declines in both new infections and HIV-related deaths.

Although not modelled, interventions to improve linkage and retention on treatment would further amplify the benefits of optimised spending on HIV prevention and testing. If 95% ART could be achieved by 2030 alongside 100% prevention spending optimised including innovative testing strategies, it is projected that Mongolia could reduce cumulative new infections by 40% and HIV-related deaths by 32% between 2023 and 2030 compared to the baseline scenario (Table 2). Achieving all 95-95-95 targets by 2030 could reduce new HIV infections and HIV-related deaths by 43% and 41%, respectively, compared to the baseline scenario.

Projected epidemic impacts of 50% spending should be interpreted with caution, as this optimisation did not include constraints and are thus not directly comparable to higher budget optimisations where only up to 50% of the budget could be reallocated. There may be negative consequences of fully defunding programs in unconstrained optimisations 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 from baseline scenario	
			New HIV infections	HIV-related deaths
No HIV prevention* spending from 2023	530	200	180 (51%)	15 (8%)
50% optimised †	340	185	-10 (3%)	0 (0%)
90% optimised	315	185	-35 (10%)	0 (0%)
Baseline	350	185		
100% optimised	305	180	-45 (13%)	-5 (3%)
150% optimised	275	180	-75 (21%)	-5 (3%)
200% optimised	270	180	-80 (23%)	-5 (3%)
100 % optimised with innovative testing	260	150	-90 (26%)	-35 (19%)
100 % optimised with innovative testing + 95% treatment coverage^	210	125	-140 (40%)	-60 (32%)
200% optimised with innovative testing	205	150	-145 (41%)	-35 (19%)
95-95-95^	200	110	-150 (43%)	-75 (41%)

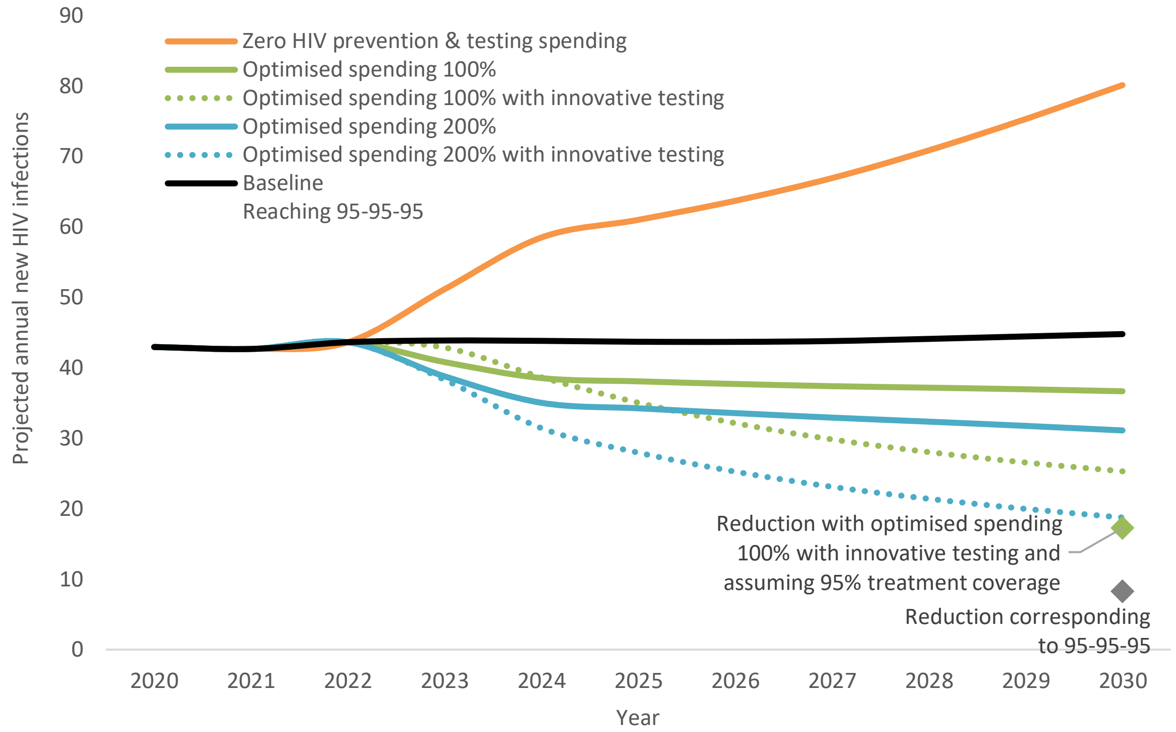
All numbers rounded to the nearest 5

* Includes no spending on HIV prevention and testing.

† 50% spending optimisations included no constraints on program spendings. Epidemic impacts are not directly comparable to optimisations at 100% spending and higher which were constrained to not reduce spending by more than 50% on any one program

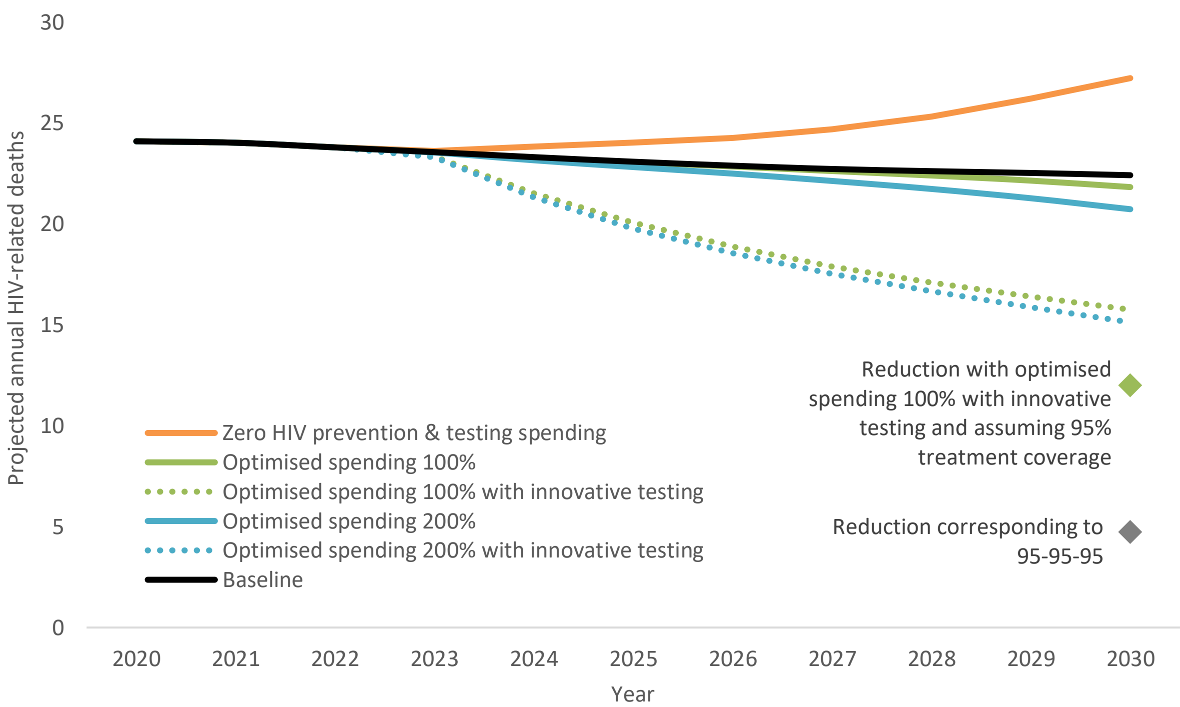
^ No scenarios were able to meet the 95 diagnosis and treatment targets with existing and proposed programs. Impact assumes the specified targets could be met but does not specify how they could be achieved.

Figure 9. Annual new HIV infections at varying budget levels, with or without an innovative testing program, 2020 to 2030



Source: Optima HIV Mongolia, 2023

Figure 10. Annual HIV-related deaths at varying budget levels, with or without an innovative testing program, 2020 to 2030



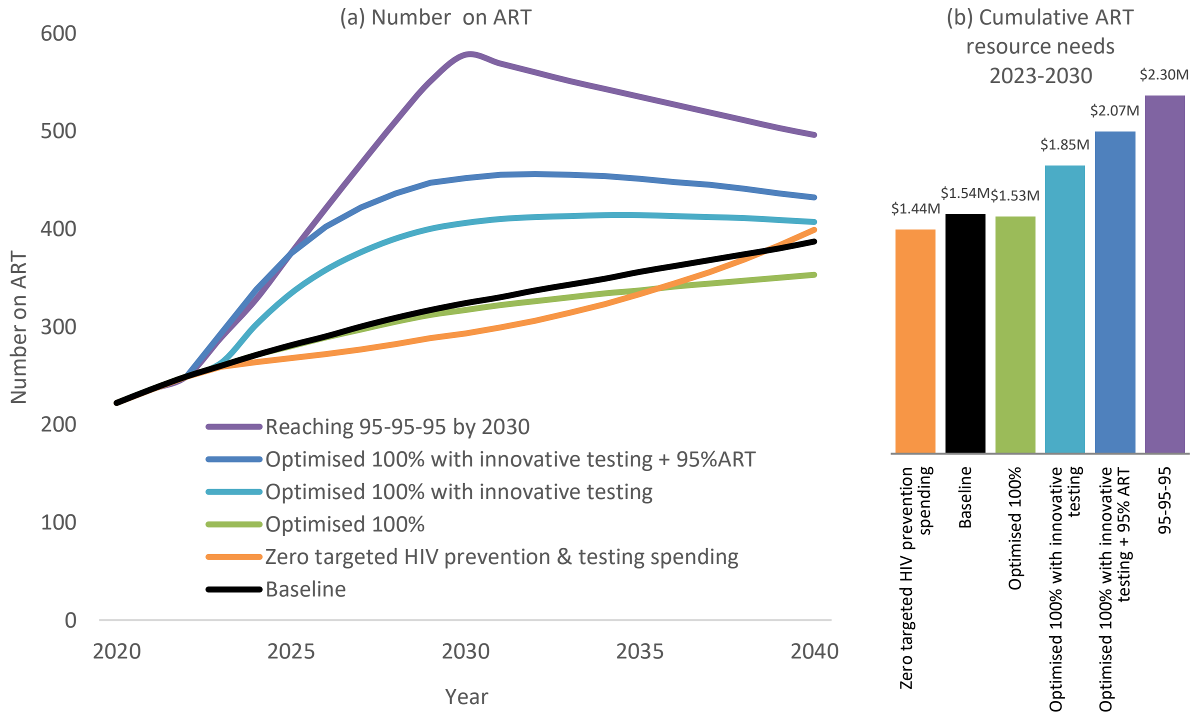
Source: Optima HIV Mongolia, 2023

3.9 Antiretroviral treatment resource needs

Resource needs for HIV treatment will increase over 2023 to 2030 with progress towards 95-95-95 targets. However, greater progress on advancing cascade achievements in the short term will lead to reduced infections, ultimately reducing treatment resource needs in the longer term. This is seen in Figure 11 up to year 2040, with trends expected to continue but not modelled over longer durations due to increased uncertainty. Assuming that current treatment coverage is maintained (86%) with a constant unit cost of US$655 per person per year, over 2023-2030 US$1.5M could be necessary to ensure up to 324 people on treatment with current conditions. Resources needs to maintain treatment coverage with other spending scenarios would differ (Figure 11):

1. In the optimised scenario, the number of people on treatment will decrease over time due to infections averted, particularly due to the scale-up of PrEP.
2. With innovative testing available and scaled up, the number of people being diagnosed with HIV increases in the short-term leading to higher ART needs, but these start to decrease in the longer-term due to infections averted.
3. If all 95 targets could be reached by 2030, cumulative resource needs could increase substantially to US$2.3 million from 2023 to 2030.
4. ART resource needs would reduce in the longer term due to overall infections averted with 100% spending optimised with innovative testing or reaching 95-95-95 but continue to increase in the baseline scenario.
5. Removing spending for HIV prevention and testing could result in a longer-term increase in spending for treatment due to an estimated increase in infections leading to a higher number of people requiring treatment.

Figure 11. ART resource needs with varying levels of targeted HIV prevention and testing spending, 2020 to 2040. Panels show: (a) Number on ART assuming fixed 85% coverage among diagnosed people living with HIV; and (b) Cumulative ART resource needs from 2023-2030 in different budget scenarios.



Source: Optima HIV Mongolia, 2023

4. Key limitations

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

- **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. In particular, data on transgender women in Mongolia are limited with acknowledged sampling biases (5), and the exact coverage of transgender women through programs focusing on men who have sex with men is not known.
- **The size and profile of the HIV epidemic in Mongolia was aligned with Spectrum and AEM** estimates, which have undergone extensive consultation and national validation. Any errors in these estimates would also apply to Optima HIV estimates.
- **Effect (i.e. impact) sizes for interventions are informed from global literature and available program data**. 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. The effect size for HIV testing with online outreach was based on a pilot study (29) and may decrease over time if follow up is less intensive in the scale-up phase.
- **Effectiveness of testing:** Population-based testing rates were adjusted to approximate the percentage of undiagnosed people living with HIV that were tested (Appendix E3). Additional assumptions were made about the low effectiveness of facility-based testing in reaching undiagnosed people living with HIV (Table E1), given relatively high estimated testing rates based on behavioural survey data and low estimated proportion of people living with HIV who are diagnosed. Improved progress in approaching the 95% diagnosis target could be achievable in the future if more targeted testing is implemented through existing programs. This was in part modelled through the innovative testing program, but other advances in improving program quality and targeting may enable further implementation efficiencies and thereby improve the yield of existing programs.
- **Due to regulatory barriers, PrEP is no longer available to key populations** in Mongolia as the medicines are not currently approved for prevention use in Mongolia and are only registered for treatment of HIV (30). Realising the projected impact of optimised spending will require reform to regulation to enable the scale-up of PrEP for men who have sex with men and transgender women.
- **The innovative testing scenario** had limited data to inform cost and impact of the program, and these were supplemented by assumptions and expert opinion. Index testing among men who have sex with men may also reach low numbers of women, but the impact of this was not modelled and may thus underestimate the benefits of scaling up innovative testing.
- **The impact of spending on programs for ART retention support and adherence support on treatment coverage and viral suppression** could not be assessed as there were insufficient information on program coverage and intervention effects in the local context. Subsequently, it was assumed that ART coverage and proportion of people on treatment with viral suppression would remain constant in budget optimisation scenarios, thus ongoing progress towards the reaching the second 95 and maintaining the third 95 target could not be accurately estimated.

- **NASA and program-provided spending** was used to inform spending for programs. These spending estimates may not fully reflect all costs involved in setting up programs. Conversely, these estimates may result in higher unit costs due to inclusion of start-up costs and overheads, particularly for new programs such as PrEP. Bringing PrEP implementation guidelines in line with 2021 WHO guidance for simplified PrEP delivery may also enable PrEP scale-up to be achieved at a lower budget than estimated (31). 2020 NASA spending estimates on HIV testing includes tests with private funding through out-of-pocket spending or social insurance salary contributions, as there was insufficient data in recent years to exclude these (21). In reality the funding mechanisms for each of the programs may limit the extent to which spending can be reallocated, particularly where private spending contributes. In accordance with the 2022 NASA, the Optima analysis assumed all tests among female sex workers and men who have sex with men were occurred through community-based services, but these populations may also test through facility-based services.
- **Attainable reach** of programs, for key populations in particular, is based on assumptions validated by country partners. In practice it may be more difficult or easier to reach these populations.
- **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.
- **Geographical heterogeneity** is not modelled, and outcomes represent national averages.
- **Programs included in the optimisation** may not capture all programs currently active in Mongolia. Some programs were excluded due to insufficient data, including online HIV and sexual health information, education and communication for young people.
- **Equity** in program coverage or HIV outcomes was not captured in the model but should be a key consideration in program implementation. Policy makers and funders are encouraged to consider resources required to improve equity, such as through investment in social enablers to remove human rights-based barriers to health, and technical or implementation efficiency gains. In addition, prevention programs may have benefits outside of HIV, such as for sexually transmitted infections 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 Mongolia highlights the necessity to invest in programs for key populations at all budget levels. Men who have sex with men and transgender women are most at risk of acquiring HIV in Mongolia, and program modalities to reach these populations are particularly important. The biggest gap in reaching the Fast-Track 95 targets is in diagnosis, and the planned scale-up of innovative HIV testing strategies may advance progress. Key findings and 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 prevention and testing programs focused on key populations.
2. **Optimisation of 100% current spending** could lead to improved impact on the HIV epidemic, by averting 13% of HIV infections and 3% of HIV-related deaths over the 2023 to 2030 period. The first priority is to reallocate funding towards pre-exposure prophylaxis programs, as well as other prevention and testing programs for men who have sex with men and female sex workers. This will require regulatory changes to approve antiretrovirals for prevention.
3. **It may be possible to reduce spending on facility-based testing and improve cost-effectiveness of detection** by limiting mandatory testing, reducing the number of tests required in antenatal care, and through better targeting of existing testing programs.
4. **Incorporating innovative testing strategies** could reach previously unidentified people living with HIV among the men who have sex with men and transgender women populations. Diagnosis rates could improve to 73% by 2030, as opposed to 54% with current spending patterns, leading to further reductions in new HIV infections and HIV-related deaths.
5. **In the short-term, annual ART resource needs will increase with improvements in diagnosis** through optimised resource allocation and scale-up of innovative testing strategies. However, in the longer-term these will decrease and beyond 2040 may eventually lead to similar or even lower resource needs than with baseline spending maintained due to prevention of new HIV infections.
6. **Reaching 95 diagnosis rate by 2030 could prove difficult, even when including innovative testing programs.** Nevertheless, achieving the 95% HIV treatment and viral suppression targets by 2030 are almost achieved. Reaching and sustaining 95-95-95 would require US$2.3M for treatment over the 2023 to 2030 period.
7. **Existing programs only reach a small proportion of transgender women**, with low potential for expanding coverage among this group. Subsequently, there is an unmet need for tailored testing and prevention services for transgender women to improve health and social outcomes and prevent HIV incidence from rising.

6. References

1. UNAIDS. AIDSInfo: HIV estimates with uncertainty bounds 1990-present 2022 [cited 2022 Aug 27]. Available from: https://aidsinfo.unaids.org/.
2. Pharos Global Health Advisors. Mongolia: Sustainability and Transition Readiness Assessment and Work Plan for TB and HIV: Pharos Global Health Advisors; 2020 [cited 2022 Jun 28]. Available from: https://pharosglobalhealth.com/wp-content/uploads/2021/01/Mongolia-Pharos.pdf.
3. Extended plan for the implementation of the National Program on Communicable Diseases Prevention and Control Ulaanbaatar: Ministry of Health, Government of Mongolia; 2020.
4. HIV and syphilis surveillance survey report, 2019. Ulaanbaatar: School of Public Health of Mongolian National University of Medical Sciences (MNUMS) and National Centre for Communicable Disease (NCCD); 2019.
5. Biological-behavioral assessment and population size estimation among transgender person in Ulaanbaatar, Mongolia-2021. Ulaanbaatar: National Centre for Communicable Disease (NCCD); 2021.
6. Biological-behavioral assessment and population size estimation among transgender person in Ulaanbaatar, Mongolia 2022: Preliminary Report. Ulaanbaatar: National Centre for Communicable Disease (NCCD); 2022.
7. HIV and syphilis surveillance survey report, 2017. Ulaanbaatar: School of Public Health of Mongolian National University of Medical Sciences (MNUMS) and National Centre for Communicable Disease (NCCD); 2018.
8. HIV and syphilis surveillance survey report, 2014. Ulaanbaatar: Ministry of Health and Sports; 2014.
9. Second generation HIV and STI surveillance report, 2011. Ulaanbaatar: Ministry of Health; 2011.
10. Second generation HIV and STI surveillance report, 2009. Ulaanbaatar: Ministry of Health; 2009.
11. Odonchimed G, Mahmud MS. Gender review of key populations and HIV in Mongolia: Australian Federation of AIDS Organisations, SKPA Regional Programme; 2020.
12. de Lind van Wijngaarden JW. Comparing HIV Services for Key Populations in Mongolia with WHO guidelines: Findings from a rapid assessment2020.
13. NSO. Mongolia Social Indicator Sample Survey-2018, Survey Findings Report. Ulaanbaatar, Mongolia: National Statistical Office of Mongolia; 2019.
14. Galvin SR, Cohen MS. The role of sexually transmitted diseases in HIV transmission. Nature Reviews Microbiology. 2004;2(1):33-42.
15. Global AIDS Monitoring 2021 [Internet]. UNAIDS. 2021. Available from: https://hivfinancial.unaids.org/hivfinancialdashboards.html#.
16. National Center for Communicable Disease (NCCD). AIDS Reponse Progress Report - Mongolia. Reporting period January 1, 2012-December 31, 2013: UNAIDS; 2014. Available from: https://www.aidsdatahub.org/resource/mongolia-global-aids-response-progress-report-2015.
17. Zayasaikhan S. Interim report the the feasibility study: introducing pre-exposure prophylaxis among MSM in Ulaanbaatar, Mongolia. Ulaanbaatar: Youth for Health Center; 2022.
18. Youth For Health Centre. Introducing HIV self-testing and community-based testing among MSM population in Mongolia. Ulanbaatar: Youth For Health Centre and National Center for Communicable Diseases 2022.
19. The HIV Financial Dashboard: UNAIDS; [cited 2022 Jun 30]. Available from: https://hivfinancial.unaids.org/.
20. Kerr CC, Stuart RM, Gray RT, Shattock AJ, Fraser N, Benedikt C, et al. Optima: a model for HIV epidemic analysis, program prioritization, and resource optimization. Journal of Acquired Immune Deficiency Syndromes. 2015;69(3):365–76.
21. Nitsoy A. National AIDS Assessment Mongolia: 2017-2021: National Center for Communicable Diseases; 2022.

22. AEM Mongolia Workbook: Mongolia_Feb_25_ 2022_WW_5May2022_AEM. Ulaanbaatar: NCCD, AIDS/STI Surveillance and Research Department; 2022.
23. AIDS Epidemic Model Report of Mongolian HIV/AIDS Prevention Program Impact Analysis, 2018. Ulaanbaatar: NCCD, AIDS/STI Surveillance and Research Department; 2018.
24. Postma S. SKPA key population unit cost study: Mongolia. [Unpublished draft report]. Received 2022 Aug 1.
25. Optima HIV User Guide Volume II: Software Reference Manual: Optima Consortium for Decision Science; 2020. Available from: http://optimamodel.com/hiv/documents.html.
26. National Center for HIV/AIDS DaS. Ending the AIDS epidemic in Cambodia: Findings from an Optima HIV modelling analysis. Phnom Penh: NCHADS; 2020. Available from: http://optimamodel.com/pubs/Cambodia_HIV_2020.pdf.
27. NCCD. National HIV Testing Report: National Center for Communicable Disease; 2021.
28. National Center for Communicable Disease (NCCD). Cumulative data of HIV and AIDS cases registed in 2019-2021. [Unpublished report]. Received 2022 Dec 20.
29. Mid-term evaluation of test4UB campaign: Australian Federation of AIDS Organisations (AFAO); 2022.
30. Order of the Ministry of Health of Mongolia: On approving the liste of diseases to be treated on an outpatient basis and regulation of the provision of medicines by the state, A/407 (2022).
31. WHO. Differentiated and simplified pre-exposure prophylaxis for HIV prevention: update to WHO implementation guidance. Geneva: World Health Organization,; 2021. Available from: https://www.who.int/publications/i/item/9789240053694.
32. Kerr CC, Dura-Bernal S, Smolinski TG, Chadderdon GL, Wilson DP. Optimization by Adaptive Stochastic Descent. PLoS One. 2018;13(3):e0192944.
33. World population prospects 2019 [Internet]. 2019.
34. National Center for Communicable Disease (NCCD) HIV and STI surveillance department. Registration of patients on ART. [Unpublished spreadsheet]. Received 2022 May 16.
35. Jiamsakul A, Kiertiburanakul S, Ng O, Chaiwarith R, Wong W, Ditangco R, et al. Long-term loss to follow-up in the TREAT Asia HIV Observational Database (TAHOD). HIV Medicine. 2019;20(7):439-49.
36. Rosenblum M, Deeks SG, van der Laan M, Bangsberg DR. The Risk of Virologic Failure Decreases with Duration of HIV Suppression, at Greater than 50% Adherence to Antiretroviral Therapy. PLOS ONE. 2009;4(9):e7196.
37. NSO. Social Indicator Sample Survey-2018, Survey Findings Report. Ulaanbaatar, Mongolia: National Statistical Office of Mongolia; 2019.
38. NSO. Social Indicator Sample Survey-2013, Multiple Indicator Cluster Survey: Final Report. Ulaanbaatar, Mongolia: National Statistical Office of Mongolia; 2015.
39. Population size estimation of female sex workers and men who have sex with men in Mongolia, 2019. Ulaanbatar, Mongolia:: Ministry of Health; 2020.
40. Mathers B, Wodak A, Shakeshaft A, Khoei EM, Dolan K. A rapid assessment and response to HIV and drug use in Mongolia. Sydney: National Drug and Alcohol Research Centre, University of New South Wales; 2009.
41. World Prison Brief: Mongolia[cited 2022 May 10]. Available from: https://www.prisonstudies.org/country/mongolia.
42. Ten Brink DC, Martin-Hughes R, Minnery ME, Osborne AJ, Schmidt HA, Dalal S, et al. Cost-effectiveness and impact of pre-exposure prophylaxis to prevent HIV among men who have sex with men in Asia: A modelling study. PLoS ONE. 2022;17(5):e0268240.
43. Individuals using the Internet (% of population). International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database [Internet]. 2021. Available from: https://data.worldbank.org/indicator/IT.NET.USER.ZS.

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) (32). 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

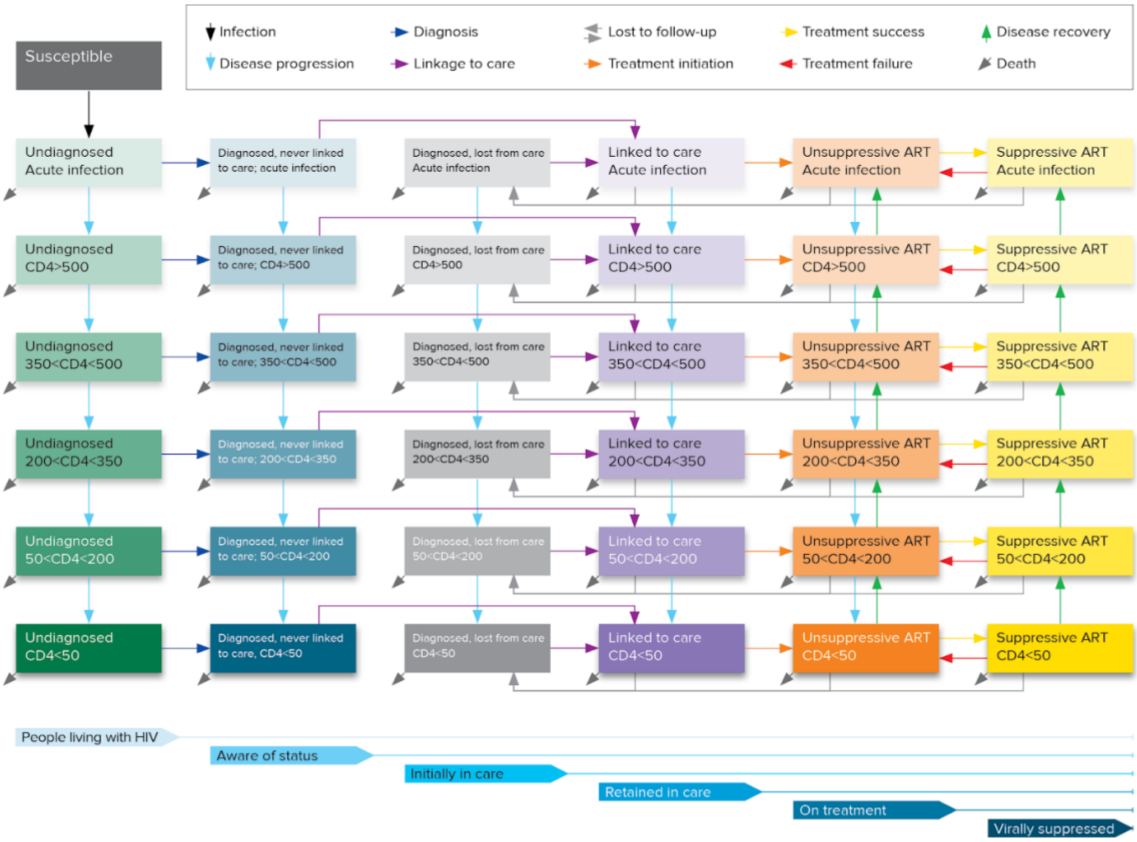
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates.

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 achieved virally suppression, receiving ART and achieved virally suppression, 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 Mongolia were sourced from national records, surveillance surveys, household surveys and other studies supplemented by expert advice from stakeholder consultations.

Table B1. Model parameter data sources

Parameter	Source
Population size*	Age and gender stratified population sizes from the United Nations World Population Prospects 2019. Key population sizes for FSW and MSM are estimated based on median value of (1) the national consensus values from the 2019 update on definition and sizing of key populations (CONAVIHSIDA, ASESAI) and (2) KP Atlas. Population size estimates for TGW are based on the IBBS-TGW 2021. Key population sizes for clients are based on assumptions in the AEM 2018. Key population sizes for prisoners are based on the World Prison Brief 2020 estimate.
HIV prevalence by population groups*	HIV prevalence data values are used as the primary point of reference during calibration. Values for key populations were aligned with AEM assumptions for 1990-2021. Survey estimates from the IBBS 2019, IBBS-TGW-2021 and 2022 and MICS 2018 were also considered. Where no data exists, values relied on expert opinion/assumptions.
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 WPP 2019 (33). For STIs, values for key populations were aligned with AEM assumptions and inputs for 1990-2021 (22). Values for more recent years were derived from surveys conducted since the AEM, including the IBBS 2019, IBBS-TGW-2021 and MICS 2018. This parameter considered either (a) the proportion of a population group reporting that they had a genital sort or ulcer in the past 12 months or (b) the prevalence of active syphilis among a population group.
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 the IBBS 2019, MICS 2018, and IBBS-TGW 2021.

Parameter	Source
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 (%)	AEM 2022 (1990-2021) and Spectrum. Data entered in this section of the Optima HIV databook are 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.
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) 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	Cascade parameters informed by programmatic data from the NCCD and Global AIDS Monitoring and expert opinion. Based on ART registration data, the median time between diagnosis and commencing treatment was 20 days in 2019 and 37 days in 2020 (34). The model assumed that time to initiation returned to pre-covid levels in 2021 (18 days). Additional assumptions were based off the TREAT Asia HIV Observational Database (TAHOD) (35) and REACH Cohort (36).
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	Where available, values for sexual behaviour aligned with inputs or assumptions used in the AEM 2022. Additional information from MICS 2018, IBBS 2019 and IBBS-TGW 2021 and 2022.
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)	Not applicable.
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	Informed by population definitions, supplemented by details from AEM 2018 and partner types reported in the IBBS 2019 and IBBS-TGW 2021.

Parameter	Source
before movement)	
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

Key references from Mongolian surveys and international databases reviewed and used to inform the model are outlined in Table B2.

Table B2. Key references used in Optima HIV Mongolia analysis, 2023

Reference	Short name	Year	Available data
AIDS Epidemic Model Report Of Mongolian HIV/AIDS Prevention Program Impact Analysis, 2018 (23)	AEM 2018	2018	Data inputs and assumptions from 2018 AEM
AIDS Epidemic Model Mongolia workbook, 2022 (22)	AEM 2022	2022	Data inputs and baseline output from 2022 AEM
Biological-Behavioral Assessment and Population Size Estimation among Transgender Persons in Ulaanbaatar, Mongolia-2021 (5)	IBBS-TGW 2021	2021	HIV & STI prevalence, sexual behaviour, testing history, PSE
HIV/STI Surveillance Survey Report, 2014 (8)	IBBS 2014	2014	FSW, MSM : HIV & syphilis prevalence, condom use, testing history, number of partners, prevention coverage
HIV and Syphilis Surveillance Survey Report, 2017 (7)	IBBS 2017	2017	FSW, MSM, young people : HIV & syphilis prevalence, condom use, testing history, number of partners, prevention coverage
HIV and Syphilis Surveillance Survey Report, 2019 (4)	IBBS 2019	2019	FSW, MSM, prisoners, and male transport drivers (some disaggregation by client status): HIV & syphilis prevalence, condom use, testing history, number of partners, prevention coverage
Mongolia Social Indicator Sample Survey-2018 [Multiple Indicator Cluster Survey] (37)	MICS 2018	2018	HIV testing history, condom use, STI prevalence, fertility rates among young people and adults
Mongolia Social Indicator Sample Survey-2013 [Multiple Indicator Cluster Survey] (38)	MICS 2013	2013	HIV testing history, condom use, STI prevalence, fertility rates among young people and adults
Population size estimation of female sex workers and men who have sex with men in Mongolia, 2019 (39)	PSE 2019	2019	PSE for FSW, MSM
A rapid assessment and response to HIV and drug use in Mongolia (40)	RAR drug use	2009	Review of data on drug use
Second generation HIV and STI Surveillance Report, 2011 (9)	SGS 2011	2011	FSW, MSM : HIV & syphilis prevalence, condom use, testing history, number of partners, prevention coverage
Second generation HIV and STI Surveillance Report, 2009 (10)	SGS 2009	2009	FSW, MSM : HIV & syphilis prevalence, condom use, testing history, number of partners, prevention coverage
United Nations World Population Prospects 2019 (33)	WPP 2019	2019	Age and gender stratified population sizes
World Prison Brief (41)	World Prison Brief	2020	PSE for male prisoners

Notes: AEM, Asian Epidemic Modelling; FSW, female sex worker; MSM, men who have sex with men; PSE, population size estimates

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.

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 2025

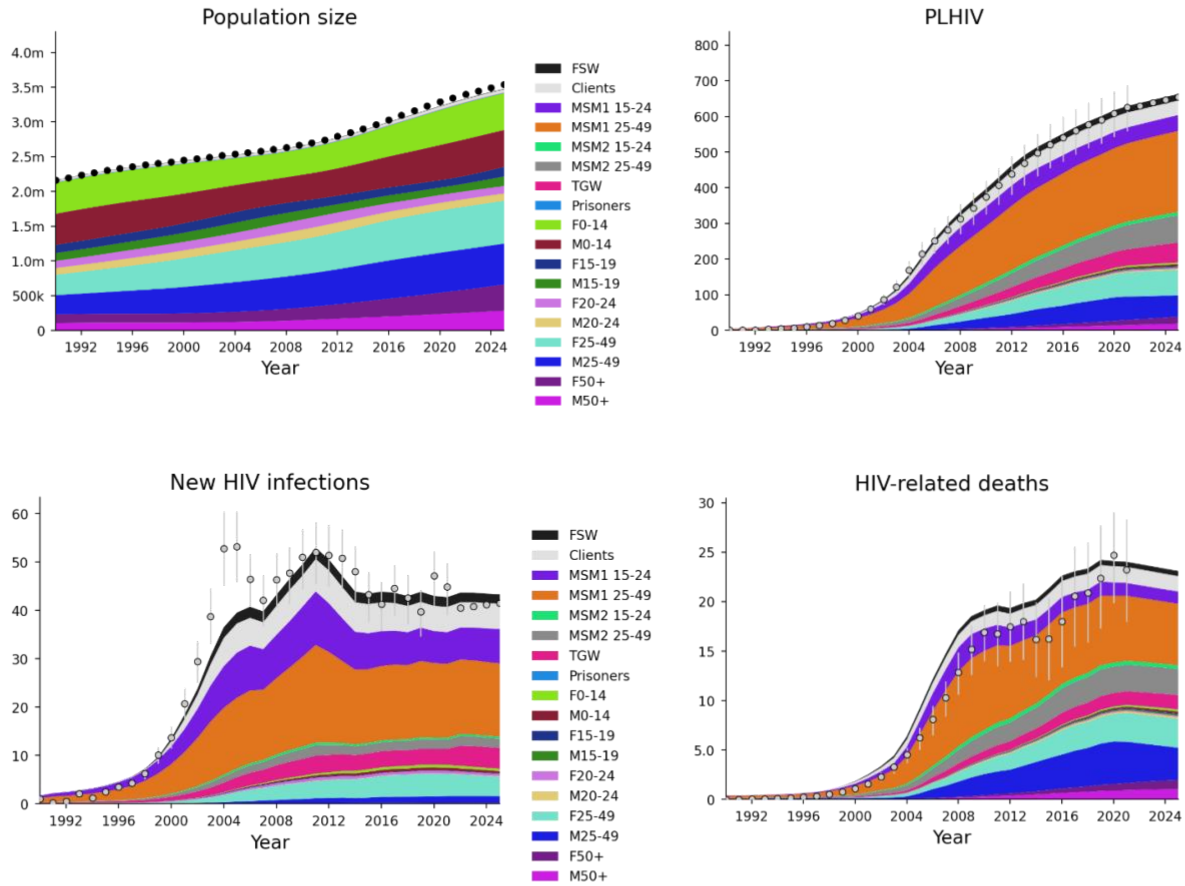


Figure B2. Calibration output for HIV treatment cascade parameters

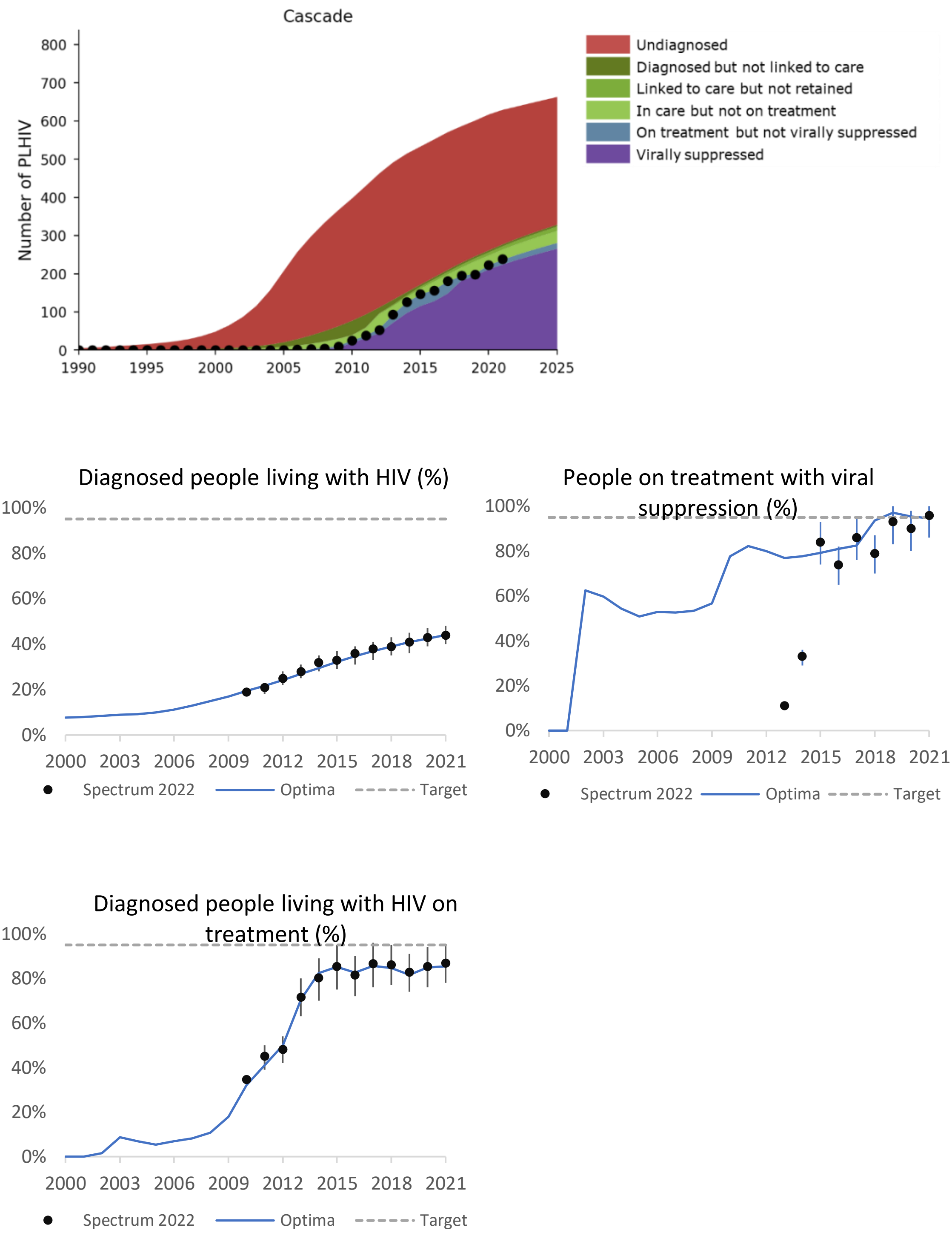
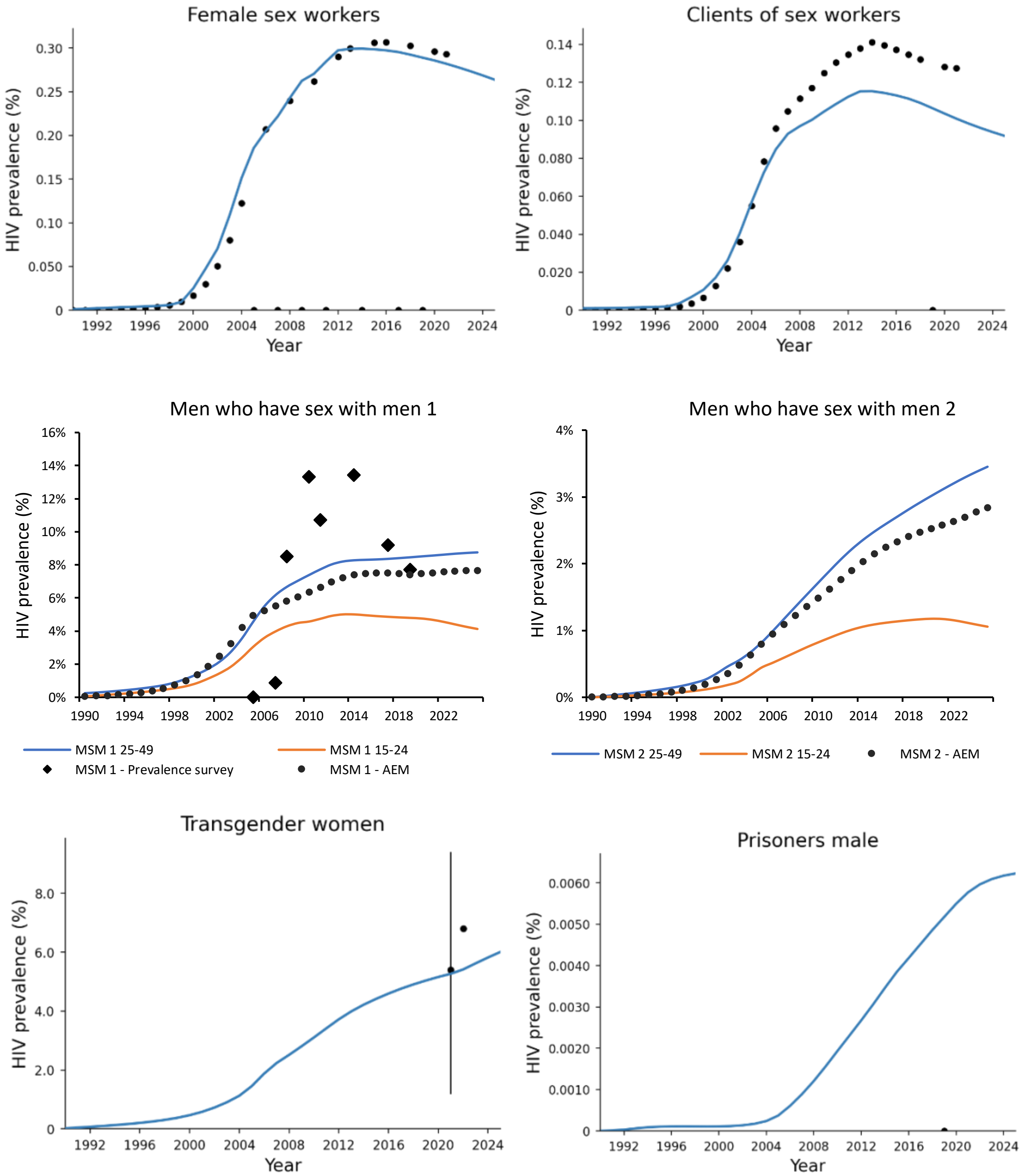
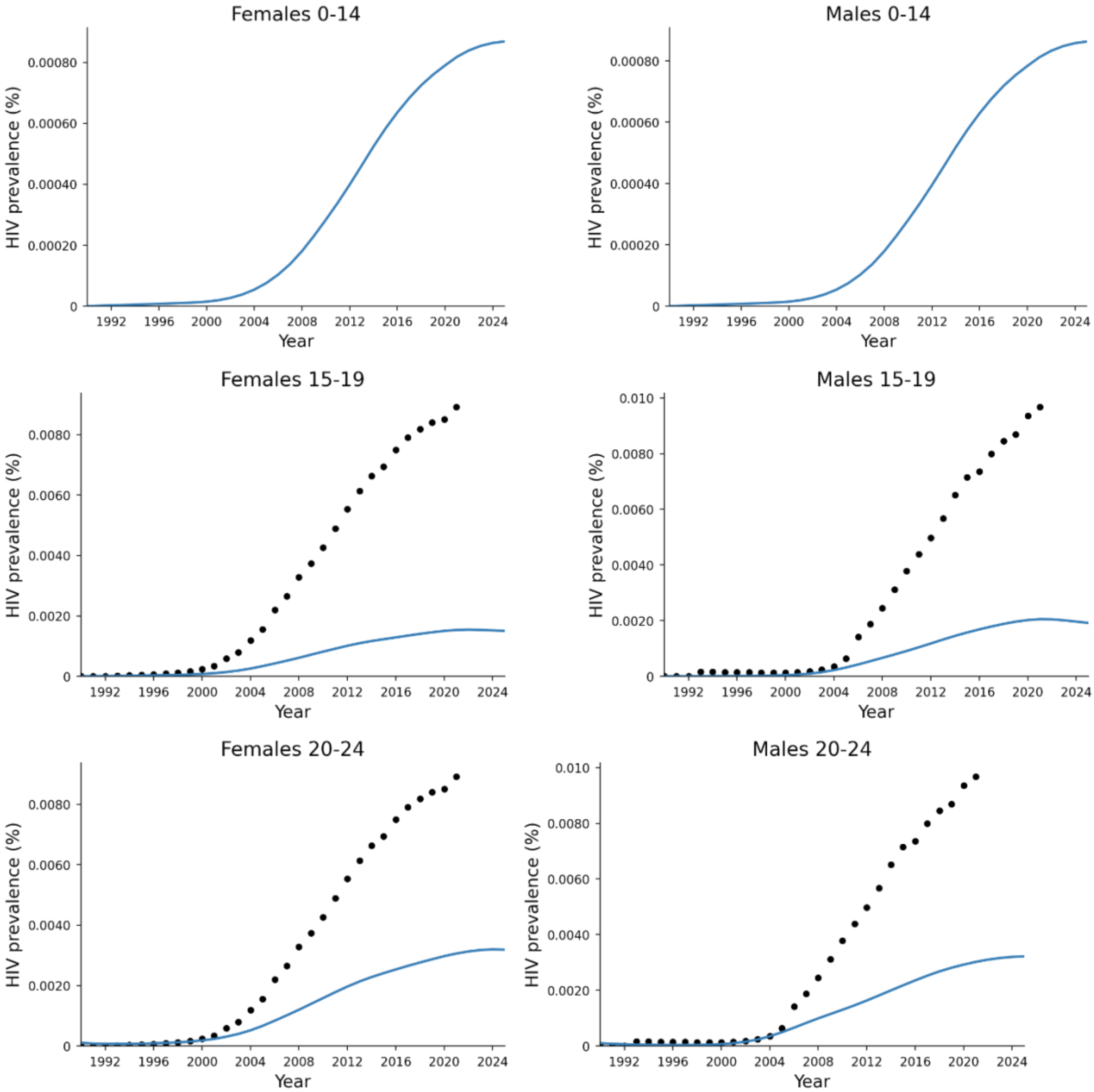
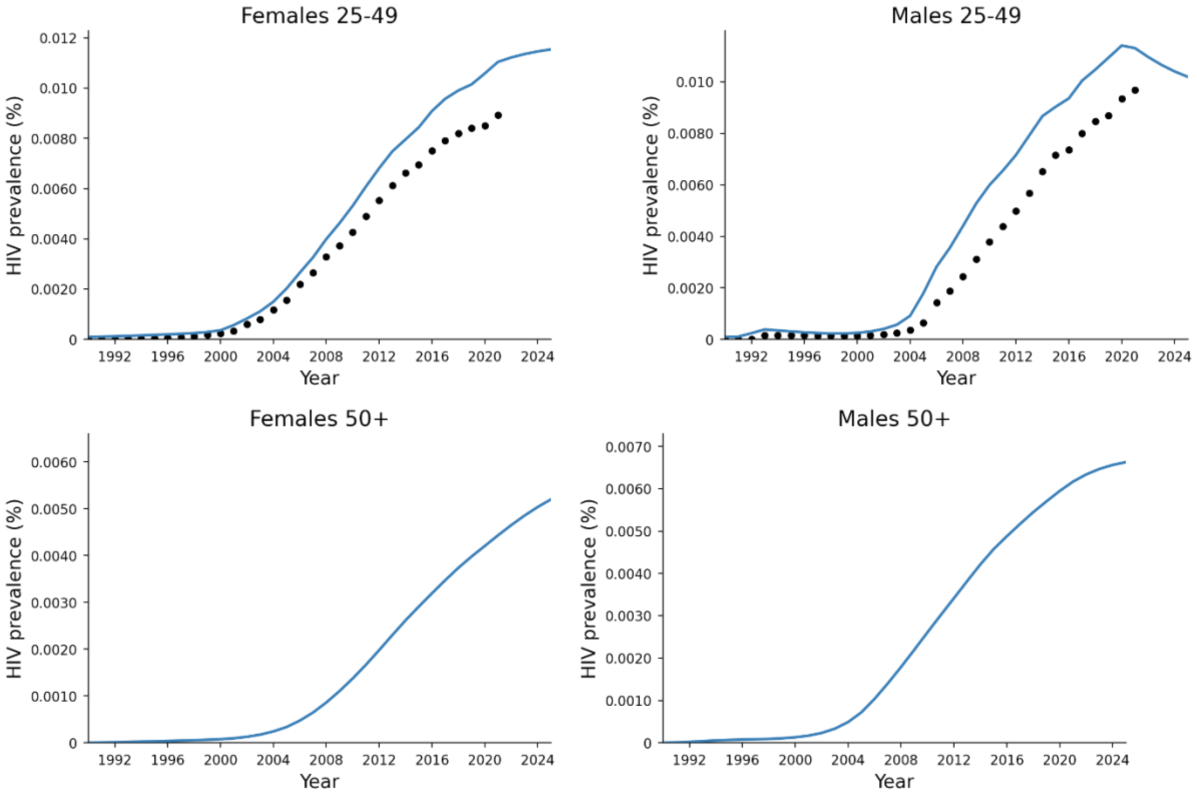


Figure B3. Calibration outputs for HIV prevalence by population for 1990 to 2025 in relation to AEM 2022 outputs and key epidemiological studies




Females 0-14
Males 0-14
Females 15-19
Males 15-19
Females 20-24
Males 20-24
HIV prevalence (%)
Year
0
0.00020
0.00040
0.00060
0.00080
0.0020
0.0040
0.0060
0.0080
0.010
1992
1996
2000
2004
2008
2012
2016
2020
2024


Females 25-49
HIV prevalence (%)
0.012
0.010
0.0080
0.0060
0.0040
0.0020
0
1992 1996 2000 2004 2008 2012 2016 2020 2024
Year
Males 25-49
HIV prevalence (%)
0.010
0.0080
0.0060
0.0040
0.0020
0
1992 1996 2000 2004 2008 2012 2016 2020 2024
Year
Females 50+
HIV prevalence (%)
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0
1992 1996 2000 2004 2008 2012 2016 2020 2024
Year
Males 50+
HIV prevalence (%)
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0
1992 1996 2000 2004 2008 2012 2016 2020 2024
Year

Appendix C. Stakeholder consultations

To meet stakeholder needs, the flexibility of Optima HIV to model context-specific subpopulations and programmes was leveraged to answer policy questions through scenario and optimization analyses. This study was conducted in consultation with stakeholder groups through a series of technical group meetings and individual discussions that were held from December 2021 to June 2023 as listed in Table C1.

Technical working group (TWG) meetings included consultation with the standing National working group to manage research and assessment on STI, HIV, AIDS and TB. Additional stakeholder meetings were convened for focused discussions on Optima HIV analysis and findings including representatives from NGOs, NCCD, MOH, UNAIDS and Health Equity Matters.

Table C1. Stakeholder consultations

Stakeholder	Key topics
Youth for Health	National priorities, HIV service model for men who have sex with men and transgender women, innovative strategies, key constraints and gaps, challenges faced by transgender community, validation of program unit costs, program definitions and coverage estimates, review and interpretation of preliminary results.
National Centre for Communicable Diseases	National priorities, HIV service models in Mongolia, HIV and STI surveillance, funding environment, key constraints and gaps, role of mass testing strategies, discussion of proposed programs, populations and scenarios, validation of preliminary results
Ministry of Health	National priorities, validation of preliminary results
Perfect Ladies	HIV and STI services for female sex workers, impact of funding reductions, role of criminalization.
Health Equity Matters (formerly known as AFAO)	Ongoing discussions regarding current key population service delivery, priorities for key population services, program definitions and expected impact of programs, review and interpretation of preliminary results.
Positive Life	Challenges experienced by people living with HIV, types of support services offered, unmet needs, role of stigma and discrimination
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

Stakeholder	Key topics
	populations, and preliminary results and interpretation.
Global Fund	History of Global Fund funding in Mongolia, current grants and subrecipients, key gaps and needs.
NASA consultant	Provided context on the findings, limitations and definitions in the 2021 NASA
TWG* 1 (Jan 2022)	Approval of Terms of Reference for Optima HIV study
TWG* 2 (Apr 2022)	Provided introduction to Optima
TWG* 3 (June 2023)	Validation of findings
Focused stakeholder meetings	Periodic meetings with a variety of national and international stakeholders to discuss new and proposed program definitions, program constraints, cost and coverage estimates and preliminary findings.

Notes: * National TWG to manage the research and assessment on STIs, HIV, AIDS and TB

Appendix D. Populations modelled

Population definitions are consistent with those applied by the NCCD in HIV estimation in Mongolia using the AEM tool (23). Additional key populations of transgender women and prisoners were also included based on national prioritised populations, as well as additional age stratification in the general population of low-risk males and females.

Key assumptions:

- There are limited primary data on behaviour of MSM 2. Assumptions were aligned with AEM and force of infection were calibrated at to match overall epidemic trends.
- There are minimal data available on clients of female sex workers in Mongolia. STI prevalence among clients was based off male transport workers who report paying for sex in the last 12 months. Due to lack of stratified data for other parameters, other HIV and behavioural data inputs are based off all male transport workers, of which 7% reported paying for sex in the past year.

Table D1. Definitions of population groups included in the analysis

<table>
<tr><th>Abbreviation</th><th>Population group</th><th>Definition</th></tr>
<tr><td>FSW</td><td>Female sex workers</td><td>Biological females, 15 to 49 years old, who sell sex in exchange of money or goods in the last 12 months.</td></tr>
<tr><td>Clients</td><td>Clients of female sex workers</td><td>Clients of female sex workers, who have paid money or goods in exchange for sex in the last 12 months.</td></tr>
<tr><td>MSM 1 15-24</td><td>Men who have sex with men 1 (reachable through hotspots), 15-19</td><td rowspan="2">Biological males, 15-49 years old, who have had anal sex with another male in last 12 months

MSM 1 are those go, work, or visit at hotspot, sauna, spa, beer garden, online and offline, and are also categorized as ‘known risk’ MSM who can be reached through programmatic interventions.</td></tr>
<tr><td>MSM 1 25-49</td><td>Men who have sex with men 1 (reachable through hotspots), 25-49</td></tr>
<tr><td>MSM 2 15-24</td><td>Men who have sex with men 2 (not reachable through hotspots), 15-19</td><td rowspan="2">Biological males, 15-49 years old, who have had anal sex with another male in last 12 months

MSM 2 are those who are of ‘unknown risk’, and who cannot readily be reached with location-based physical outreach programmes.</td></tr>
<tr><td>MSM 2 25-49</td><td>Men who have sex with men 2 (not reachable through hotspots), 25-49</td></tr>
<tr><td>TGW</td><td>Transgender women</td><td>Assigned male sex at birth, 15-49 years old, self-identified as female ever having anal sex with a male.</td></tr>
<tr><td>Prisoners</td><td>Male prisoners</td><td>Defined as men remanded in prison (4)</td></tr>
<tr><td>F0-14
M0-14
F15-19
M15-19
F20-24
M20-24
F25-49
M25-49
F50+
M50+</td><td>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+)</td><td>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.</td></tr>
</table>

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. The source of spending and coverage data were the 2021 NASA, unless indicated (21).

E.1 Overview of HIV program inputs

Table E1. HIV programs included in the model; 2021 spending and unit costs (in US dollars), annual coverage, target populations, saturation value and population factor

Category	Program	Spending 2021[1]	Unit cost 2021	Coverage 2021, n (%)	Target population(s)	Saturation value[6]	Population factor (PF)[7]	Notes
Treatment	Antiretroviral therapy [2]	$155,925	$655.15	238 (85%)	Diagnosed people living with HIV	100%	1.0	Program not optimised
	Prevention of mother-to-child transmission [2]	$699	$174.80	4	Pregnant women living with HIV	100%	1.0	Program not optimised
HIV testing	Facility-based HIV testing services [3]	$533,717	$2.00	281,353	All populations	100%	3.0	PF greater than 1 implies that the program needs to reach more people to have the modelled impact due to program not reaching those with highest risk of acquiring HIV
	Innovative HIV testing	$0	$51.16	0	MSM1, MSM2, TGW	50% MSM1 50% MSM2 25% TGW	1.0	Weighted unit cost for HIV self testing, community-based testing and index testing derived through stakeholder input and the 2022 SKPA costing study on top of a base unit cost of testing among MSM (2022 NASA). In 2021, coverage of HIV self testing and community-based testing was 814. However, the pilot implementation does

Category	Program	Spending 2021[1]	Unit cost 2021	Coverage 2021, n (%)	Target population(s)	Saturation value[6]	Population factor (PF)[7]	Notes
								not meet the broader definitions of the innovative testing program, thus coverage input as zero.
HIV prevention and testing in key populations	Prevention programmes for FSW	$174,572	$52.50	3,327 (52%)	FSW	75%	1.0	Saturation based on 65% of FSW living in Ulaanbaatar plus an assumed 10% living in other 5 provinces covered by NGO services
	Prevention programmes for MSM [4]	$318,606	$103.30	2,100 (59%) 900 (30%) 83 (10%)	MSM1 MSM2 TGW	90% 45% 15%	1.0	Spending and coverage from 2021 NASA adjusted to exclude the estimated costs and coverage from the HIV self-testing and community-based testing pilot. Saturation for MSM1 based on 74% of MSM living in Ulaanbaatar plus an assumed 16% living in 5 provinces covered by NGO services, with adjustment for other populations who are not directly targeted by the program.
	Pre-exposure prophylaxis (PrEP) [5]	$46,159	$332.08	139 (3%)	MSM1, TGW	20%	0.5	Applied PF assumes that PrEP uptake is focused among those engaged in more sex acts, leading to 2:1 coverage of sex acts per percent population coverage of PrEP (42).
	Online outreach (MSM, TGW)	$55,708	$22.21	2,125 (60%) 301 (10%) 83 (10%)	MSM1 MSM2 TGW	90% 45% 45%	1.0	Saturation for MSM1 informed by 84% of population (all ages) using the internet (43) and assuming the proportion is higher among the target demographic. Assumed lower coverage among MSM2 and TGW based on stakeholder feedback. Coverage based on expert opinion due to limitations of evaluation data.
Non-targeted HIV programs	Strategic information, management,	$1,180,266	N/A	N/A	N/A	N/A	N/A	HIV care incorporates testing and treatment of opportunistic and co-infections. Also includes other HIV

Category	Program	Spending 2021[1]	Unit cost 2021	Coverage 2021, n (%)	Target population(s)	Saturation value[6]	Population factor (PF)[7]	Notes
	health systems strengthening and enabling environment, management, HIV care							programs that were not targeted or with insufficient data to include in the modelling analysis.
Total		$2,485,404						Difference to NASA spending total ($2.47M) due to inclusion of online outreach not costed in the 2022 NASA analysis

Notes: FSW, female sex worker MSM, men who have sex with men; NASA, National AIDS Spending Assessment; PF, population factor; TGW, transgender women

1 Source 2021 NASA unless indicated

2 Not included in the optimisation

3 Includes antenatal testing, testing in general population, testing for vulnerable populations, and mandatory testing (not differentiated in recent years). To adjust total tests to individuals tested, coverage estimate assumes 2.2 tests per pregnant women and 1.2 for all others based on GAM reporting. Spending includes tests with private funding through out-of-pocket spending or social insurance salary contributions, as there was insufficient data in recent years to exclude this. Includes a small number of tests done in the community through NCCD/hospitals.

4 Spending and coverage from 2021 NASA adjusted to exclude the estimated costs and coverage from the HIV self-testing and community-based testing pilot

5 Coverage based on country-provided program data

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

7 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;

E.2. Innovative testing services

The prospective unit cost for innovative testing services for men who have sex with men and transgender women was estimated based on the base unit cost of HIV testing as part of the MSM program (2021 NASA), SKPA unit cost study (24) and stakeholder input. The unit cost incorporated estimated spending for commodities, staff and demand generation and assumed each client would only be tested once (Table E2). The overall unit cost and expected yield were weighted based on the expected contribution of each modality to overall innovative testing numbers.

Table E2. Overview of prospective unit cost (US$)[1] of innovative HIV testing program for men who have sex with men and transgender women

	Self-testing	**Community-based testing**	**Index testing**
Setting	80% assisted in community, 20% home-based	Community	NCCD
Cost components			
1. Base cost (USD per client)[2]	$41.98	$41.98	$41.98
2. Commodity costs (USD per unit)[3]	$3.82	$ 3.86	$17.15
3. Staff Resources (USD per client)			
Contact tracing	$0	$0	$3.88
Testing staff[4]	$2.50	$2.34	$3.46
Laboratory staff	$0.01	$0.01	$0.75
4. Demand generation (USD per client)	$1.14	$1.13	$0
Expected yield (%)	1%	1%	10%
Proportional contribution to total innovative testing	40%	50%	10%
Total unit cost	$49.45	$49.31	$67.22
	Weighted average innovative HIV testing		
Positive yield (%)	1.9%		
Weighted unit cost (US$)	$51.16		

Notes: 1 Assumed exchange rate of 1 MTN: US$ 0.00038 as per the SKPA unit cost study; 2 Based on the unit cost for testing among MSM defined by the 2021 NASA; 3 OraQuick rapid test or ELISA (index testing only) and proportional costs for confirmatory testing;4 Assumes 1% require confirmatory testing, but 10% in the case of index testing;

E.3 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.

The estimated testing rates and impact of testing programs were adjusted in the model to approximate the percentage of undiagnosed people living with HIV that were tested given number of tests conducted historically and estimated proportion of people living with HIV diagnosed in 2021 (Table E3, Table E4, Figure E1). The number of reported diagnoses in Mongolia is low relative to the number of tests, suggesting that testing is not effectively reaching individuals with undiagnosed HIV. This may be due to barriers to access among most-affected populations, mandatory and mass testing among populations regardless of risk indications, concentration of testing among individuals most aware of their risk, or over-reporting of recent HIV testing in populations surveys. The modelled likelihood that an undiagnosed person would be diagnosed within 12 months shown in the second row was calibrated to align with reported national diagnosis rates relative to the reported testing rates by population, and this is significantly lower under current conditions.

The baseline testing rates represents testing through NCCD and private services and are aligned with testing rates in the AEM model if key population programs were removed (23). The men who have sex with men program assumed 80% of people reached are tested (as informed by program data), and in the model we assumed a lower impact among young MSM. The online outreach program, conversely, assumed a higher impact among young MSM and 28% lower impact for other groups, based on the ratio of perceived usefulness of testing information received between younger and older respondents in the online outreach pilot study (29).

For all other parameters, where no specific source is given, values were reconciled based on available evidence to align with the most recently reported behavioural data (Table E5).

- “Most recent value”: based on reported behaviours taken from behavioural surveys where available. May be informed by assumptions for some sub-populations.
- “Baseline value”: The proportion of people who would be tested or use a condom without any HIV interventions, informed by logic applied in the 2018 AEM where possible.
- “For each individual reached by this program”: The proportion of people who would be tested or use condoms when reached with the specific HIV interventions (the difference between this value and the baseline value represents the *behavioural change*).

Table E3. Impact of HIV testing programs among men who have sex with men (MSM) and transgender women (TGW), representing the estimated percentage tested in the past year among those reached (Est.) and the adjusted testing rate among undiagnosed people living with HIV (Adj.)

HIV testing rate: men who have sex with men and transgender women												
		MSM1 15-24		**MSM1 25-49**		**MSM2 15-24**		**MSM2 25-49**		**TGW**		**Assumptions and sources**
		Est.	**Adj.**	**Est.**	**Adj.**	**Est.**	**Adj.**	**Est.**	**Adj.**	**Est.**	**Adj.**	
Most recent reported value		51%	6.0%	73%	9.0%	14%	1.0%	21%	2%	80%	10.0%	Based on 2019 IBBS for MSM1 25-49, and assumed 30% lower among young MSM. MSM2 based on adult males in general population (2018 MICS). Transgender women based on 2022 IBBS
Baseline value without program		18.0%	2.3%	25.7%	3.9%	14.2%	1.4%	20.3%	2.0%	18.0%	2.7%	Assume coverage would reduce by 0.78 if program removed compared to AEM coverage input (33% in MSM1 and 26% in MSM2) (AEM 2018). Baseline coverage may include testing through NCCD or private services.
Maximum achievable value at program saturation	**Key population-focused program**	56.0%	7.3%	80.0%	12.0%	30.0%	5.60%	80.0%	8.0%	80.0%	12.0%	Based on program data, on average 80% of individuals reached by the key population-program are tested. Program impact values assumed 30% lower among young MSM.
	Online outreach	66.0%	8.6%	48.0%	7.2%	66.0%	6.6%	48.0%	4.8%	48.0%	7.2%	Impact of online program based on 66% accessing HIV testing after seeing the pilot campaign. Assumed maximum impact for young MSM and 28% lower impact among older MSM/TGW based on difference in reported perceived usefulness of testing information. Assume that online is more effective at reaching young MSM than standard program. N.B. Effect size may decrease if follow up is less intensive during scale up phase, but this was not modelled.
	Facility-based testing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	In line with NASA cost calculations, assumed key populations only reached through key population-programs. Facility-based testing captured through baseline testing rate.
	Innovative HIV testing	64.8%	64.8%	64.8%	64.8%	64.8%	64.8%	64.8%	64.8%	64.8%	64.8%	Based on innovative HIV testing having a yield (1.9%) 6x higher than standard programs (0.3%), and assuming 10% of contacts were no shows/tests not used.

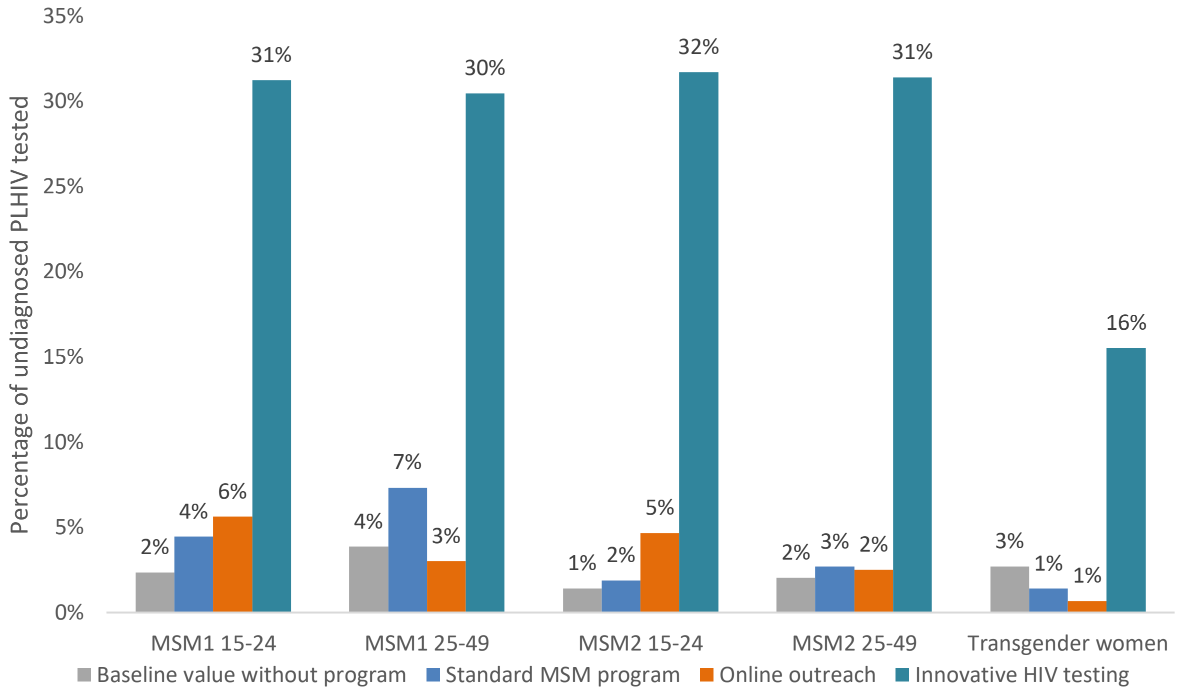
Notes: Est., Estimated proportion of population tested; Adj., Adjusted testing rate representing proportion of undiagnosed people living with HIV tested; AEM, Asian Epidemic Modelling; IBBS, Integration Biological-behavioural surveillance; MSM, men who have sex with men; N/A, not applicable; NASA, National AIDS Spending Assessment; NCCD, National Centre for Communicable Diseases

Table E4. Impact of HIV testing programs among female sex workers (FSW) and non-key populations, representing the estimated percentage tested in the past year among those reached (Est.) and the adjusted testing rate among undiagnosed people living with HIV (Adj.)

HIV testing rate: Female sex workers					**HIV testing rate: Non-key populations**				
		FSW		**Assumptions and sources**	**M15-49**		**F15-49**		**Assumptions and sources**
		Est.	**Adj.**		**Est.**	**Adj.**	**Est.**	**Adj.**	
Most recent reported value		54%	6%	2019 IBBS	16.2%	1.6%	24.0%	2.4%	Based on 2018 MICS. Reported as average for 15-19, 20-24 and 25-49 year olds.
Baseline value without program		43.1%	4.3%	Used same logic as for MSM (AEM 2018), assuming coverage would reduce by 0.78 if program removed.	8.5%	1.2%	12.0%	1.2%	Baseline possible through private testing.
Maximum achievable value at program saturation	**Key population-focused program**	95%	9.5%	Based on program data, 95% of those reached by Perfect Ladies are tested.	N/A	N/A	N/A	N/A	
	Online outreach	N/A	N/A	Online outreach for MSM and TGW only.	N/A	N/A	N/A	N/A	
	Facility-based testing	N/A	N/A	In line with NASA cost calculations, assumed key populations only reached through key population programs. Facility-based testing captured through baseline testing rate.	100%	14.2%	150%	40.5%	Higher among women due to antenatal testing requirements (average 2.2 test per pregnant women).
	Innovative HIV testing	N/A	N/A	Assume only very small numbers may be reached through index testing, thus not modelled. Not a focus population for self testing and community-based testing.	N/A	N/A	N/A	N/A	Based on 2018 MICS. Reported as average for 15-19, 20-24 and 25-49 year olds.

Notes: Est., Estimated proportion of population tested; Adj., Adjusted testing rate representing proportion of undiagnosed people living with HIV tested; F15-49, females aged 15-49 years; FSW, female sex worker; M15-49, males aged 15-49 years; MICS, Multiple Indicator Cluster Survey; MSM, men who have sex with men; N/A, not applicable; NASA, National AIDS Spending Assessment; TGW, transgender women

Figure E1. Annual capacity of each program for men who have sex with men and transgender women to reach additional undiagnosed people living with HIV among each population when scaled up to saturation



Notes: MSM, Men who have sex with men; PLHIV, people living with HIV
Source: Optima HIV Mongolia, 2023

Table E5. 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
Online outreach	Condom use for casual acts	MSM1 15-24, MSM1 15-24	61%	61%	67%	67%
Online outreach	Condom use for casual acts	MSM1 15-24, MSM1 25-49	61%	61%	67%	67%
Online outreach	Condom use for casual acts	MSM1 15-24, MSM2 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 15-24, MSM2 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 15-24, TGW	61%	61%	64%	64%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM1 15-24	61%	61%	67%	67%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM1 25-49	61%	61%	67%	67%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM2 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM2 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 25-49, TGW	61%	61%	64%	64%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM1 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM1 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 25-49, MSM1 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 25-49, MSM1 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	TGW, MSM1 15-24	61%	61%	64%	64%
Online outreach	Condom use for casual acts	TGW, MSM1 25-49	61%	61%	64%	64%
Online outreach	Condom use for casual acts	MSM1 15-24, MSM2 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 15-24, MSM2 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM2 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM1 25-49, MSM2 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM1 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM1 25-49	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM2 15-24	42%	42%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, MSM2 25-49	42%	42%	57%	57%
Online outreach	Condom use for casual acts	MSM2 15-24, TGW	52%	52%	55%	55%
Online outreach	Condom use for casual acts	MSM2 25-49, MSM1 15-24	52%	52%	57%	57%
Online outreach	Condom use for casual acts	MSM2 25-49, MSM1 25-49	52%	52%	57%	57%

HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
Online outreach	Condom use for casual acts	MSM2 25-49, MSM2 15-24	42%	42%	46%	46%
Online outreach	Condom use for casual acts	MSM2 25-49, MSM2 25-49	42%	42%	46%	46%
Online outreach	Condom use for casual acts	MSM2 25-49, TGW	52%	52%	55%	55%
Online outreach	Condom use for casual acts	TGW, MSM2 15-24	52%	52%	55%	55%
Online outreach	Condom use for casual acts	TGW, MSM2 25-49	52%	52%	55%	55%
Online outreach	Condom use for casual acts	MSM1 15-24, TGW	61%	61%	64%	64%
Online outreach	Condom use for casual acts	MSM1 25-49, TGW	61%	61%	64%	64%
Online outreach	Condom use for casual acts	MSM2 15-24, TGW	52%	52%	55%	55%
Online outreach	Condom use for casual acts	MSM2 25-49, TGW	52%	52%	55%	55%
Online outreach	Condom use for casual acts	TGW, MSM1 15-24	61%	61%	64%	64%
Online outreach	Condom use for casual acts	TGW, MSM1 25-49	61%	61%	64%	64%
Online outreach	Condom use for casual acts	TGW, MSM2 15-24	52%	52%	55%	55%
Online outreach	Condom use for casual acts	TGW, MSM2 25-49	52%	52%	55%	55%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM1 15-24	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM1 25-49	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM2 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM2 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 15-24, TGW	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM1 15-24	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM1 25-49	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM2 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM2 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 25-49, TGW	61%	61%	87%	87%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM1 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM1 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM1 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM1 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	TGW, MSM1 15-24	61%	61%	88%	88%

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	Condom use for casual acts	TGW, MSM1 25-49	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM2 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 15-24, MSM2 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM2 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM1 25-49, MSM2 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM1 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM1 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM2 15-24	42%	42%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, MSM2 25-49	42%	42%	70%	70%
MSM programs	Condom use for casual acts	MSM2 15-24, TGW	52%	52%	79%	79%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM1 15-24	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM1 25-49	52%	52%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM2 15-24	42%	42%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, MSM2 25-49	42%	42%	70%	70%
MSM programs	Condom use for casual acts	MSM2 25-49, TGW	52%	52%	79%	79%
MSM programs	Condom use for casual acts	TGW, MSM2 15-24	52%	52%	79%	79%
MSM programs	Condom use for casual acts	TGW, MSM2 25-49	52%	52%	79%	79%
MSM programs	Condom use for casual acts	MSM1 15-24, TGW	61%	61%	88%	88%
MSM programs	Condom use for casual acts	MSM1 25-49, TGW	61%	61%	87%	87%
MSM programs	Condom use for casual acts	MSM2 15-24, TGW	52%	52%	79%	79%
MSM programs	Condom use for casual acts	MSM2 25-49, TGW	52%	52%	79%	79%
MSM programs	Condom use for casual acts	TGW, MSM1 15-24	61%	61%	88%	88%
MSM programs	Condom use for casual acts	TGW, MSM1 25-49	61%	61%	88%	88%
MSM programs	Condom use for casual acts	TGW, MSM2 15-24	52%	52%	79%	79%
MSM programs	Condom use for casual acts	TGW, MSM2 25-49	52%	52%	79%	79%
FSW programs	Condom use for commercial acts	Clients, FSW	45%	45%	95%	95%
FSW programs	Condom use for commercial acts	MSM2 15-24, FSW	45%	45%	90%	90%
FSW programs	Condom use for commercial acts	MSM2 25-49, FSW	45%	45%	90%	90%

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	Condom use for commercial acts	MSM1 15-24, MSM1 15-24	50%	50%	68%	68%
MSM programs	Condom use for commercial acts	MSM1 15-24, MSM2 15-24	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM1 15-24, TGW	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	MSM1 25-49, MSM1 25-49	50%	50%	75%	75%
MSM programs	Condom use for commercial acts	MSM1 25-49, MSM2 25-49	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM1 25-49, TGW	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	MSM2 15-24, MSM1 15-24	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM2 25-49, MSM1 25-49	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	TGW, MSM1 15-24	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM1 25-49	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	MSM1 15-24, MSM2 15-24	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM1 25-49, MSM2 25-49	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM2 15-24, MSM1 15-24	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM2 15-24, TGW	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	MSM2 25-49, MSM1 25-49	48%	48%	65%	65%
MSM programs	Condom use for commercial acts	MSM2 25-49, TGW	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM2 15-24	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM2 25-49	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	MSM1 15-24, TGW	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	MSM1 25-49, TGW	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	MSM2 15-24, TGW	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	MSM2 25-49, TGW	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM1 15-24	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM1 25-49	50%	50%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM2 15-24	48%	48%	78%	78%
MSM programs	Condom use for commercial acts	TGW, MSM2 25-49	48%	48%	78%	78%
HTS	HIV testing rate (per year)	Clients	1%	1%	58%	58%
HTS	HIV testing rate (per year)	F0-14	0%	0%	0%	0%
HTS	HIV testing rate (per year)	M0-14	0%	0%	0%	0%

HIV program	Parameter	Population interactions or population	In absence of any programs		For each individual reached by this program	
			Low	High	Low	High
HTS	HIV testing rate (per year)	F15-19	1%	1%	4%	4%
HTS	HIV testing rate (per year)	M15-19	1%	1%	1%	1%
HTS	HIV testing rate (per year)	F20-24	2%	2%	49%	49%
HTS	HIV testing rate (per year)	M20-24	2%	2%	2%	2%
HTS	HIV testing rate (per year)	F25-49	1%	1%	69%	69%
HTS	HIV testing rate (per year)	M25-49	1%	1%	40%	40%
HTS	HIV testing rate (per year)	F50+	0%	0%	23%	23%
HTS	HIV testing rate (per year)	M50+	0%	0%	15%	15%
Innovative testing	HIV testing rate (per year)	MSM1 15-24	2%	2%	65%	65%
Innovative testing	HIV testing rate (per year)	MSM1 25-49	4%	4%	65%	65%
Innovative testing	HIV testing rate (per year)	MSM2 15-24	1%	1%	65%	65%
Innovative testing	HIV testing rate (per year)	MSM2 25-49	2%	2%	65%	65%
Innovative testing	HIV testing rate (per year)	TGW	2%	2%	65%	65%
Online outreach	HIV testing rate (per year)	MSM1 15-24	2%	2%	9%	9%
Online outreach	HIV testing rate (per year)	MSM1 25-49	4%	4%	7%	7%
Online outreach	HIV testing rate (per year)	MSM2 15-24	1%	1%	7%	7%
Online outreach	HIV testing rate (per year)	MSM2 25-49	2%	2%	5%	5%
Online outreach	HIV testing rate (per year)	TGW	2%	2%	6%	6%
FSW programs	HIV testing rate (per year)	FSW	4%	4%	10%	10%
MSM programs	HIV testing rate (per year)	MSM1 15-24	2%	2%	7%	7%
MSM programs	HIV testing rate (per year)	MSM1 25-49	4%	4%	12%	12%
MSM programs	HIV testing rate (per year)	MSM2 15-24	1%	1%	6%	6%
MSM programs	HIV testing rate (per year)	MSM2 25-49	2%	2%	8%	8%
MSM programs	HIV testing rate (per year)	TGW	2%	2%	10%	10%
PrEP	Proportion of exposure events covered by PrEP	MSM1 15-24	1%	1%	100%	100%
PrEP	Proportion of exposure events covered by PrEP	MSM1 25-49	1%	1%	100%	100%
PrEP	Proportion of exposure events covered by PrEP	TGW	1%	1%	25%	25%

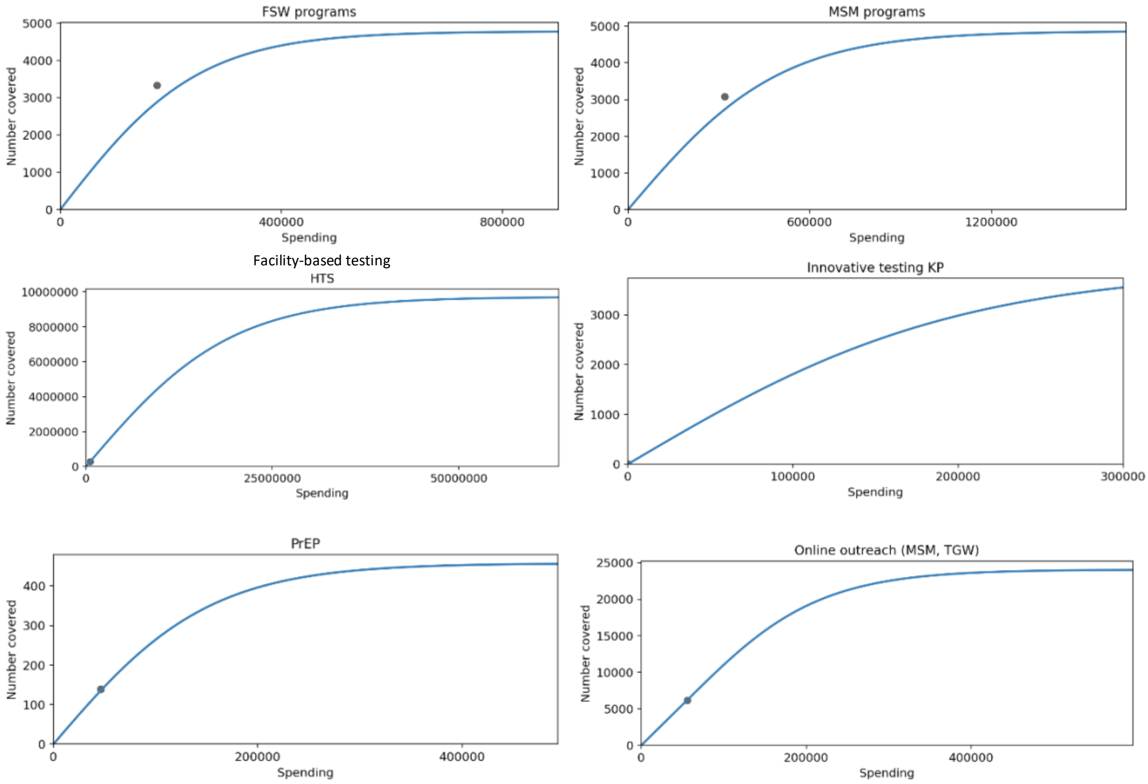
Notes: FSW, female sex worker; HTS, HIV testing services (facility-based); MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; TGW, transgender women

Source: Optima HIV Mongolia, 2023

E.4 Cost functions

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

Figure E2. Cost functions for HIV programs in Mongolia



Appendix F. Optimisation results - annual HIV budget allocations at varying budgets

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

Programs	Baseline	Optimized spending 50%	Optimized spending 90%	Optimized spending 100%	Optimized spending 100% with innovative testing	Optimized spending 150%	Optimized spending 200%	Optimized spending 200% with innovative testing
Facility-based HIV testing	$553,700	$0	$276,900	$276,900	$276,900	$276,900	$724,000	$276,900
HIV prevention and testing programs for female sex workers	$174,600	$184,700	$234,200	$272,600	$243,000	$441,500	$460,600	$534,100
HIV prevention and testing programs for men who have sex with men[1]	$318,600	$227,500	$325,100	$390,900	$190,500	$659,900	$761,500	$641,600
PrEP	$46,200	$105,400	$145,500	$163,400	$106,400	$271,000	$250,000	$291,300
Online outreach (MSM, TGW)	$55,700	$56,700	$52,200	$44,900	$34,300	$73,900	$101,400	$61,100
Innovative testing strategies (MSM, TGW)	$0	$0	$0	$0	$297,600	$0	$0	$492,600
Total	**$1,148,800**	**$574,400**	**$1,033,900**	**$1,148,800**	**$1,148,800**	**$1,723,100**	**$2,297,500**	**$2,297,500**

Notes: All values rounded to nearest 100. MSM, men who have sex with men; PrEP, pre-exposure prophylaxis; TGW, transgender women; 1, Program also reaches small numbers of transgender women.

Source: Optima HIV Mongolia, 2023