

Resource optimization to maximize the HIV response in Moldova

Executive summary

In order to maintain the HIV response in Eastern Europe and Central Asia it is imperative to ensure that national HIV programs continue to be sustainably financed. Continued commitment by national governments to finance the HIV the response is critical. Moreover, with planned transition away from donor support, there will be increased demand on domestic fiscal investment. As such it is vital to make cost-effective funding allocations decisions to maximize impact. An allocative efficiency modeling analysis was conducted through partnership with the Moldovan Government, the Global Fund, UNAIDS, and the Burnet Institute. The Optima HIV model was applied to estimate the optimized resource allocation across a mix of HIV programs. It is anticipated that recommendations from this analysis, as summarized below, will inform subsequent National Strategic Plans and Global Fund funding applications.

Key recommendations for HIV resource optimization include:

- **Scaling up antiretroviral therapy (ART)**, which could lead to increased treatment coverage of people diagnosed with HIV from 58% (status quo) to 79% (optimized) in 2019, with high coverage levels maintained to 2030.
- **Scaling up investment for HIV testing and prevention programs targeting female sex workers (FSW)**. At 100% optimized budget, results suggest scaling up investment for HIV testing and prevention programs targeting FSW, given that over 30% of new HIV infections in Moldova are estimated to have occurred among FSW in 2018. Should additional resources become available, investment in FSW programs should continue to be scaled-up.
- **Scaling up investment for HIV testing and prevention programs targeting men who have sex with men (MSM)**. At 100% optimized budget, results suggest scaling up investment for HIV testing and prevention programs targeting MSM, with continued increases in investment in MSM programs, should additional resources become available.

Given relatively low new HIV infections among the general population, it is **not recommended to prioritize HIV investment towards the general population at the latest reported budget level**, but rather to target limited funds towards key populations at higher risk of acquiring and transmitting HIV.



Background

Moldova's HIV epidemic continues to be concentrated among key populations, mainly among people who inject drugs (PWID), with an increasing contribution from sex workers (SW) and men who have sex with men (MSM). In 2016, IBBS surveys indicated an HIV prevalence of 12.6% among PWID, 7.7% among MSM, and 6.1% among FSW.¹ While there is limited data for the left and right bank regions of Moldova, national statistics suggest HIV prevalence is significantly higher in the left bank region, at around 563 per 100,000, compared to 240 in the right bank.²

At the national level, the HIV/AIDS program in Moldova is implemented through the 2017–2020 National Programme on Prevention and Control of HIV/AIDS and STI (NAP). Global Fund investment will support the achievement of targets described in the 2017–2020 NAP.³ Development of the transition and sustainability plans for the HIV response in Moldova and the Transnistrian region by all national stakeholders, guided by the coordination unit of the National Programme will support Moldova's HIV financing plans beyond Global Fund investment.⁴

Over the 2014-2015 period, an HIV allocative efficiency analysis was conducted using the Optima HIV model with support from the World Bank, UNAIDS, the Global Fund, and other partners. Since then, following on recommendations from the 2014-2015 analysis, there have been significant improvements in the adoption of updated HIV testing and treatment protocols, reductions in treatment costs, updated epidemiological values, and improvements in service delivery leading to cost savings. Following on from this initial study, an updated allocative efficacy modeling analysis was conducted to estimate the optimal allocation of HIV resources based on latest reported values. Analyses have been conducted for the left bank and the right bank separately with findings described separately for each bank as well as at the national level as shown below.

Objectives

1. Given 2015-2017 resource allocation, how many new HIV infections, HIV-related deaths, and HIV-related DALYs (comparable to QALYs saved) are estimated to have been averted through HIV program implementation?
2. What is the optimized resource allocation to minimize HIV infections and HIV-related deaths by 2030 under optimized varying budget levels?
3. What is the optimized HIV resource allocation for best achieving the 90-90-90 and 95-95-95 targets by 2020 and by 2030, respectively, and what are the minimum levels of resources required for best achieving these targets?

Methodology

An allocative efficacy modeling analysis was undertaken in collaboration with the HIV program of Moldova. Epidemiological and program data was provided by the Moldova country team and validated during a regional workshop that was held July 2019 in Kiev, Moldova. Country teams were consulted before and after the workshop on data collation and validation, objective and scenario building, and results validation. Demographic, epidemiological, behavioural, programmatic, and expenditure data from various sources including UNAIDS Global AIDS Monitoring and National AIDS Spending Assessment reports, Integrated bio-behavioural surveillance surveys, national reports and systems, as well as from other sources were collated. This allocative efficacy analysis was conducted using Optima HIV, an epidemiological model of HIV transmission overlaid with a programmatic component and a

resource optimization algorithm. A more detailed description of the Optima HIV model has been published by Kerr et al.⁵

Populations and HIV programs modeled

Populations considered in this analysis were:

- Key populations
 - Female sex workers (FSW)
 - Clients of female sex workers (Clients)
 - Men who have sex with men (MSM)
 - Males who inject drugs (MWID)
 - Females who inject drugs (FWID)
- General populations
 - Males 0-14 (M0-14)
 - Females 0-14 (F0-14)
 - Males 15-49 (M15-49)
 - Females 15-49 (F15-49)
 - Males 50+ (M50+)
 - Females 50+ (F50+)

HIV programs considered in this analysis:

- Antiretroviral therapy (ART)
- Condoms and social and behaviour change communication (Condoms and SBCC)
- HIV testing and prevention targeting MSM
- HIV testing and prevention targeting FSW
- HIV testing services (HTS) for the general population
- Needle and syringe program (NSP)
- Prevention of mother-to-child transmission (PMTCT)
- Opiate substitution therapy (OST)

Model constraints

Within the optimization analyses, no one on treatment, including ART, PMTCT, and OST, can be removed from treatment, unless by natural attrition.

Model weightings

Objective weightings to minimize new HIV infections and HIV-related deaths by 2030 were weighted as 1 to 1 for infections to deaths.

Findings

Objective 1. Given 2015-2017 resource allocation, how many new HIV infections, HIV-related deaths, and HIV-related DALYs are estimated to have been averted through HIV program implementation?

To estimate the impact of past HIV spending on the status of HIV in Moldova, all spending on targeted HIV programs (non-targeted HIV program spending was not considered) was removed from 2015 to 2017, representing the previous Global Fund funding cycle period. This was compared with actual program spending over the same period. This is referred to as the baseline scenario.

Results suggests that past investment had an important impact on the HIV response. Had the HIV program not been implemented from 2015 to 2017, by 2018 it is estimated that there could have been over 80% more new HIV infections (almost 2,100 more HIV infections) and almost 100% more HIV-related deaths (approximately 1,600 more HIV-related deaths) over this period (figure 1). The total annual spending of the HIV program in 2018 amounted to US\$9.1M, of which the estimated share of Global Fund contribution was 50%.

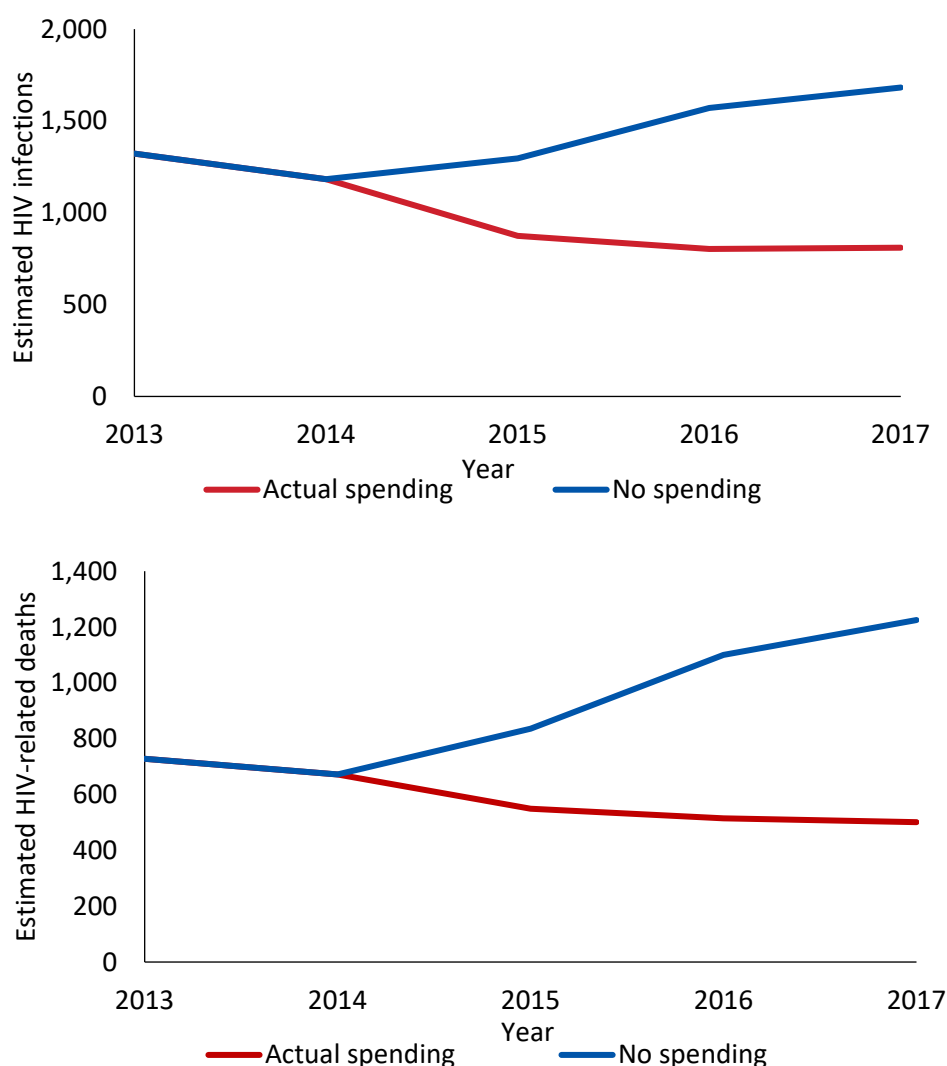


Figure 1. Estimated new HIV infections and HIV-related deaths in the absence of HIV program spending from 2015 to 2017

Objective 2. What is the optimized resource allocation to minimize HIV infections and HIV-related deaths by 2030 under varying budget levels?

Moldova has a latest reported HIV program budget of US\$9.1M in 2018 with approximately 22% of the overall budget invested in non-targeted HIV programs (figures 2 and 3). As non-targeted HIV programs are not considered within the optimization, budgets for these programs are fixed. Optimization at the national level and separately for the right and left banks results suggest scaling up ART (figures 2 and 3; tables A7-A9). This prioritization could lead to increased treatment coverage from 58% (status quo) to 79% (optimized) in 2019 at the national level with high coverage levels maintained to 2030.

At 100% optimized budget, results suggest scaling up investment for HIV testing and prevention programs targeting FSW (figures 2 and 3; table A7), given that over 30% of new HIV infections in Moldova are estimated to have occurred among FSW in 2018 at the national level. FSW programs should also be prioritized for the right bank at 100% optimized budget. Should additional resources become available, investment in FSW programs should continue to be scaled-up at the national level and for the right bank (figure 2; tables A7-A8). HIV testing and prevention programs targeting MSM should be scaled up at the 100% budget level and continue to be scaled up as additional resources become available at the national level and for the right bank (figure 2; table A7-A8) and for the left bank if the budget were to be doubled to 200% (table A9).

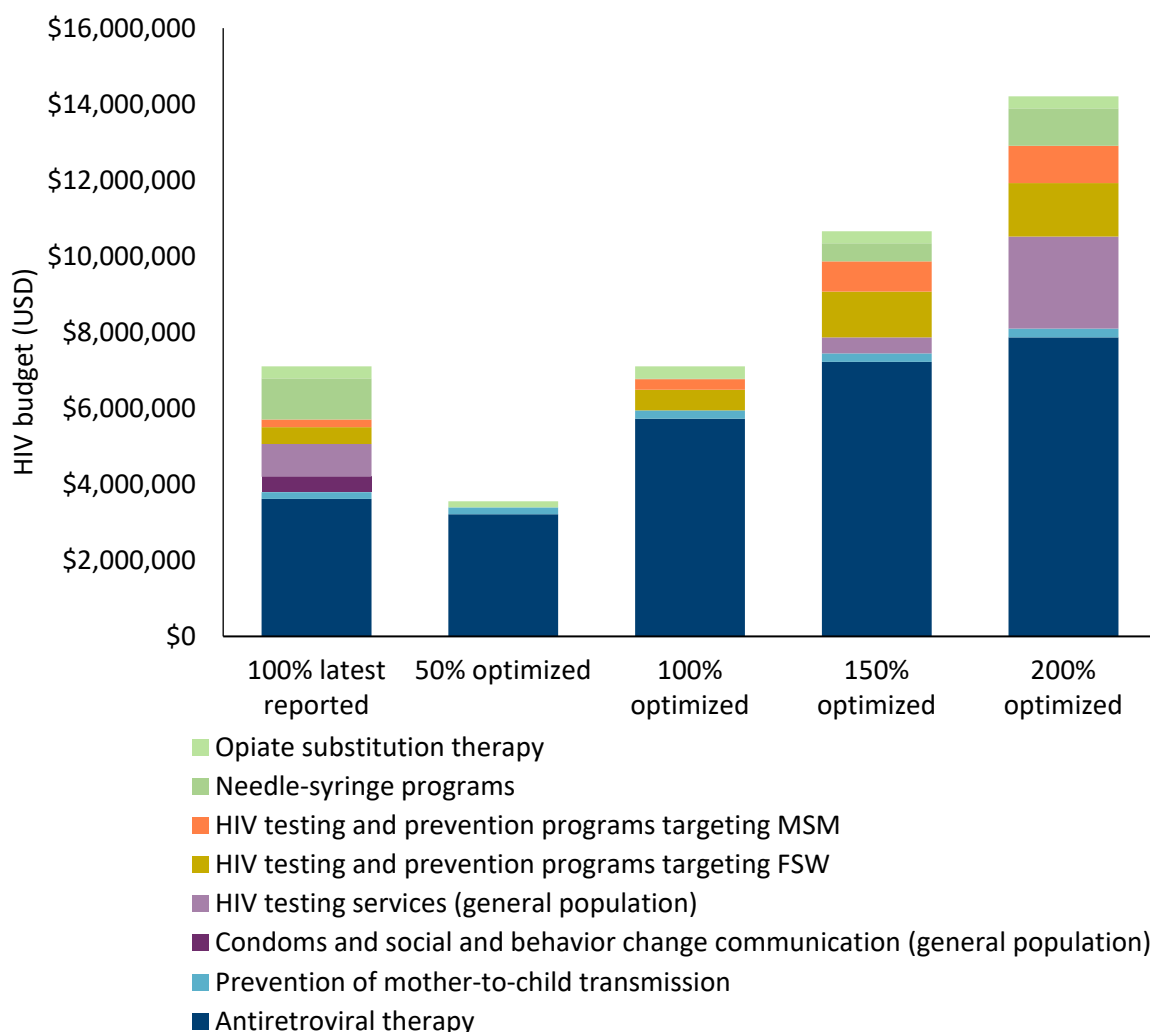
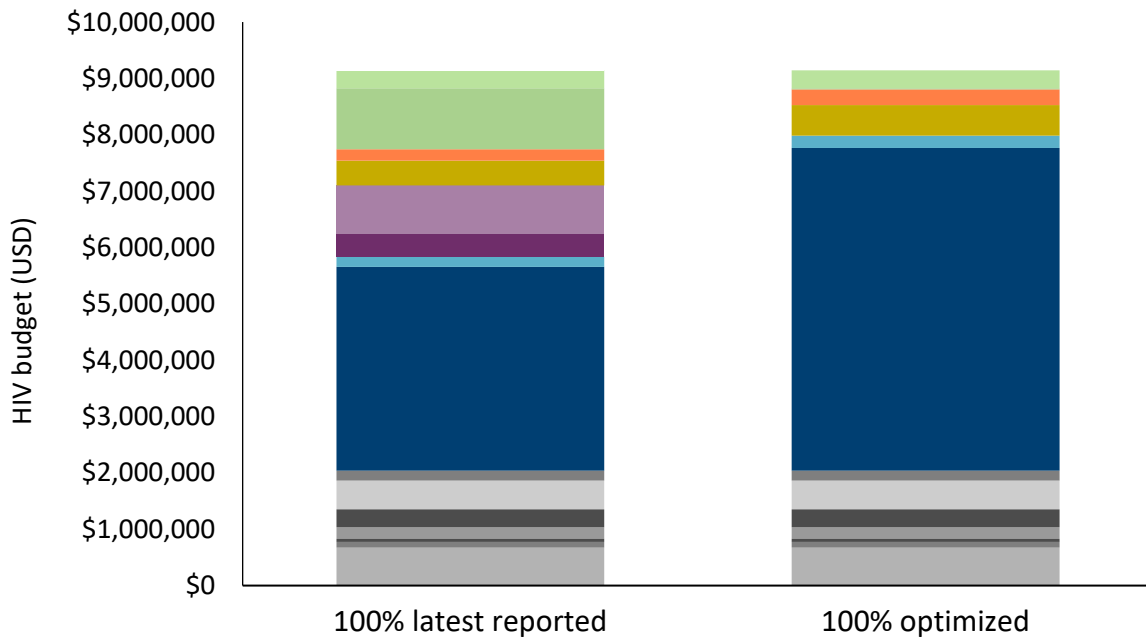


Figure 2. Optimized allocations under varying levels of annual HIV budgets for 2019 to 2030, to minimize new HIV infections and HIV-related deaths by 2030.



- Targeted HIV spending**
- Opiate substitution therapy
 - Needle-syringe programs
 - HIV testing and prevention programs targeting MSM
 - HIV testing and prevention programs targeting FSW
 - HIV testing services (general population)
 - Condoms and social and behavior change communication (general population)
 - Prevention of mother-to-child transmission
 - Antiretroviral therapy
- Non targeted HIV spending**
- Orphans and vulnerable children
 - Other HIV costs
 - Other HIV care
 - Management
 - Monitoring and evaluation
 - Infrastructure
 - Enabling environment

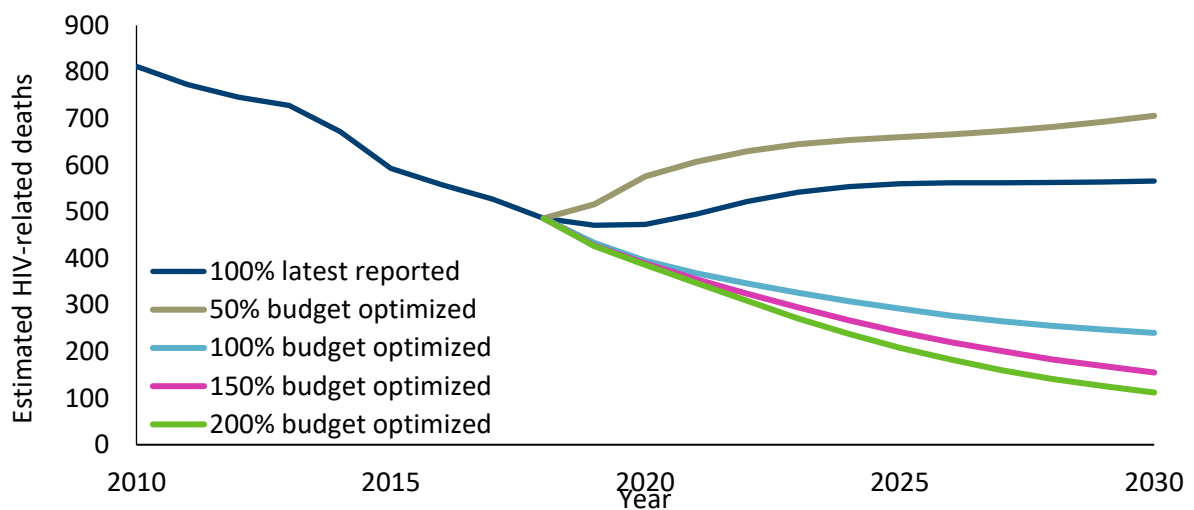
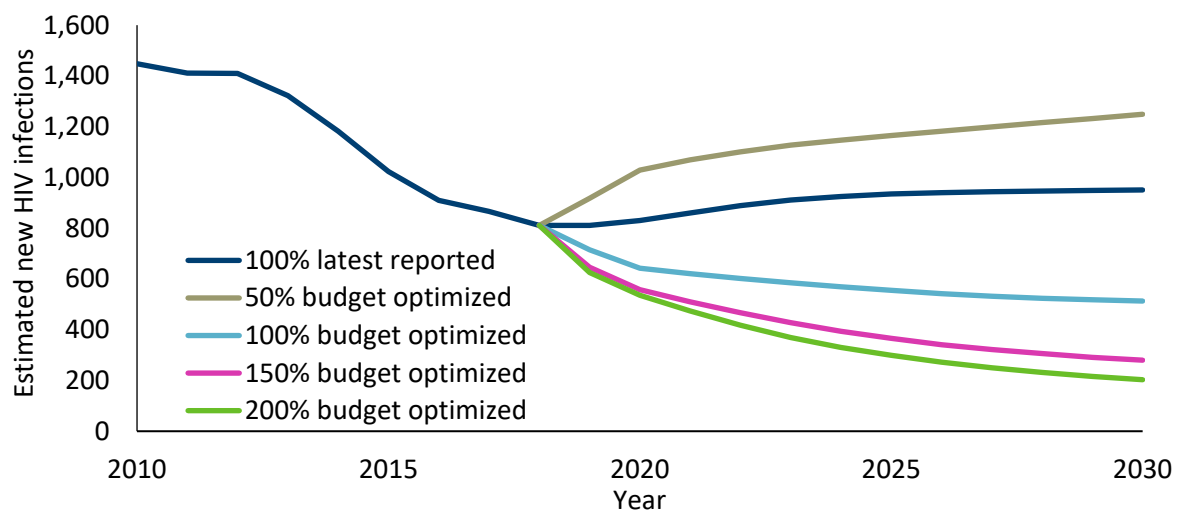
Figure 3. Optimized HIV annual resource allocation, 2019 to 2030 to minimize new infections and HIV-related deaths by 2030. Non-targeted HIV program budgets are shown here but are not considered within the optimization.

For the left bank, the needle-syringe program (NSP) should be prioritized if at least 150% budget were to become available, following optimization budget allocation recommendations. It should be noted that no spending was reported for opiate substitution therapy (OST) for Moldova’s left bank, as such NSP is the only program in reported to be in operation specifically targeting people who inject drugs in this region for analysis purposes.

Under 100% optimized annual budget to minimize new HIV infections and HIV-related deaths from 2019 to 2030, it is estimated that by 2030 an additional 30% of new HIV infections could be averted (3,000 more infections averted) and 35% more HIV-related deaths could be averted (2,000 more

deaths averted) compared with the latest reported allocation being maintained over the same period (figure 4). By 2030, an additional 55,000 DALYs could be averted under an optimized budget allocation.

If the budget were doubled to 200% and the allocation optimized, it is estimated that by 2030 new HIV infections could be reduced by an additional 60% (6,700 more infections averted), HIV-related deaths by 55% (3,500 more deaths averted), and HIV-related DALYs by 50% (89,000 more DALYs averted) compared with latest reported allocation of 100% budget (figure 4). It is estimated that investment beyond 270% will only have a very marginal impact on reducing HIV infections and deaths given the current mix of programs, as programs will reach set saturation levels, estimated as 95% of the maximum achievable reduction in infections and deaths in 2030 compared to 2018 levels (table A10).



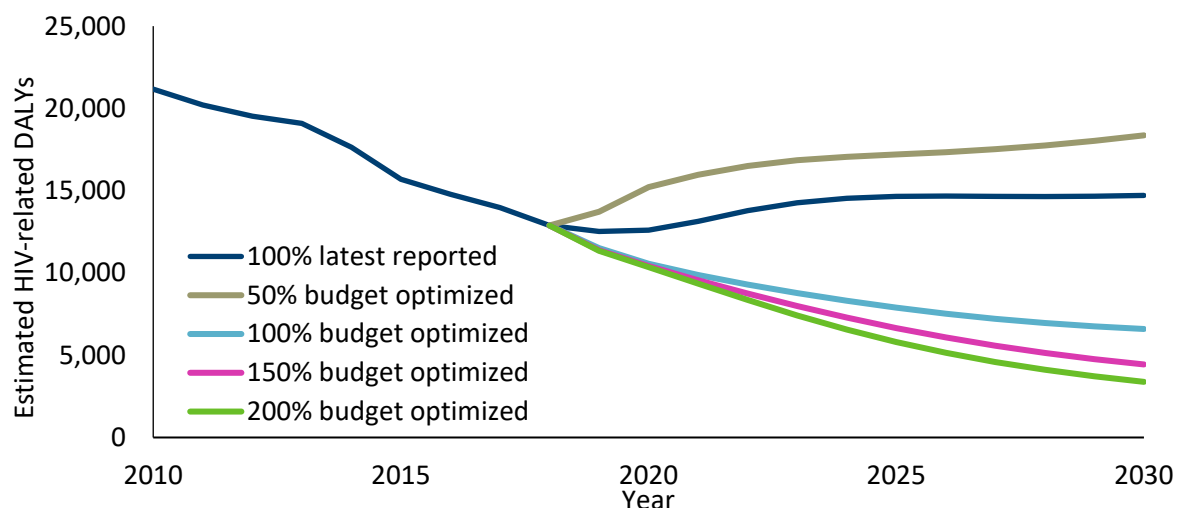


Figure 4. Estimated new HIV infections, HIV-related deaths, and HIV-related DALYs under optimized varying annual budget levels 2019 to 2030 to minimize infections and deaths by 2030

Objective 3. What is the optimized HIV resource allocation for best achieving the 90-90-90 and 95-95-95 targets by 2020 and 2030, respectively, and what are the minimum levels of resources required for best achieving these targets?

Under latest reported budget, it is estimated that by 2020, 62% of people living with HIV will be diagnosed, 55% of those diagnosed will receive treatment, and 96% of those on treatment will achieve viral suppression (figure 5). Even with an increased budget, optimization results suggest that 90-90-90 targets will not be met by 2020, as this is such a short timeframe.

To approach 95-95-95 targets, it is estimated that the annual HIV program budget from 2019 to 2030 should be increased to 230% of the latest reported budget level (an additional \$9.4M annually) and optimized with prioritization of antiretroviral therapy (ART), HIV testing services (general population), HIV testing and prevention programs targeting FSW and MSM (figure 6). By 2030, this could allow Moldova to have 93% of people living with HIV being aware of their status, 95% of those diagnosed on treatment, and 95% of those on treatment having achieved viral suppression (figure 5).

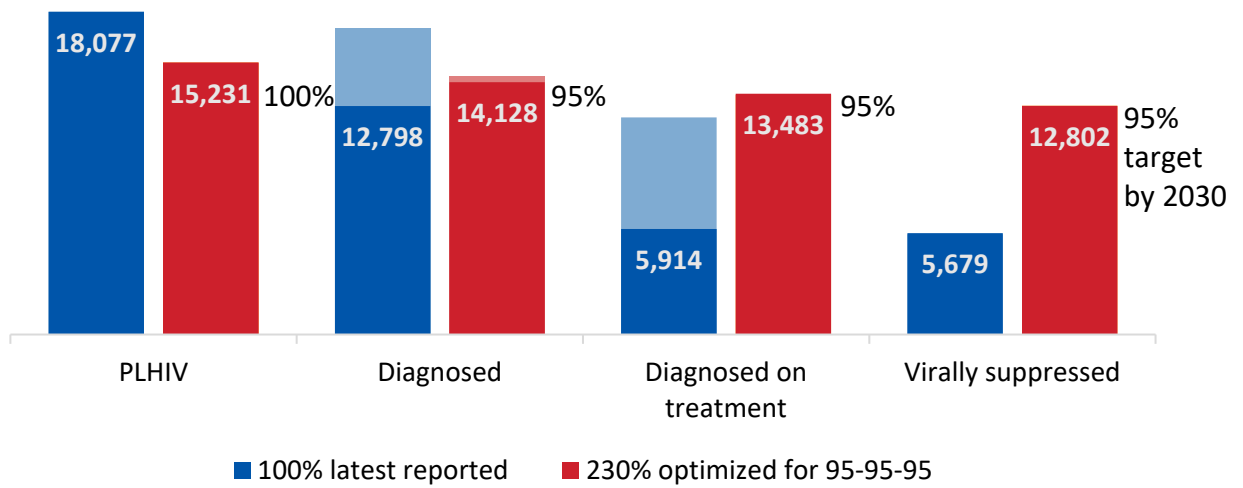


Figure 5. HIV cascade under optimized resource allocation to best achieve 95-95-95 targets by 2030. Dark blue bars represent progress towards 95-95-95 targets under 100% latest reported budget, with light blue bars showing the gap to achieving targets. Red bars represent progress towards 95-95-95 targets under 230% optimized resource allocation to best achieve 95-95-95 targets, with light red bars showing the gap to achieving targets.



Figure 6. Optimized HIV budget level and allocation to best achieve 95-95-95 targets by 2030. Compared with latest reported 100% budget allocation, by 2030 under optimized allocation of 230% budget towards achieving 95-95-95 targets it is estimated that an additional 65% of new HIV infections could be averted (approximately 7,000 more infections averted) and 60% of HIV-related deaths could be averted (approximately 3,800 more deaths averted) (figure 8).

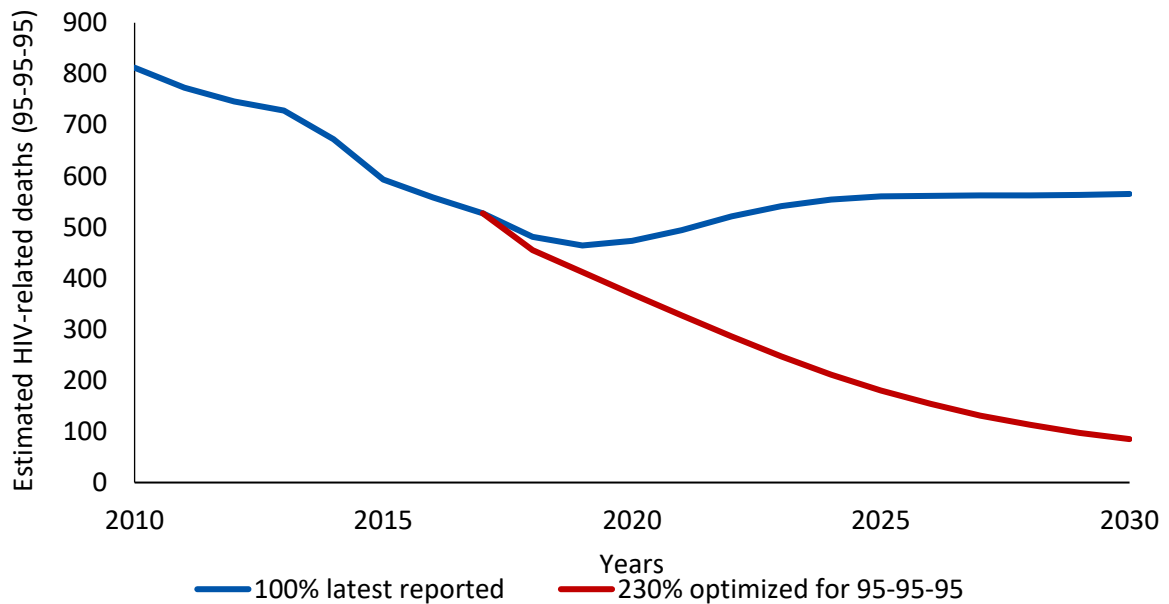
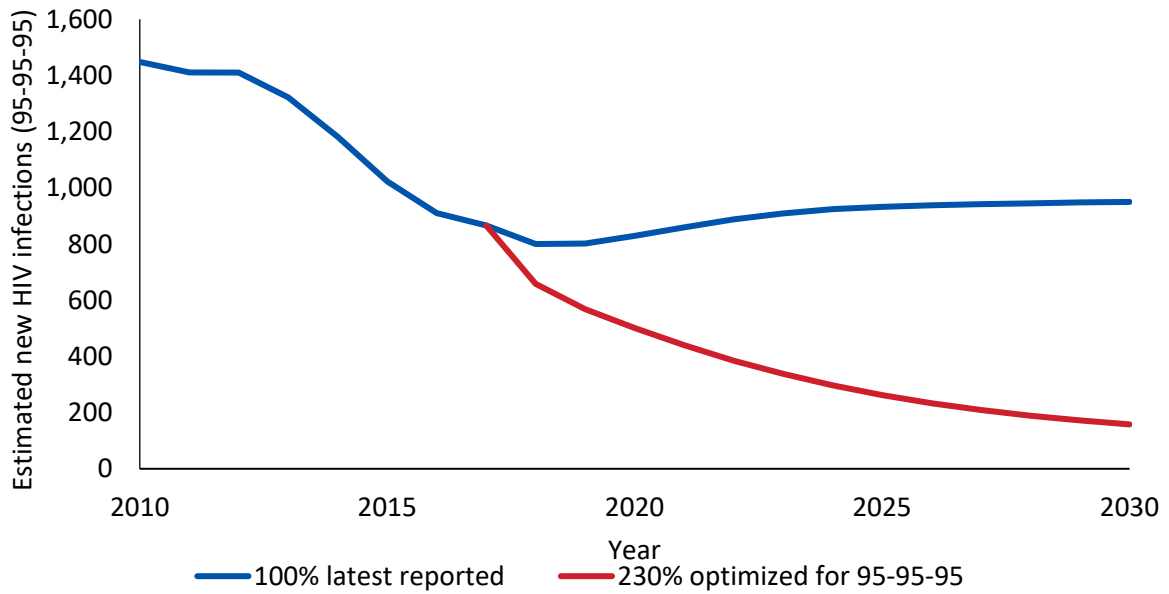


Figure 8. Estimated new HIV infections and HIV-related deaths under optimized allocation towards best achieving 95-95-95 targets by 2030

Study limitations

As with any modelling study, there are limitations that should be considered when interpreting results and recommendations from this analysis. First, limitations in data availability and reliability can lead to uncertainty surrounding projected results. Although the model optimization algorithm accounts for inherent uncertainty, it might not be possible to account for all aspects of uncertainty because of poor quality or insufficient data, particularly for cost and coverage values informing cost functions. Coupled with epidemic trends, cost functions are a primary factor in modeling optimized resource allocations. Second, we used contextual values and expert opinion where available, otherwise evidence from systematic reviews of clinical and research studies were used to inform model assumptions. Lastly, we did not capture the effects of migration of on the HIV epidemic.

Conclusions

The results of this allocative efficiency modeling analysis demonstrate the impact that an optimized resource allocation across a mix of HIV programs can have on reducing infections and deaths. The purpose of this modelling analysis was to evaluate the allocative efficiency of core HIV programs. However, additional gains could be achieved through improving technical or implementation efficiency. In addition, 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. These elements have not been explicitly dealt with in this analysis.

References

1. Integrated Biological-Behavioural Surveillance Survey of Moldova, the Government of the Republic of Moldova, 2017.
2. Moldova progress report, Global AIDS Monitoring 2018. UNAIDS, 2018.
3. National Programme on Prevention and Control of HIV/AIDS and STI for 2016–2020 (NAP), The Government of the Republic of Moldova, 2016.
4. The Global Fund Country Portfolio – Moldova, The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2019.
5. Kerr CC, Stuart RM, Gray RT, Shattock AJ, Fraser-Hurt N, Benedikt C, et al. Optima: A model for HIV epidemic analysis, program prioritization, and resource optimization. *JAIDS*, 2015;69(3):365-76.

Appendices

Appendix 1. Model parameters

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

Interaction-related transmissibility (% per act)	
Insertive penile-vaginal intercourse	0.04%
Receptive penile-vaginal intercourse	0.08%
Insertive penile-anal intercourse	0.09%
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)	0.30
CD4 (500) to CD4 (350-500)	1.11
CD4 (350-500) to CD4 (200-350)	3.10
CD4 (200-350) to CD4 (50-200)	3.90
CD4 (50-200) to CD4 (<50)	1.90
Changes in transmissibility (%)	
Condom use	95%
Circumcision	58%
Diagnosis behavior change	0%
STI cofactor increase	265%
Opiate substitution therapy	54%
PMTCT	90%
Pre-exposure prophylaxis	73%
Unsuppressive ART	50%
Suppressive ART	92%
Disutility weights	
Untreated HIV, acute	0.15
Untreated HIV, CD4 (>500)	0.01
Untreated HIV, CD4 (350-500)	0.02
Untreated HIV, CD4 (200-350)	0.07
Untreated HIV, CD4 (50-200)	0.27
Untreated HIV, CD4 (<50)	0.55
Treated HIV	0.05

Source: [Optima HIV User Guide Volume VI Parameter Data Sources](#)

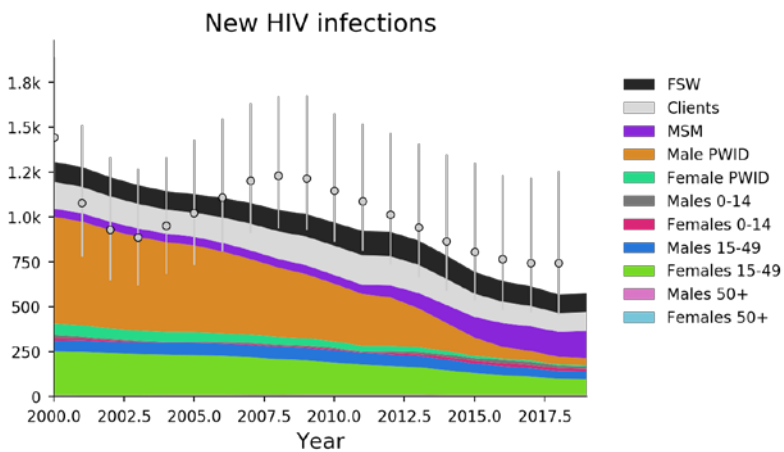
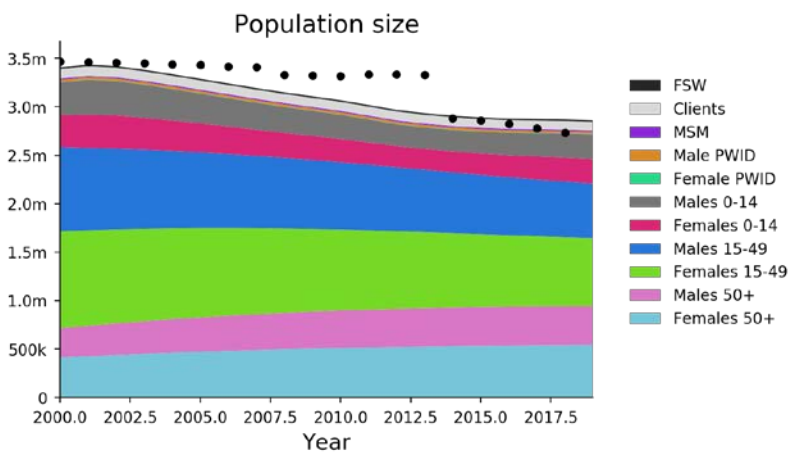
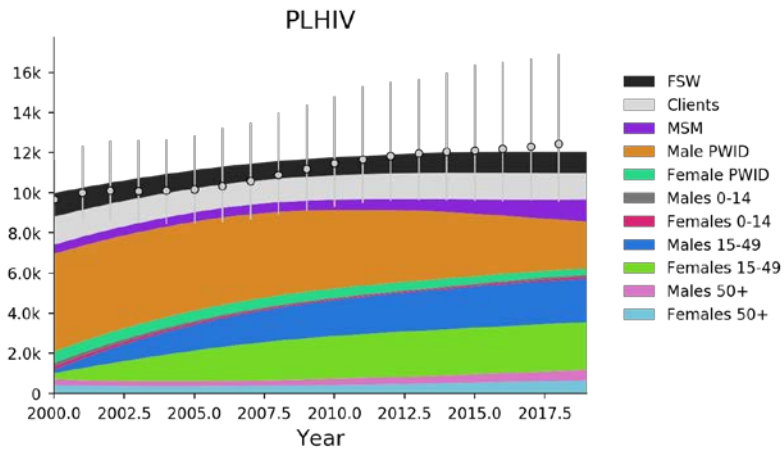
Table A2. Model parameters: treatment recovery and CD4 changes due to ART, and death rates

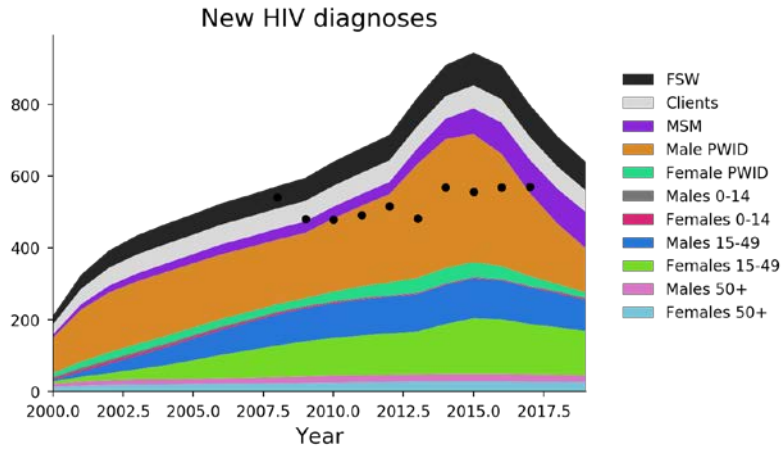
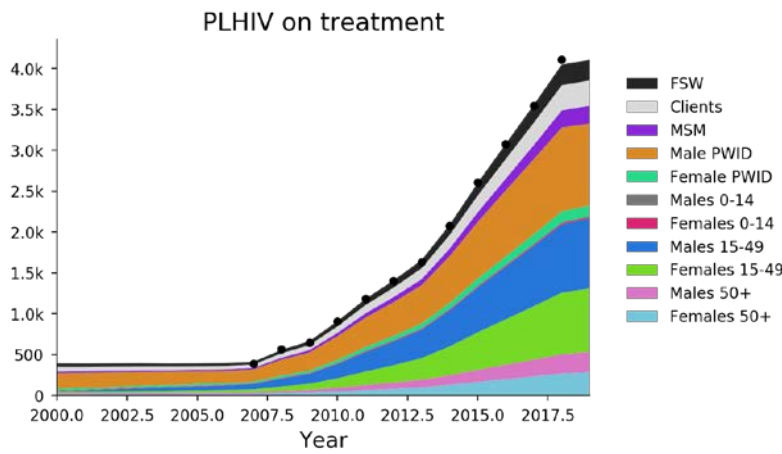
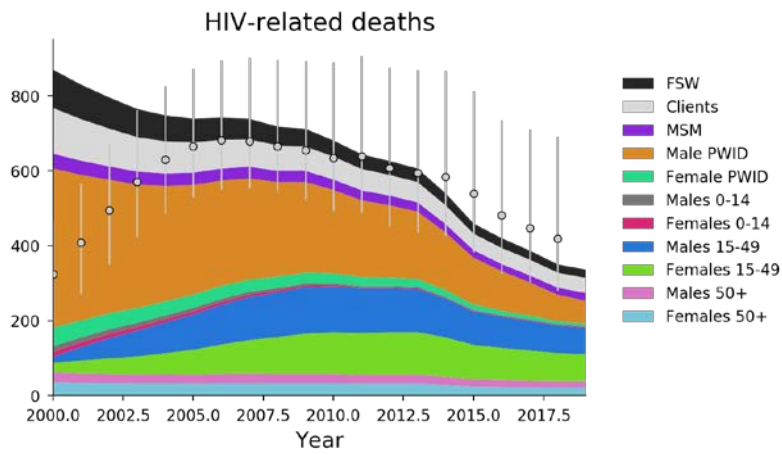
Treatment recovery due to suppressive ART (average years to move)	
CD4 (350-500) to CD4 (>500)	2.20
CD4 (200-350) to CD4 (350-500)	1.42
CD4 (50-200) to CD4 (200-350)	2.14
CD4 (<50) to CD4 (50-200)	0.66
Time after initiating ART to achieve viral suppression (years)	0.20
Number of VL tests recommended per person per year	2.00
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 (% mortality per year)	
Acute infection	0%
CD4 (>500)	0%
CD4 (350-500)	1%
CD4 (200-350)	1%
CD4 (50-200)	8%
CD4 (<50)	43%
Relative death rate on suppressive ART	30%
Relative death rate on non-suppressive ART	70%
Tuberculosis cofactor	217%

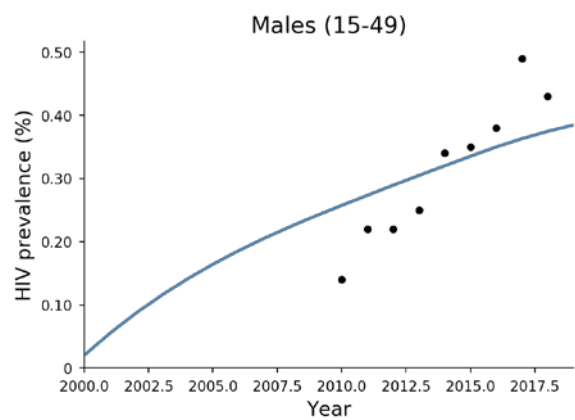
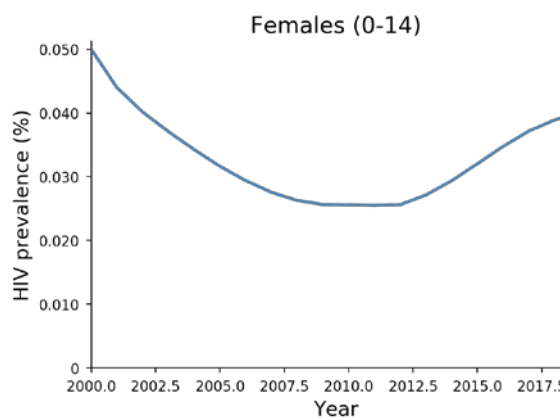
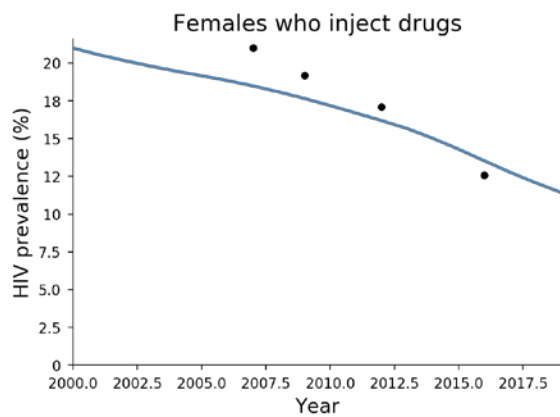
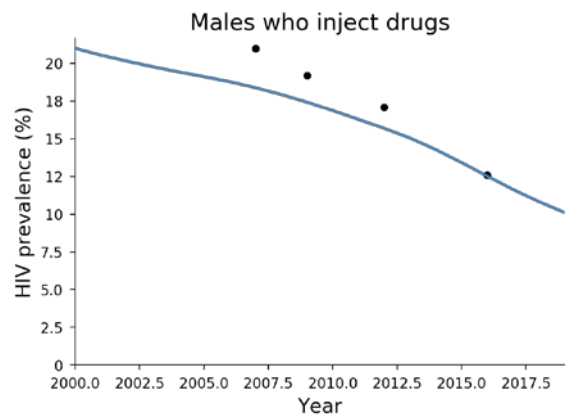
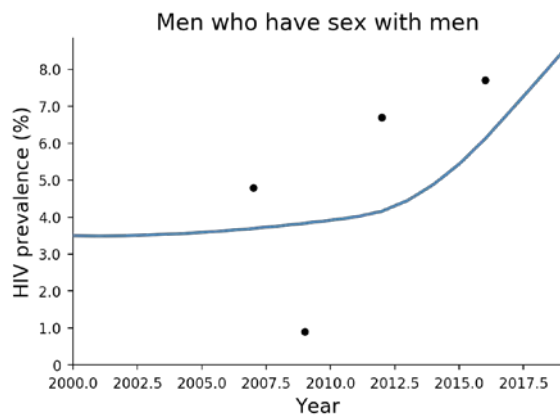
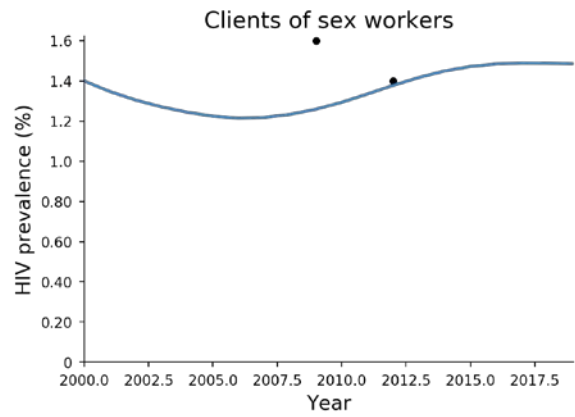
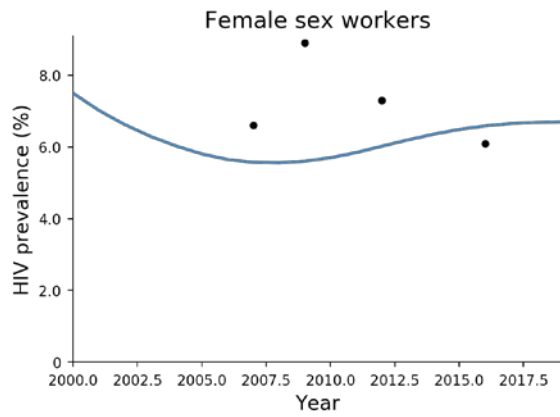
Source: [Optima HIV User Guide Volume VI Parameter Data Sources](#)

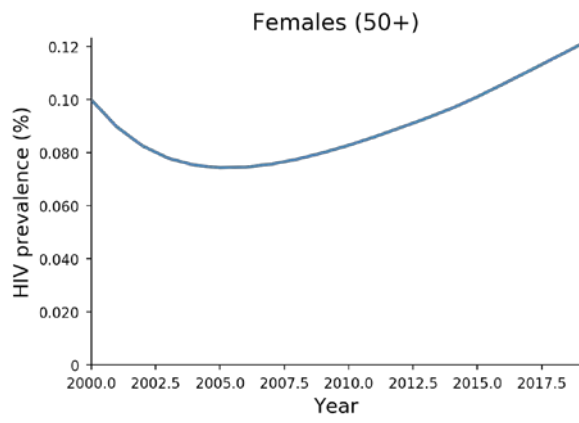
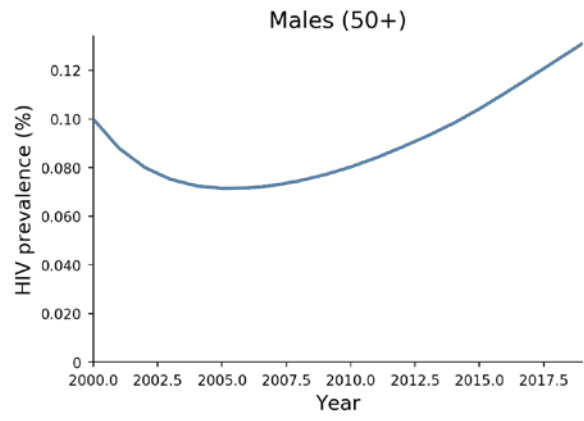
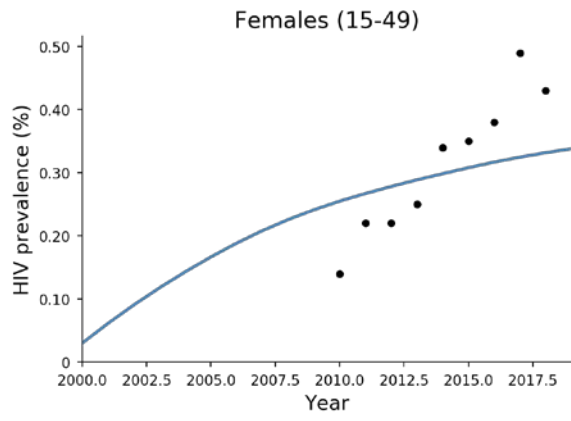
Appendix 2. Model calibration

Moldova Right bank

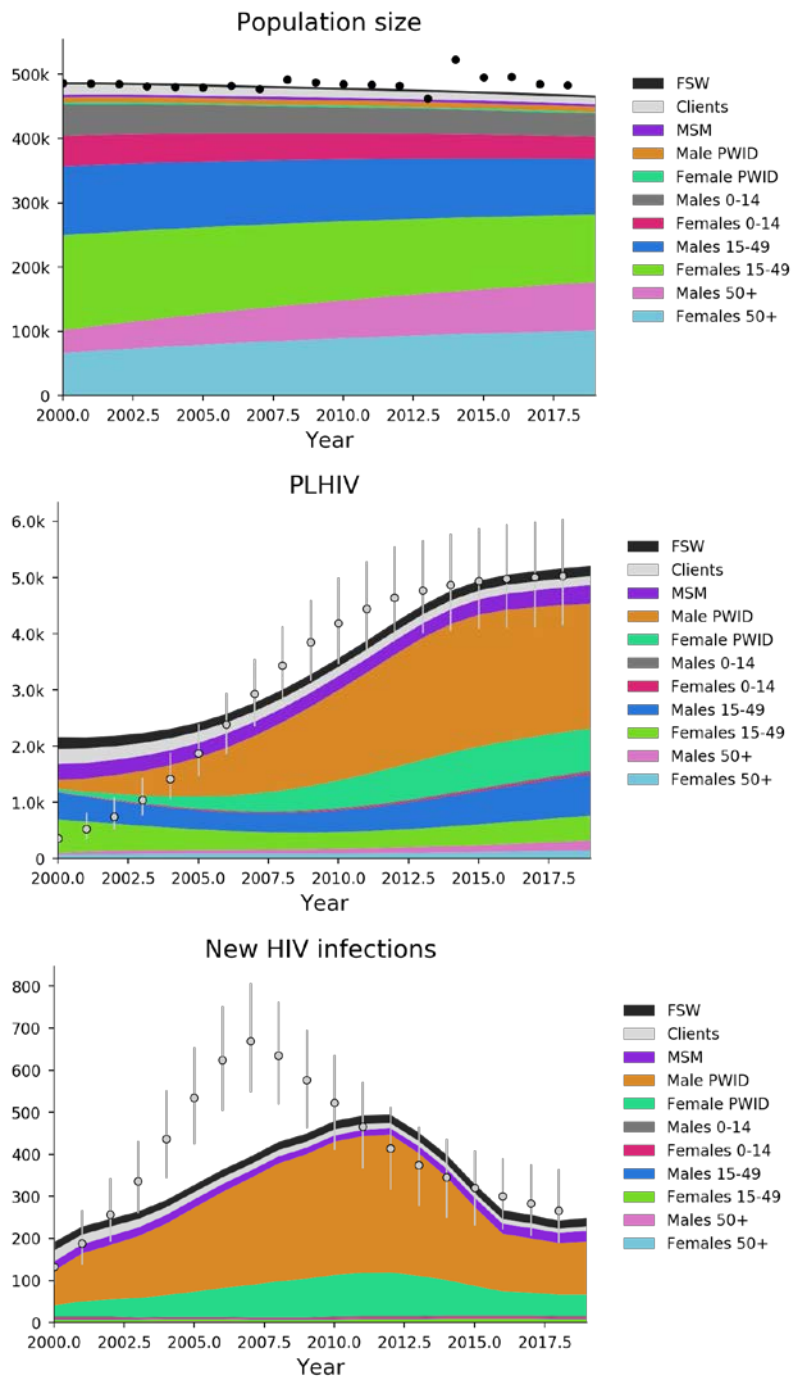




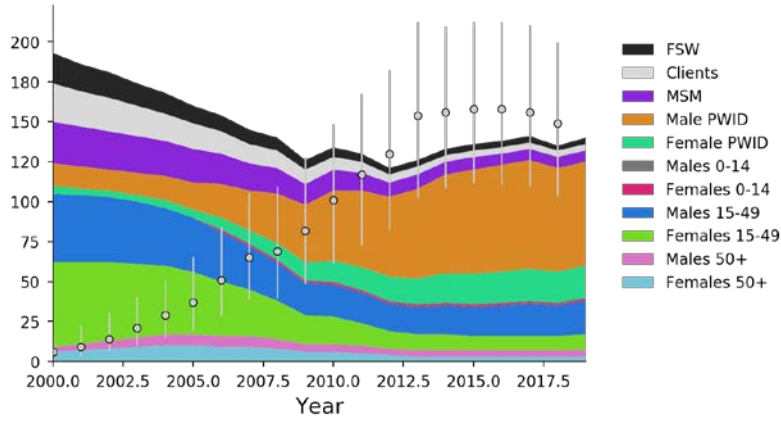




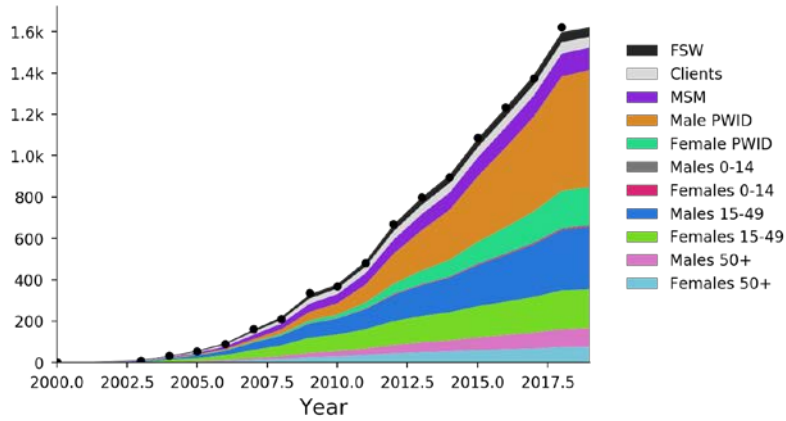
Moldova Left bank



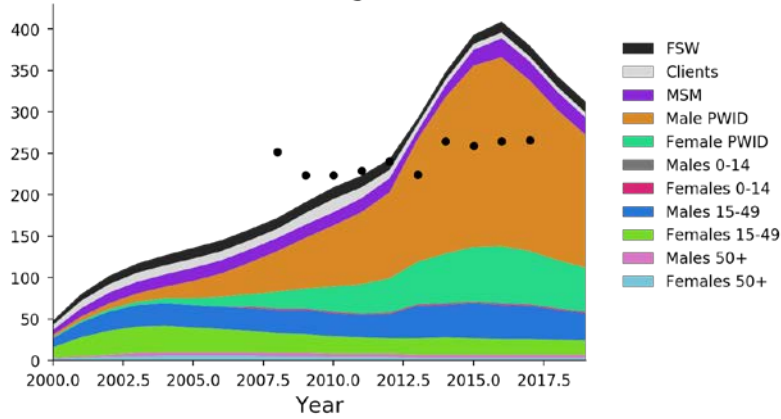
HIV-related deaths



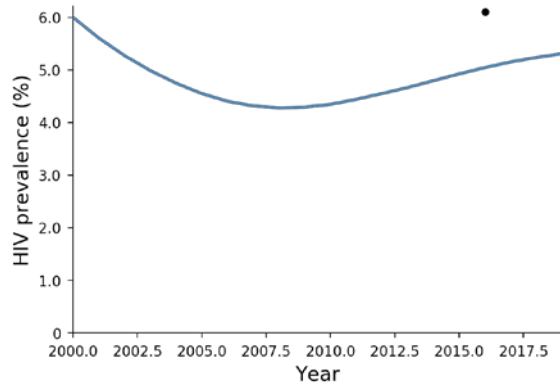
PLHIV on treatment



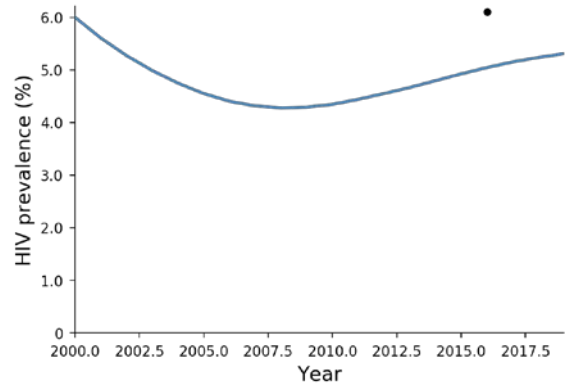
New HIV diagnoses

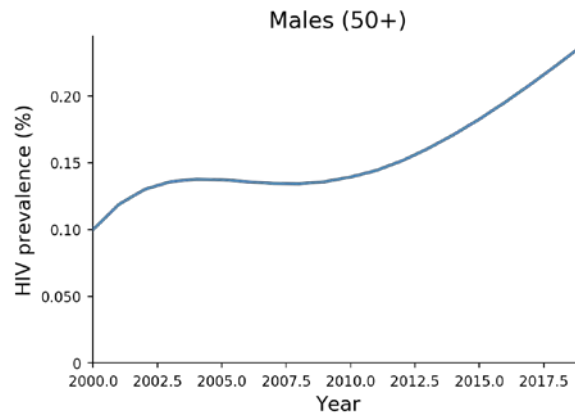
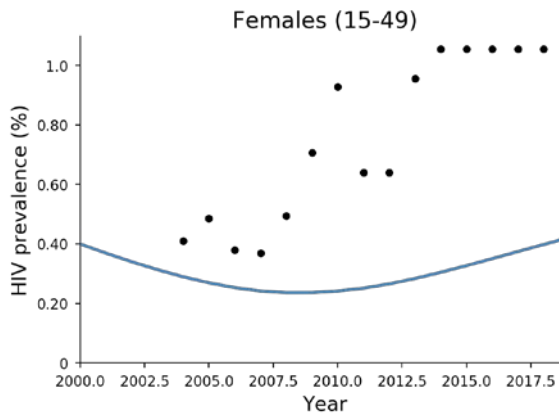
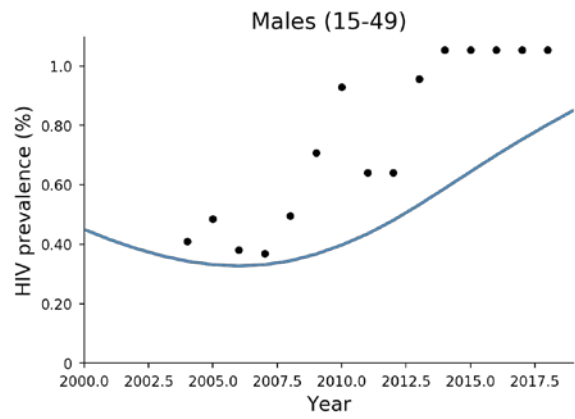
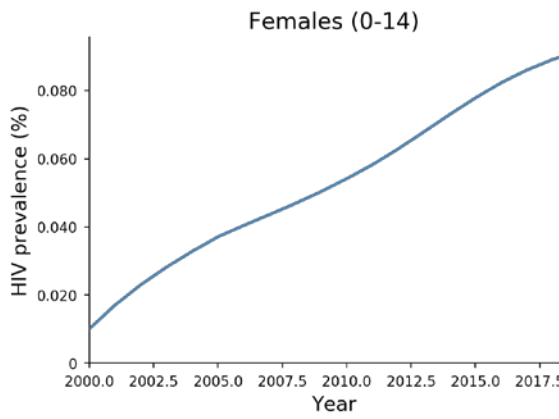
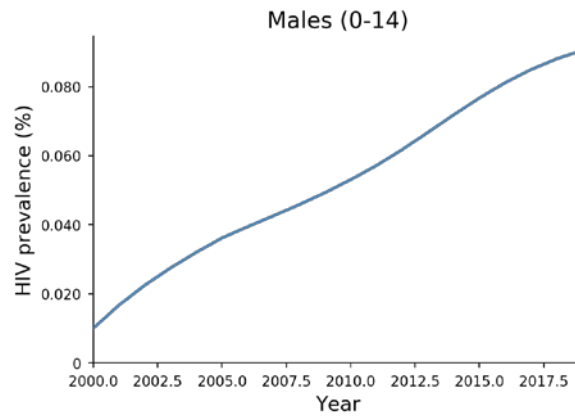
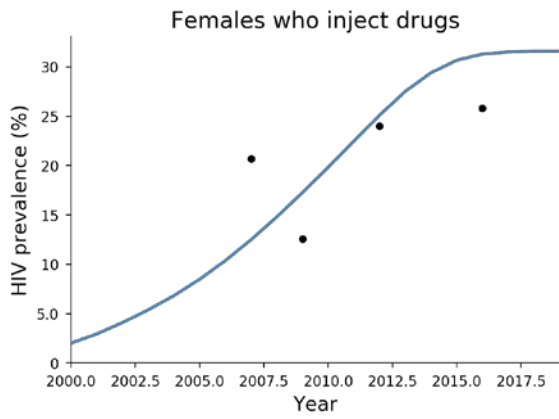
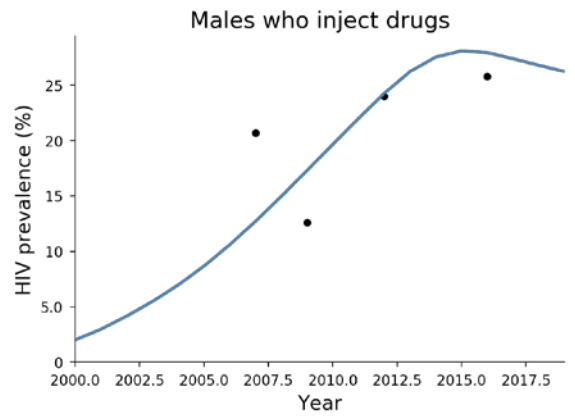
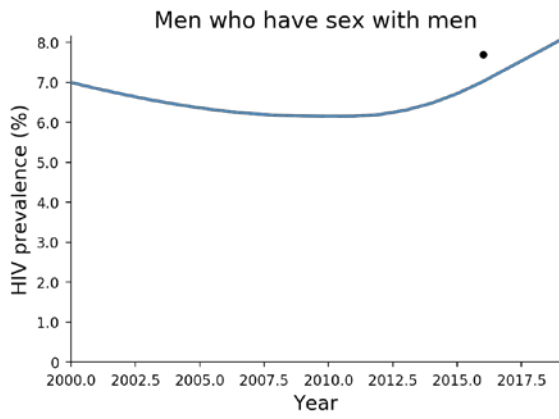


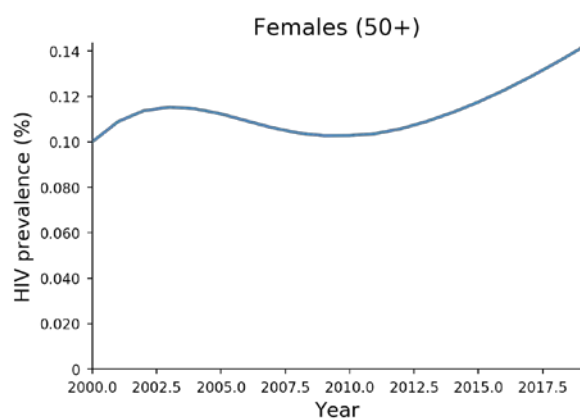
Female sex workers



Female sex workers







Appendix 3. HIV program costing

Table A3. HIV program unit costs and saturation values – Moldova Right bank

HIV programs	Unit cost (USD)	Saturation (low)	Saturation (high)
Antiretroviral therapy (ART)	\$663.21	95%	100%
HIV testing services (general population)	\$3.21	85%	95%
HIV testing and prevention targeting FSW	\$51.27	90%	90%
HIV testing and prevention targeting MSM	\$41.78	90%	90%
Needle and syringe program (NSP)	\$54.78	80%	80%
Opiate substitution therapy (OST)	\$634.53	20%	40%
Prevention of mother-to-child transmission (PMTCT)	\$1,115.22	100%	100%
SBCC and condoms	\$1.25	90%	90%

Table A4. HIV program unit costs and saturation values – Moldova Left bank

HIV programs	Unit cost (USD)	Saturation (low)	Saturation (high)
Antiretroviral therapy (ART)	\$550.47	85%	95%
HIV testing services (general population)	\$2.41	90%	90%
HIV testing and prevention targeting FSW	\$56.10	85%	95%
HIV testing and prevention targeting MSM	\$56.71	90%	90%
Needle and syringe program (NSP)	\$41.84	90%	90%
Prevention of mother-to-child transmission (PMTCT)	\$461.18	100%	100%

Table A5. Values used to inform HIV program cost functions – Moldova Right bank

HIV programs	Parameter	Population interactions or populations	In absence of any programs		At max attainable coverage	
			low	high	low	high
NSP	Condom use (casual acts)	('Male PWID', 'FSW')	67%	67%	67%	67%
SBCC and condoms	Condom use (casual acts)	('Male PWID', 'FSW')	67%	67%	67%	67%
FSW programs	Condom use (casual acts)	('Male PWID', 'FSW')	67%	67%	67%	67%
SBCC and condoms	Condom use (casual acts)	('Males 15-49', 'FSW')	67%	67%	76%	76%
FSW programs	Condom use (casual acts)	('Males 15-49', 'FSW')	67%	67%	76%	76%
MSM programs	Condom use (casual acts)	('MSM', 'MSM')	59%	59%	89%	89%
SBCC and condoms	Condom use (casual acts)	('MSM', 'MSM')	59%	59%	75%	75%
MSM programs	Condom use (casual acts)	('MSM', 'Female PWID')	42%	42%	85%	85%
SBCC and condoms	Condom use (casual acts)	('MSM', 'Female PWID')	42%	42%	69%	69%
NSP	Condom use (casual acts)	('MSM', 'Female PWID')	42%	42%	48%	48%
MSM programs	Condom use (casual acts)	('MSM', 'Females 15-49')	26%	26%	81%	81%
SBCC and condoms	Condom use (casual acts)	('MSM', 'Females 15-49')	26%	26%	62%	62%
NSP	Condom use (casual acts)	('Clients', 'Female PWID')	37%	37%	43%	43%
SBCC and condoms	Condom use (casual acts)	('Clients', 'Female PWID')	37%	37%	66%	66%

HIV programs	Parameter	Population interactions or populations	In absence of any programs		At max attainable coverage	
			low	high	low	high
SBCC and condoms	Condom use (casual acts)	('Clients', 'Females 15-49')	21%	21%	60%	60%
NSP	Condom use (casual acts)	('Male PWID', 'Female PWID')	52%	52%	53%	53%
SBCC and condoms	Condom use (casual acts)	('Male PWID', 'Female PWID')	52%	52%	86%	86%
NSP	Condom use (casual acts)	('Male PWID', 'Females 15-49')	31%	31%	41%	41%
SBCC and condoms	Condom use (casual acts)	('Male PWID', 'Females 15-49')	31%	31%	61%	61%
SBCC and condoms	Condom use (casual acts)	('Males 15-49', 'Female PWID')	59%	59%	74%	74%
SBCC and condoms	Condom use (casual acts)	('Males 15-49', 'Females 15-49')	39%	39%	70%	70%
SBCC and condoms	Condom use (casual acts)	('Males 50+', 'Females 15-49')	40%	40%	74%	74%
SBCC and condoms	Condom use (casual acts)	('Males 50+', 'Females 50+')	51%	51%	84%	84%
FSW programs	Condom use (casual acts)	('Clients', 'FSW')	72%	72%	93%	93%
HTS	HIV testing rate	FSW	2%	5%	10%	15%
FSW programs	HIV testing rate	FSW	13%	13%	45%	55%
HTS	HIV testing rate	Clients	10%	10%	75%	75%
MSM programs	HIV testing rate	MSM	6%	6%	70%	70%
HTS	HIV testing rate	MSM	4%	4%	20%	20%
NSP	HIV testing rate	Male PWID	1%	1%	48%	48%
HTS	HIV testing rate	Male PWID	5%	5%	16%	16%
NSP	HIV testing rate	Female PWID	1%	1%	40%	40%
HTS	HIV testing rate	Female PWID	1%	1%	14%	14%

HIV programs	Parameter	Population interactions or populations	In absence of any programs		At max attainable coverage	
			low	high	low	high
HTS	HIV testing rate	Males 15-49	10%	10%	20%	20%
HTS	HIV testing rate	Females 15-49	10%	10%	40%	49%
HTS	HIV testing rate	Males 50+	2%	5%	16%	16%
HTS	HIV testing rate	Females 50+	13%	13%	16%	16%
HTS	HIV testing rate	Males 0-14	10%	10%	30%	30%
HTS	HIV testing rate	Females 0-14	6%	6%	30%	30%
NSP	Needle sharing	Male PWID	1.46%	1.46%	0.99%	0.99%
NSP	Needle sharing	Male PWID	1.46%	1.46%	0.99%	0.99%

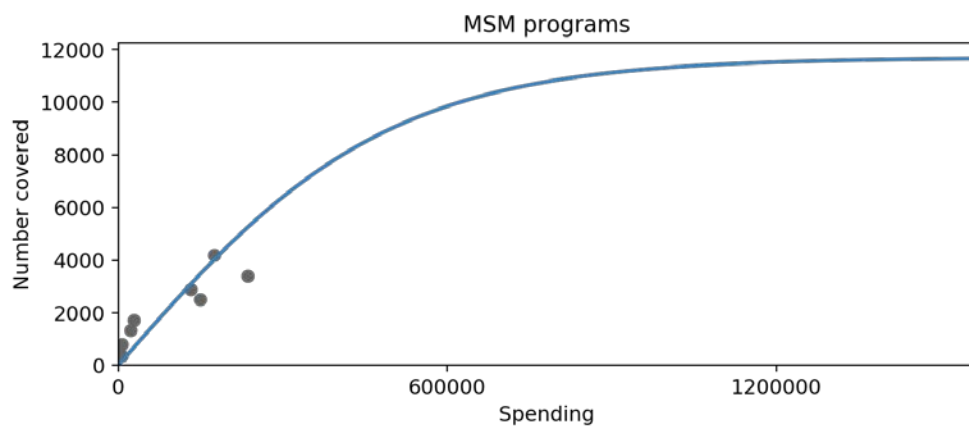
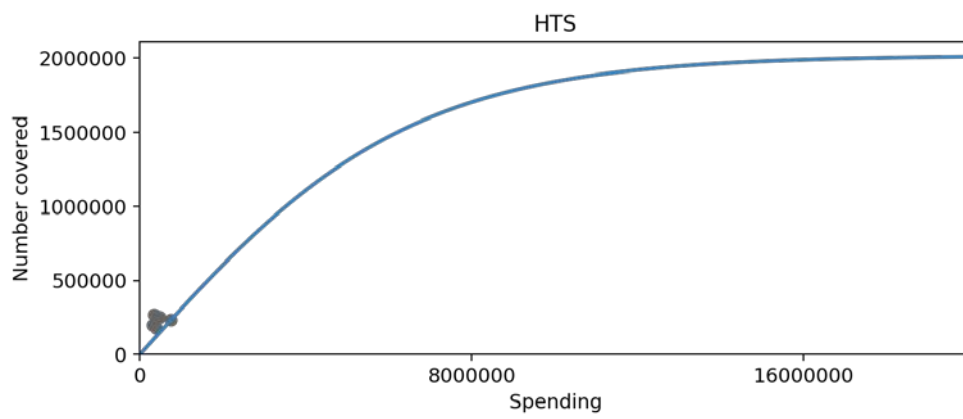
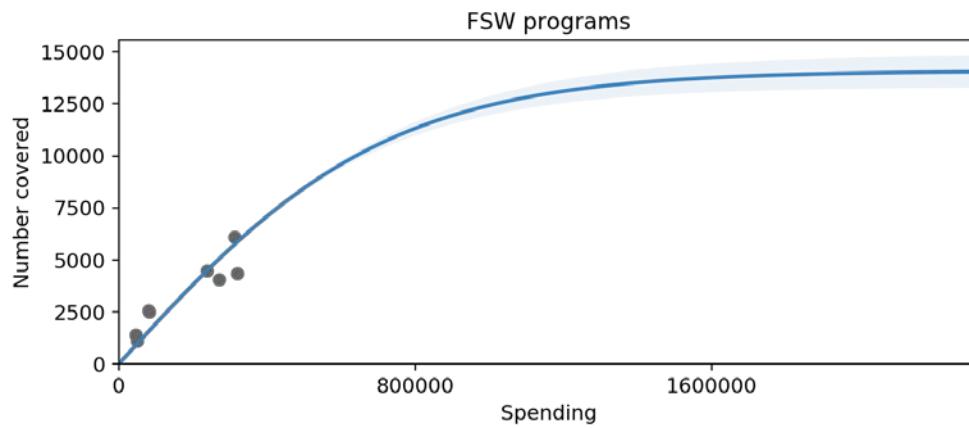
Table A6. Values used to inform HIV program cost functions – Moldova Left bank

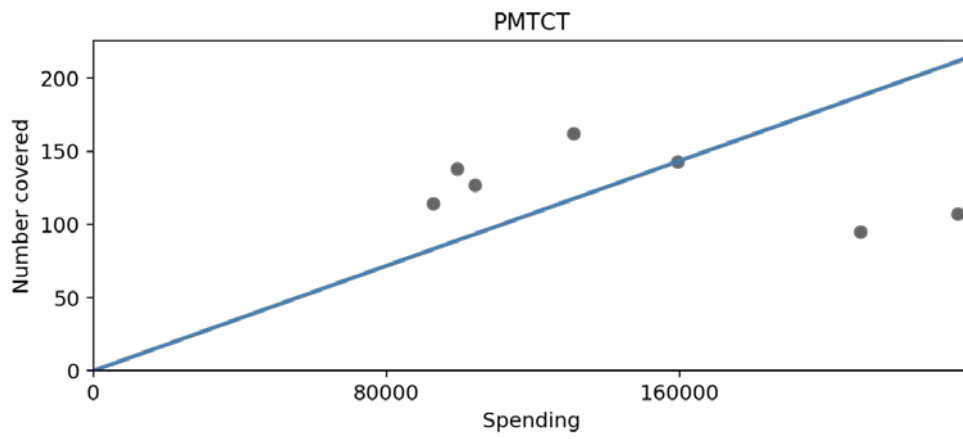
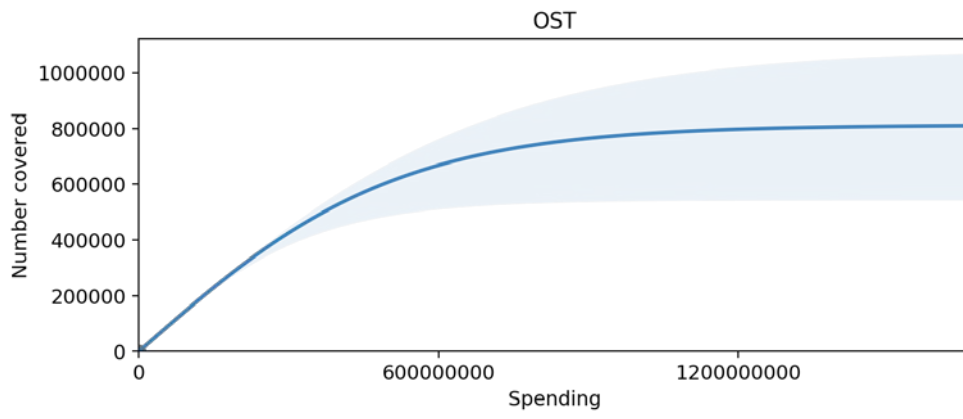
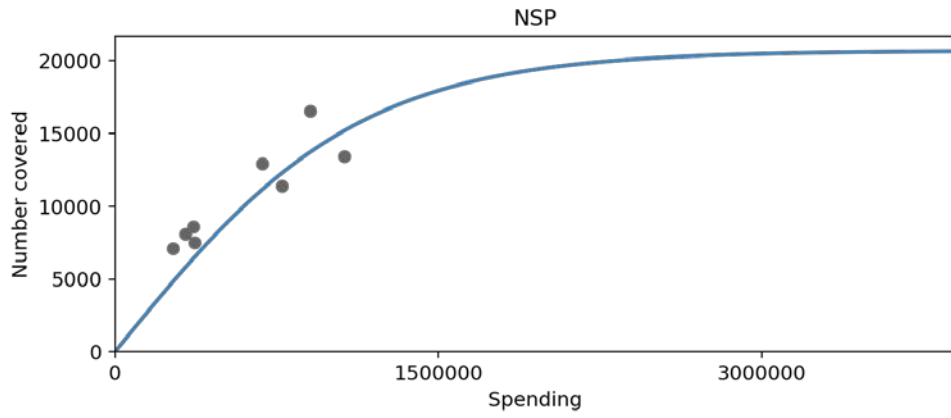
HIV programs	Parameter	Population interactions or populations	In absence of any programs		At max attainable coverage	
			low	high	low	high
NSP	Condom use (casual acts)	('Male PWID', 'FSW')	72%	72%	72%	72%
FSW programs	Condom use (casual acts)	('Male PWID', 'FSW')	72%	72%	72%	72%
FSW programs	Condom use (casual acts)	('Males 15-49', 'FSW')	65%	65%	74%	74%
MSM programs	Condom use (casual acts)	('MSM', 'MSM')	65%	65%	90%	90%
MSM programs	Condom use (casual acts)	('MSM', 'Female PWID')	60%	60%	89%	89%
NSP	Condom use (casual acts)	('MSM', 'Female PWID')	33%	33%	64%	64%
MSM programs	Condom use (casual acts)	('MSM', 'Females 15-49')	33%	33%	89%	89%
NSP	Condom use (casual acts)	('Clients', 'Female PWID')	42%	42%	48%	48%
NSP	Condom use (casual acts)	('Male PWID', 'Female PWID')	63%	63%	63%	63%

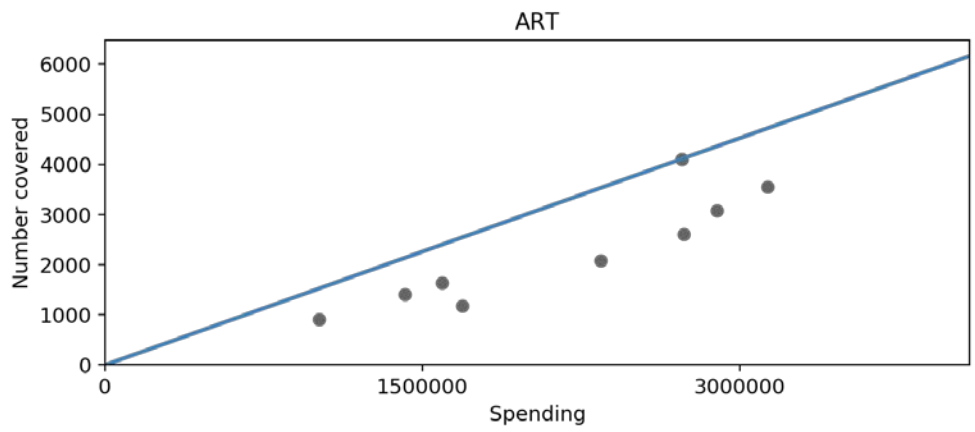
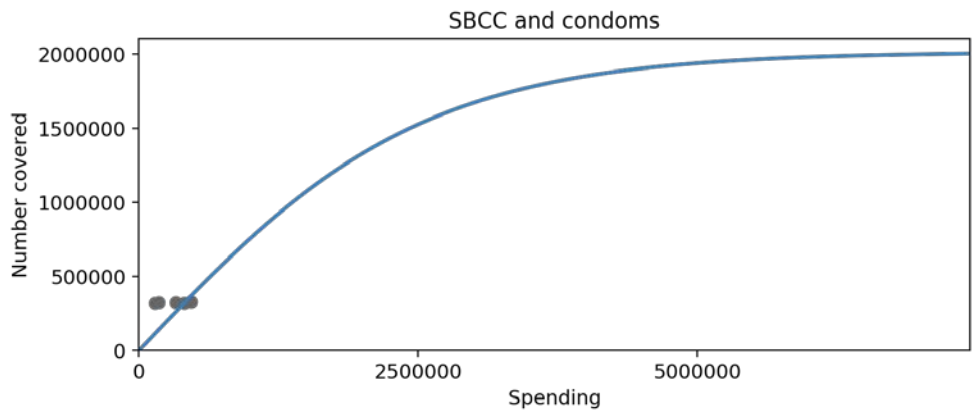
HIV programs	Parameter	Population interactions or populations	In absence of any programs		At max attainable coverage	
			low	high	low	high
NSP	Condom use (casual acts)	('Male PWID', 'Females 15-49')	38%	38%	44%	44%
FSW programs	Condom use (Commercial acts)	('Clients', 'FSW')	64%	64%	93%	93%
HTS	HIV testing rate	FSW	1%	1%	3%	3%
FSW programs	HIV testing rate	FSW	1%	1%	22%	22%
HTS	HIV testing rate	Clients	1%	1%	41%	41%
MSM programs	HIV testing rate	MSM	7%	7%	74%	74%
HTS	HIV testing rate	MSM	7%	7%	37%	37%
NSP	HIV testing rate	Male PWID	1%	1%	30%	30%
HTS	HIV testing rate	Male PWID	1%	1%	7%	7%
NSP	HIV testing rate	Female PWID	1%	1%	30%	30%
HTS	HIV testing rate	Female PWID	1%	1%	6%	6%
HTS	HIV testing rate	Males 15-49	5%	5%	56%	56%
HTS	HIV testing rate	Females 15-49	5%	5%	60%	60%
HTS	HIV testing rate	Males 50+	0%	0%	17%	17%
HTS	HIV testing rate	Females 50+	0%	0%	16%	16%
NSP	Needle sharing	Male PWID	1.37%	1.37%	0.93%	0.93%
NSP	Needle sharing	Female PWID	1.37%	1.37%	0.93%	0.93%

Appendix 4. Cost functions

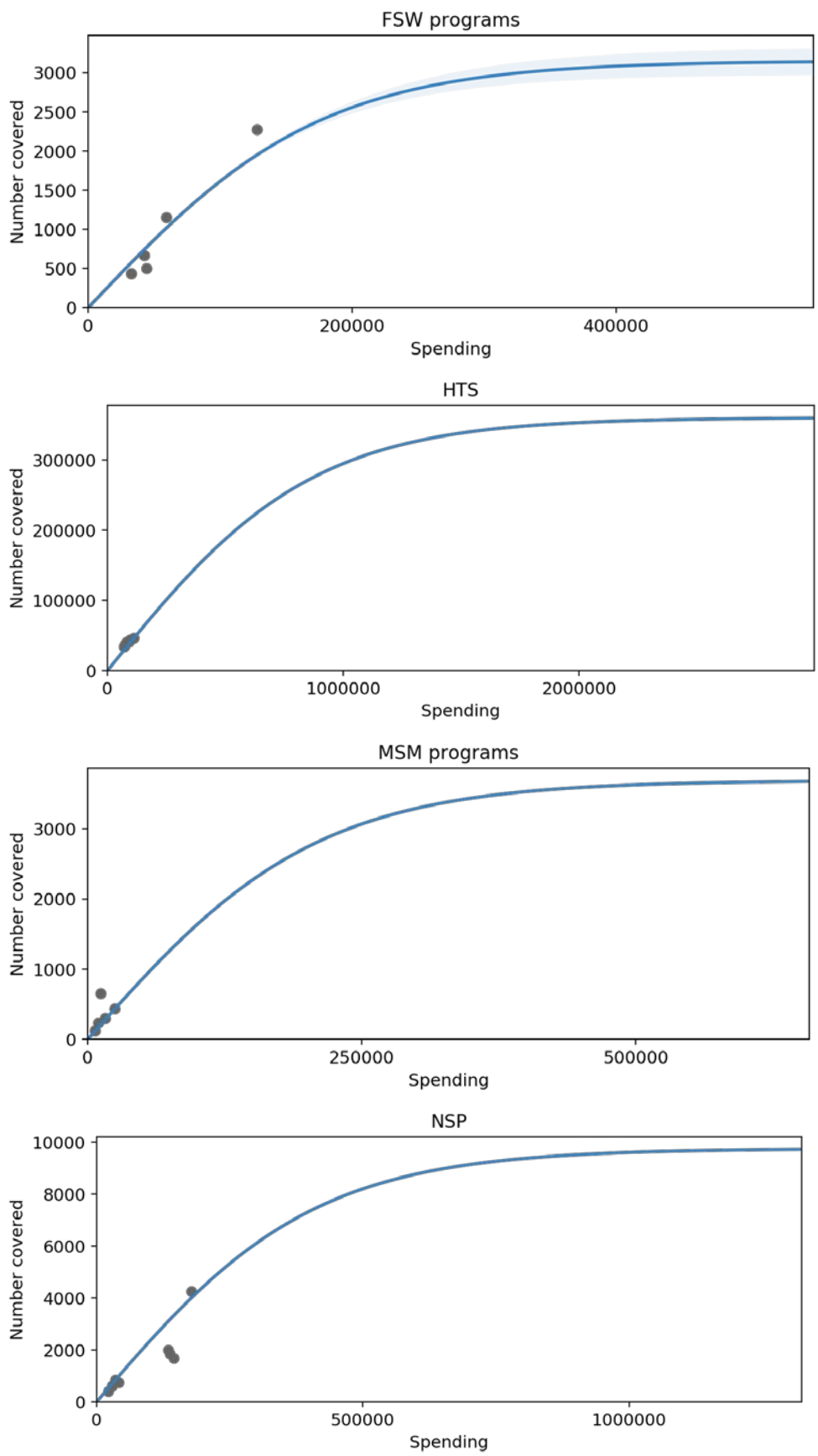
Moldova Right bank

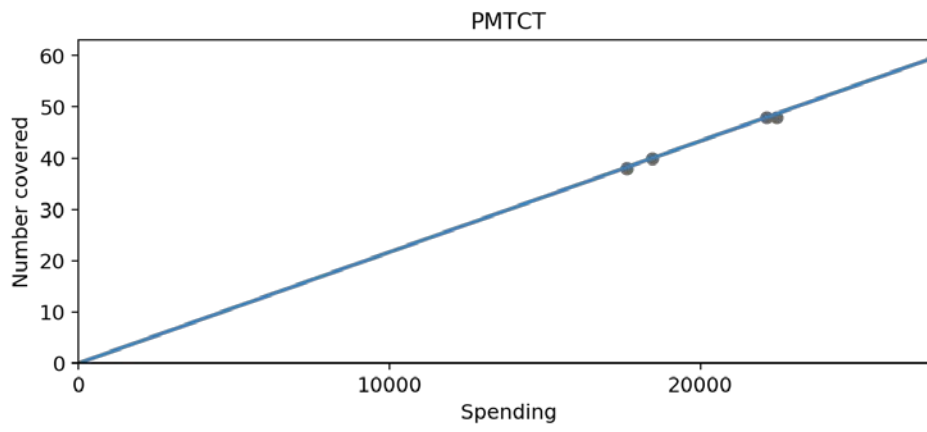
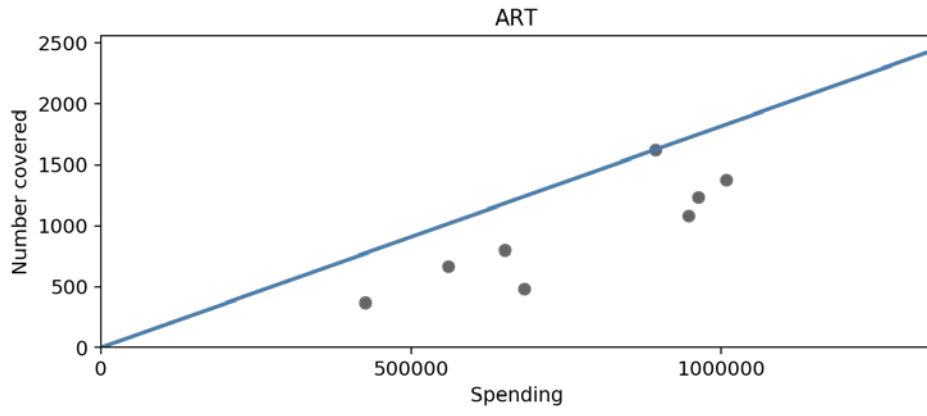






Moldova Left bank





Appendix 5. Annual HIV budget allocations at varying budgets

Table A7. Annual HIV budget allocations at varying budgets for 2019 to 2030 – National

	100% latest reported (2018)	50% optimized	100% optimized	150% optimized	200% optimized
Targeted HIV program					
Antiretroviral therapy (ART)	\$3,617,879	\$3,211,791	\$5,728,777	\$7,223,283	\$7,864,641
Prevention of mother-to-child transmission (PMTCT)	\$177,923	\$182,289	\$218,593	\$222,534	\$234,329
Condoms and social and behavior change communication	\$402,515	\$0	\$0	\$0	\$0
HIV testing services (HTS) (general population)	\$865,221	\$0	\$0	\$420,864	\$2,417,537
HIV testing and prevention programs targeting FSW	\$440,268	\$0	\$540,815	\$1,204,704	\$1,408,584
HIV testing and prevention programs targeting MSM	\$199,961	\$0	\$280,224	\$795,996	\$980,045
Needle-syringe programs (NSP)	\$1,084,393	\$0	\$19,751	\$472,858	\$987,183
Opiate substitution therapy (OST)	\$315,998	\$157,999	\$315,998	\$315,998	\$315,998
Non-targeted HIV program					
Enabling environment	\$675,044	\$675,044	\$675,044	\$675,044	\$675,044
Human resources	\$0	\$0	\$0	\$0	\$0
Infrastructure	\$101,042	\$101,042	\$101,042	\$101,042	\$101,042
Monitoring and evaluation	\$53,906	\$53,906	\$53,906	\$53,906	\$53,906
Management	\$206,179	\$206,179	\$206,179	\$206,179	\$206,179
Other HIV care	\$317,196	\$317,196	\$317,196	\$317,196	\$317,196
Other HIV costs	\$510,953	\$510,953	\$510,953	\$510,953	\$510,953
Orphans and vulnerable children (OVC)	\$173,807	\$173,807	\$173,807	\$173,807	\$173,807
Total HIV program budget	\$9,142,285	\$5,590,206	\$9,142,285	\$12,694,364	\$16,246,443

Table A8. Annual HIV budget allocations at varying budgets for 2019 to 2030 – Moldova Right bank

	100% latest reported (2018)	50% optimized	100% optimized	150% optimized	200% optimized
Targeted HIV program					
Antiretroviral therapy	\$2,724,473	\$2,552,736	\$4,411,971	\$5,575,413	\$5,900,974
Prevention of mother-to-child transmission	\$159,476	\$163,842	\$200,146	\$204,087	\$215,882
Condoms and social and behavior change communication	\$402,515	\$0	\$0	\$0	\$0
HIV testing services (general population)	\$752,669	\$0	\$0	\$420,864	\$2,417,537
HIV testing and prevention programs targeting FSW	\$312,480	\$0	\$540,815	\$1,154,640	\$1,271,573
HIV testing and prevention programs targeting MSM	\$175,234	\$0	\$280,224	\$795,996	\$885,597
Needle-syringe programs	\$906,309	\$0	\$0	\$156,734	\$490,747
Opiate substitution therapy	\$315,998	\$157,999	\$315,998	\$315,998	\$315,998
Non-targeted HIV program					
Enabling environment	\$674,160	\$808,808	\$699,305	\$611,854	\$675,044
Human resources					
Infrastructure	\$833,126	\$74,680	\$165,121	\$278,615	\$101,042
Monitoring and evaluation	\$81,461	\$59,066	\$192,276	\$57,390	\$53,906
Management	\$769,244	\$432,978	\$357,363	\$492,587	\$206,179
Other HIV care	\$34,263	\$199,462	\$233,204	\$321,647	\$316,809
Other HIV costs	\$426,284	\$309,345	\$322,094	\$392,686	\$510,953
Orphans and vulnerable children	\$1,539,680	\$154,824	\$84,161	\$141,589	\$173,807
Total HIV program budget	\$10,107,373	\$4,913,739	\$7,802,678	\$10,920,097	\$13,536,048

Table A9. Annual HIV budget allocations at varying budgets for 2019 to 2030 – Moldova Left bank

	100% latest reported (2018)	50% optimized	100% optimized	150% optimized	200% optimized
Targeted HIV program					
Antiretroviral therapy	\$893,406	\$659,055	\$1,316,806	\$1,647,870	\$1,963,666
Prevention of mother-to-child transmission	\$18,447	\$18,447	\$18,447	\$18,447	\$18,447
Condoms and social and behavior change communication	\$0	\$0	\$0	\$0	\$0
HIV testing services (general population)	\$112,552	\$0	\$0	\$0	\$0
HIV testing and prevention programs targeting FSW	\$127,788	\$0	\$0	\$50,065	\$137,011
HIV testing and prevention programs targeting MSM	\$24,727	\$0	\$0	\$0	\$94,448
Needle-syringe programs	\$178,084	\$0	\$19,751	\$316,124	\$496,436
Opiate substitution therapy	\$0	\$0	\$0	\$0	\$0
Non-targeted HIV program					
Enabling environment					
Human resources					
Infrastructure					
Monitoring and evaluation					
Management					
Other HIV care	\$387	\$387	\$387	\$387	\$387
Other HIV costs					
Orphans and vulnerable children					
Total HIV program budget	\$1,355,391	\$677,889	\$1,355,391	\$2,032,893	\$2,710,395

Table A10. HIV budget saturation (95% of maximum achievable reduction in infections and deaths)

	Max impact budget	Reduction in HIV infections in 2030 compared to 2018	Reduction in HIV-related deaths in 2030 compared to 2018	Reduction in HIV infections in 2030 compared to 2010	Reduction in HIV-related deaths in 2030 compared to 2010
Moldova National	270%	80% (650)	83% (400)	89% (1,250)	90% (700)
Moldova Left Bank	300%	77% (200)	78% (100)	88% (400)	77% (100)
Moldova Right Bank	250%	82% (450)	85% (300)	89% (850)	93% (600)

Calculated as the budget required to achieve 95% of the maximum reduction in infections and deaths under the current mix of programs were delivered at the same unit cost and modeled program impact. Additional reductions in infections and deaths could be made if; the current programs could be delivered more cost-efficiently or other cost-effective targeted HIV programs were to be implemented.

Appendix 6. Model outputs by region

Moldova Right bank

Figure A1. Estimated new HIV infections and HIV-related deaths in the absence of HIV program spending from 2015 to 2017 – Moldova Right bank

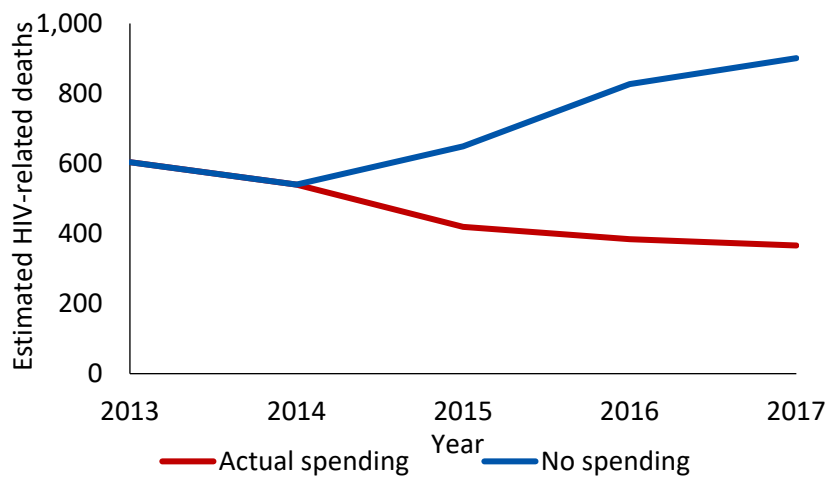
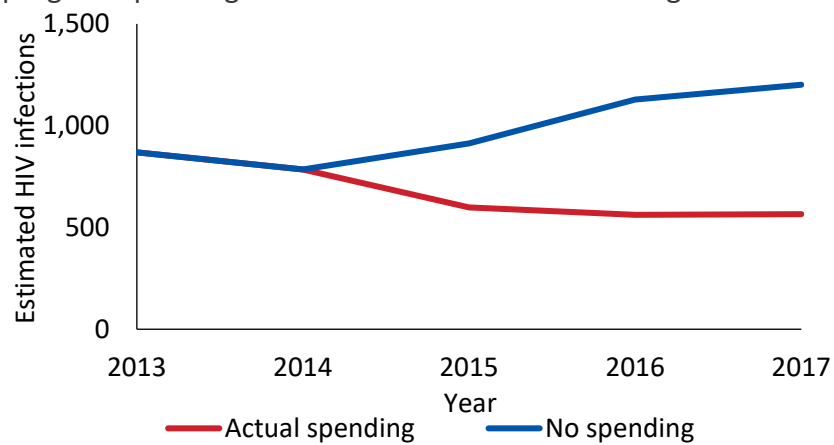


Figure A2. Estimated new HIV infections and HIV-related deaths in the absence of HIV program spending from 2015 to 2017 – Moldova Left bank

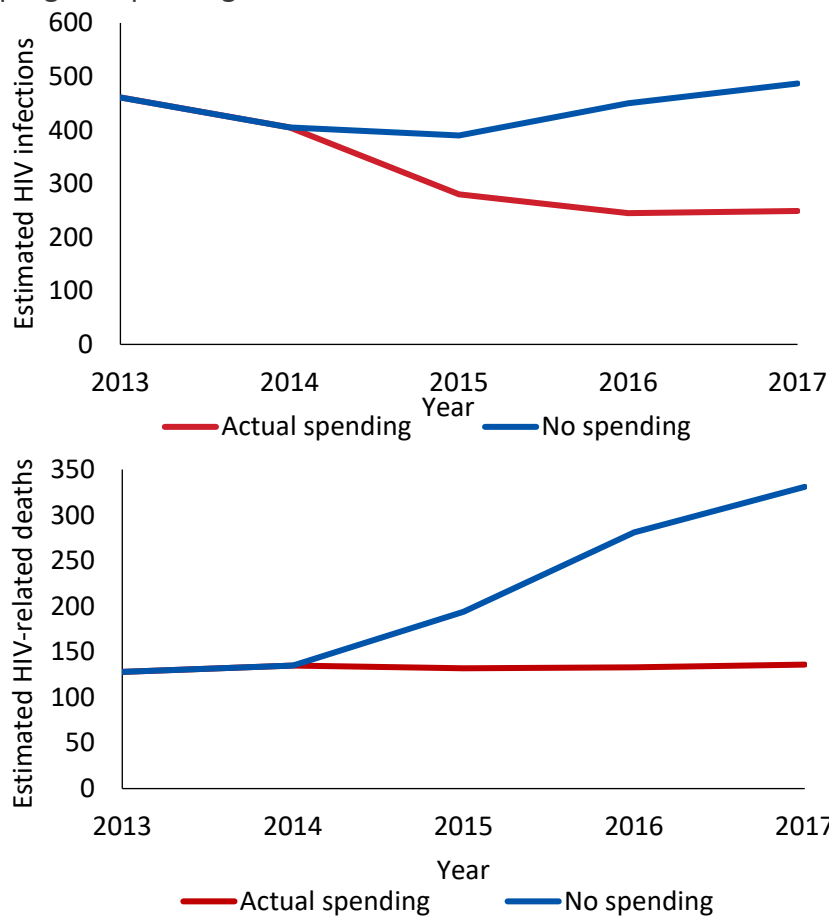


Figure A3. Optimized allocations under varying levels of annual HIV budgets for 2019 to 2030, to minimize new HIV infections and HIV-related deaths by 2030 – Moldova Right bank

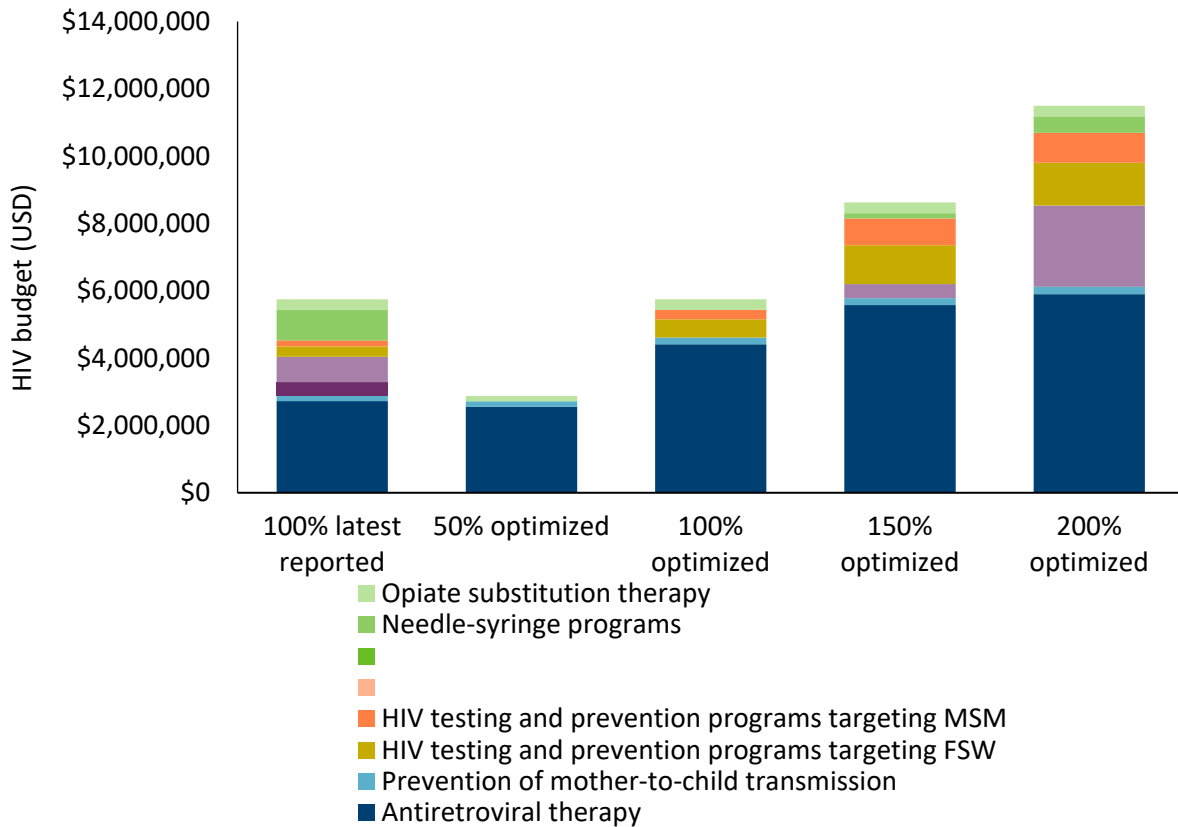


Figure A4. Optimized allocations under varying levels of annual HIV budgets for 2019 to 2030, to minimize new HIV infections and HIV-related deaths by 2030 – Moldova Left bank

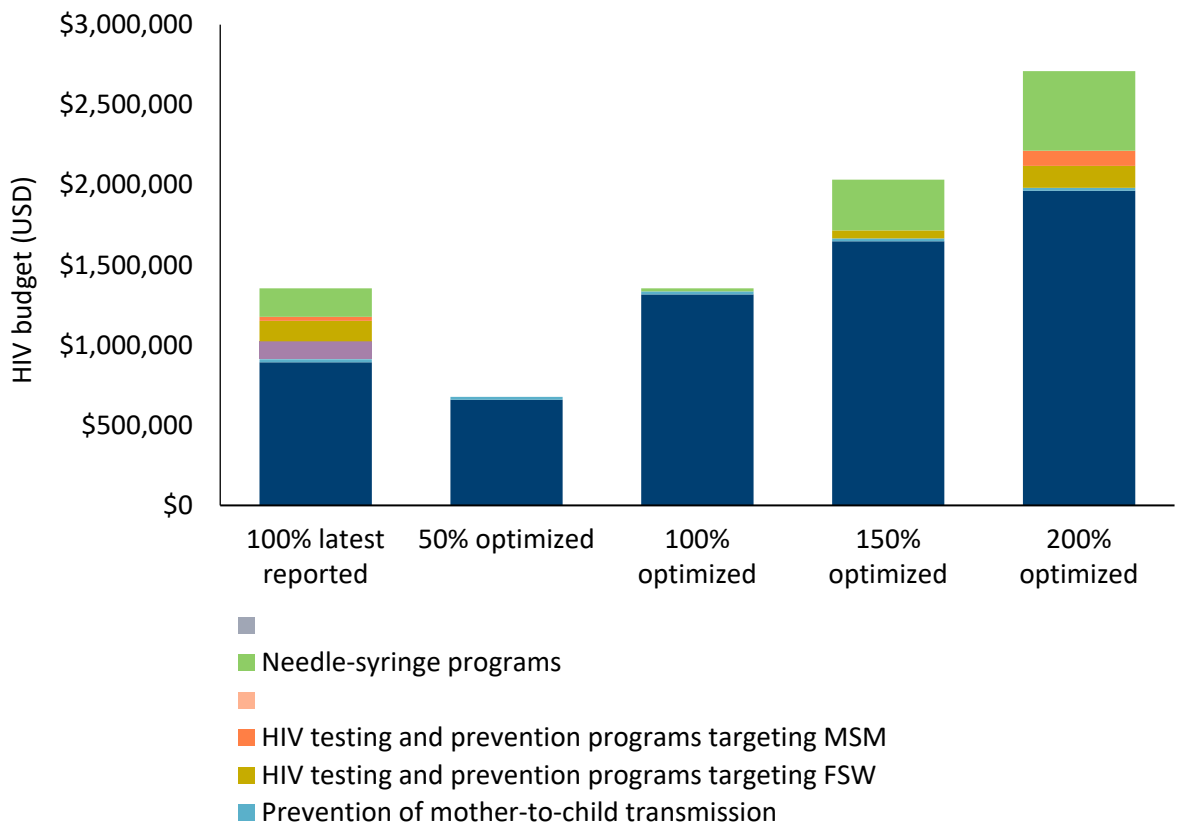


Figure A5. Optimized HIV annual resource allocation, 2019 to 2030 to minimize new infections and HIV-related deaths by 2030 – Moldova Right bank

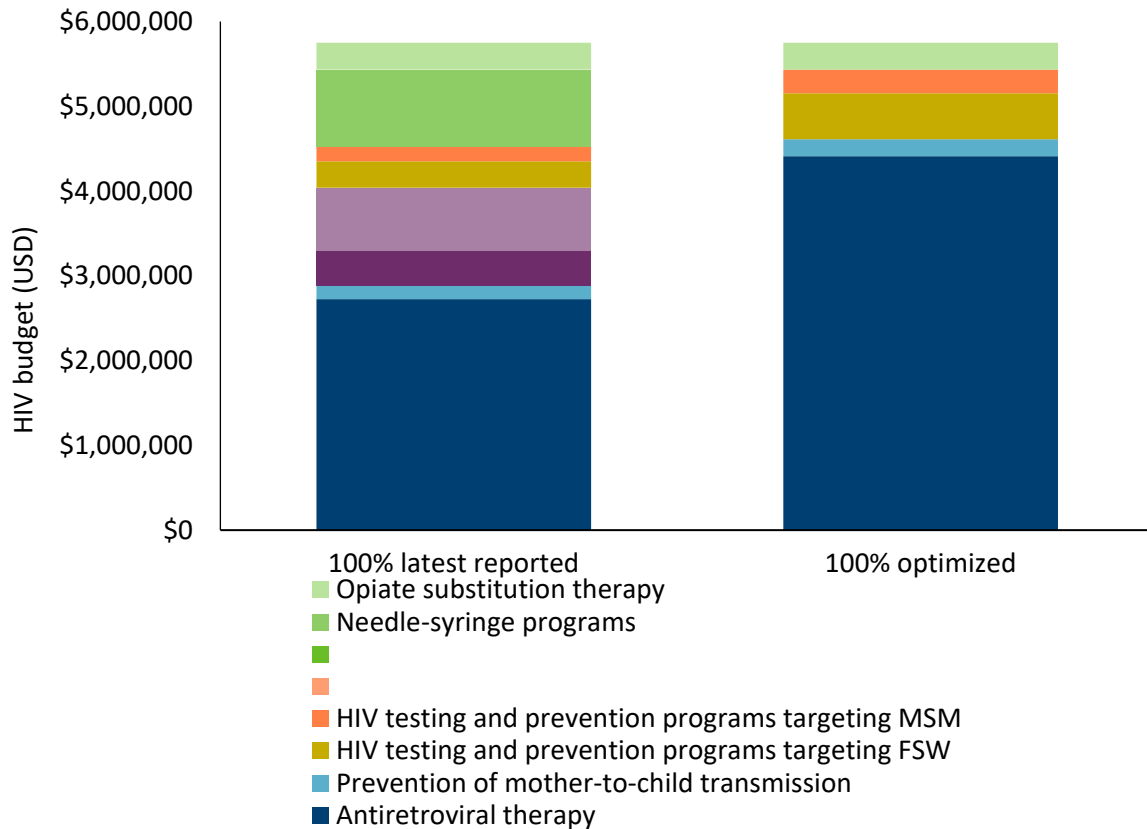


Figure A6. Optimized HIV annual resource allocation for 2019 to 2030 to minimize new HIV infections and HIV-related deaths by 2030 – Moldova Left bank

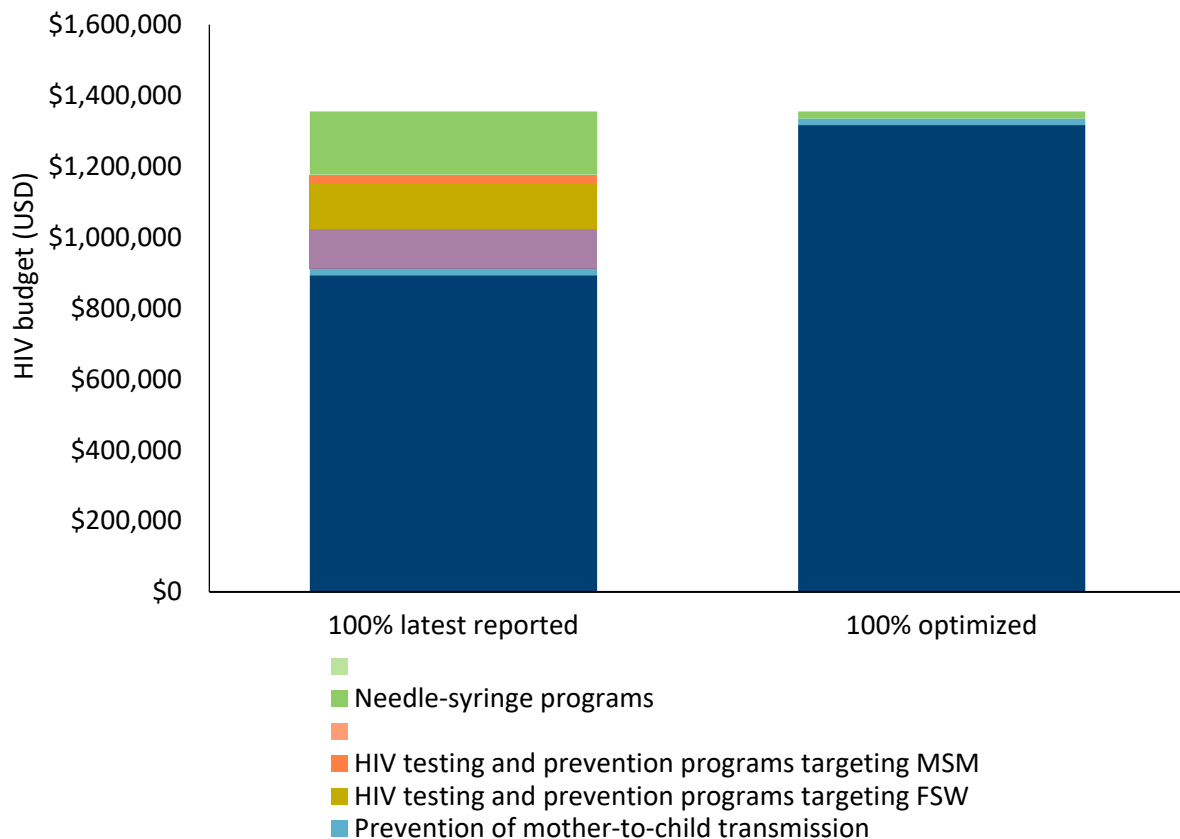


Figure A7. Estimated new HIV infections, HIV-related deaths, and HIV-related DALYs under optimized varying annual budget levels 2019 to 2030 to minimize HIV infections and HIV-related deaths by 2030 – Moldova Right bank

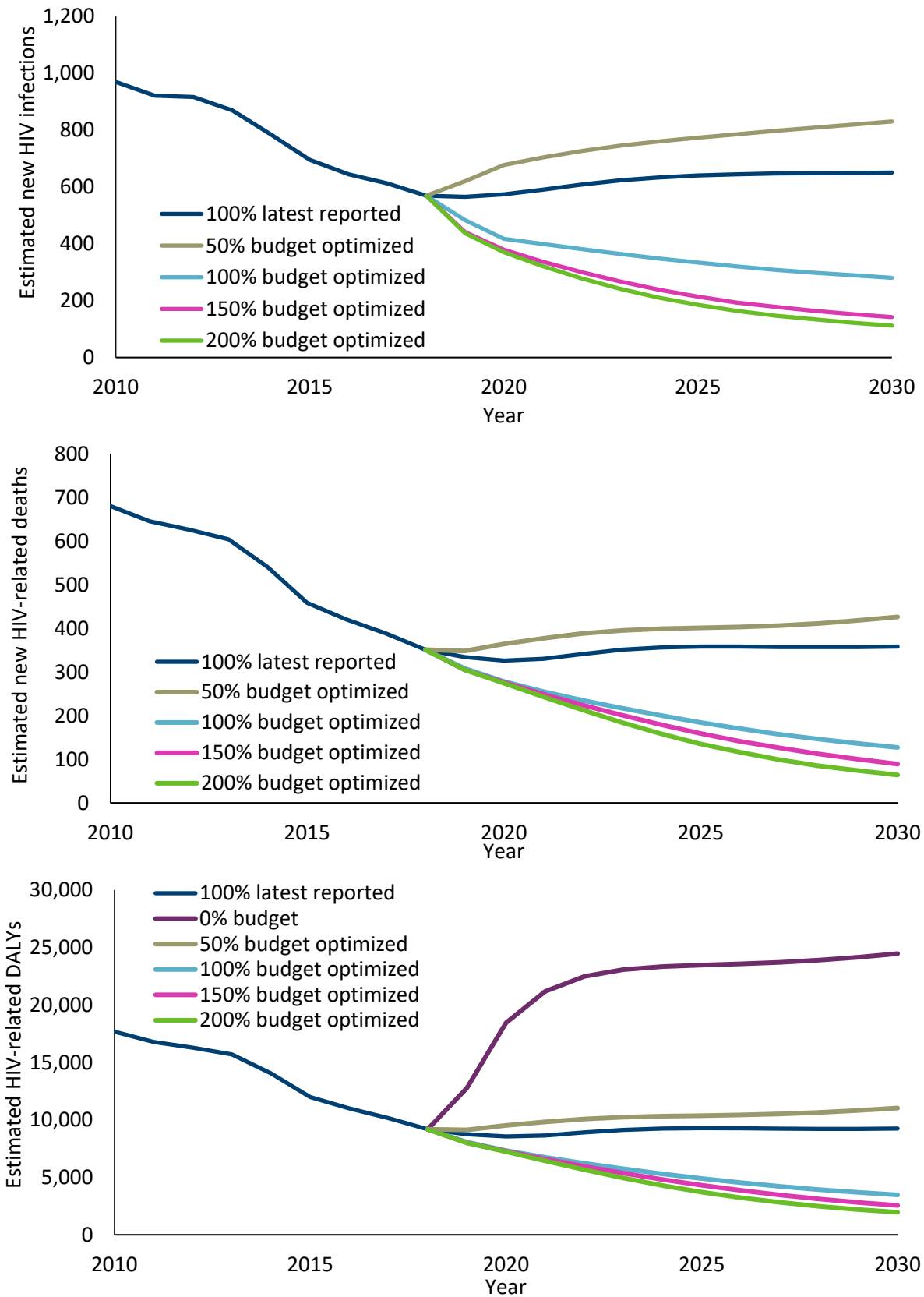


Figure A7. Estimated new HIV infections, HIV-related deaths, and HIV-related DALYs under optimized varying annual budget levels 2019 to 2030 to minimize HIV infections and HIV-related deaths by 2030 – Moldova Left bank

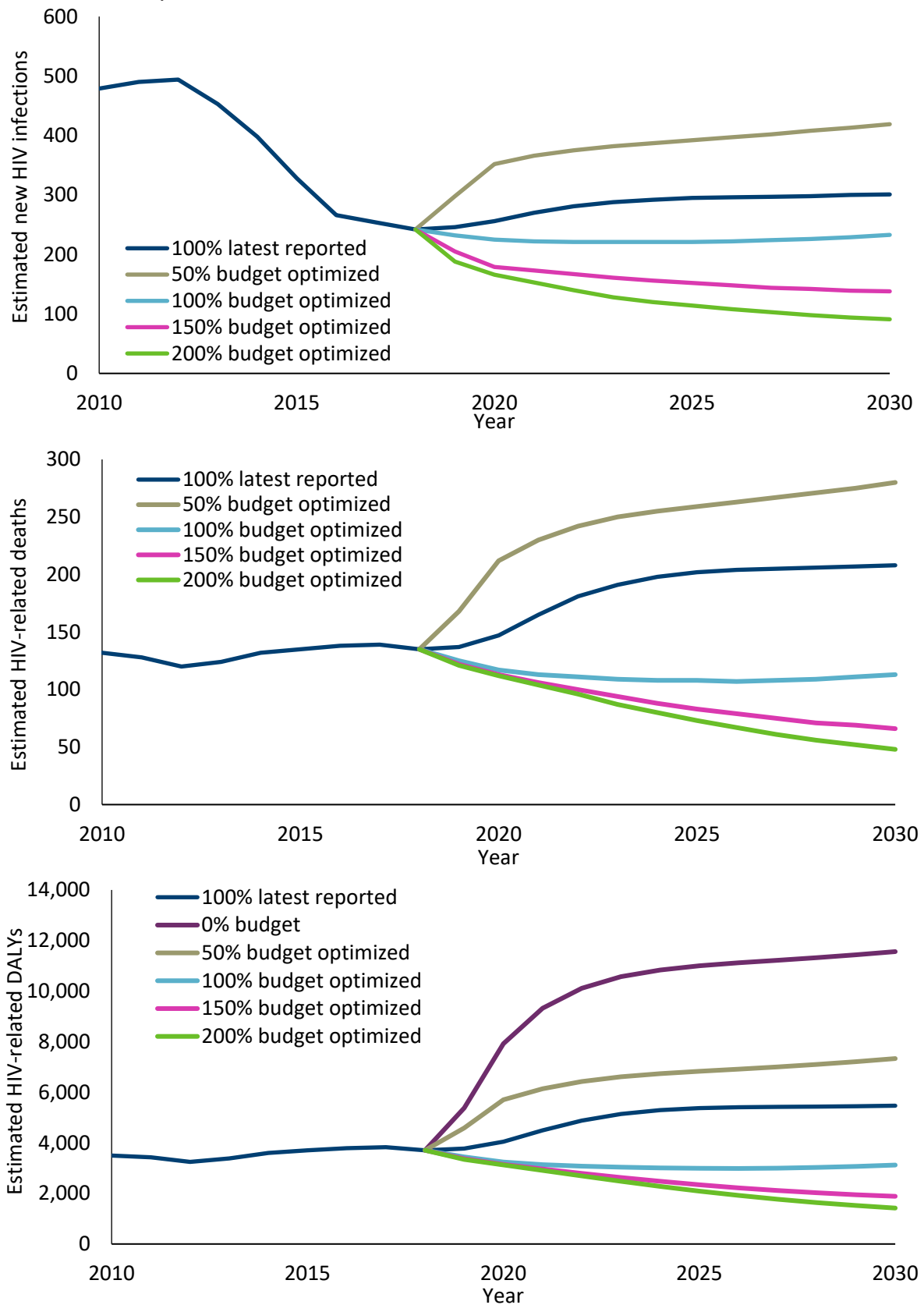


Figure A8. HIV cascade under 210% optimized resource allocation to best achieve 95-95-95 targets by 2030 – Moldova Right bank

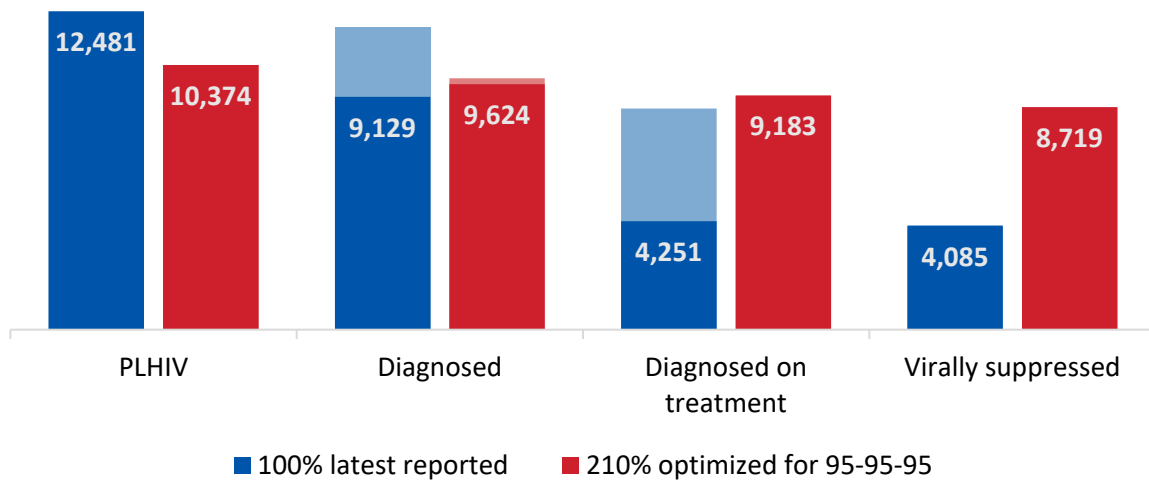


Figure A9. HIV cascade under 330% optimized resource allocation to best achieve 95-95-95 targets by 2030 – Moldova Left bank

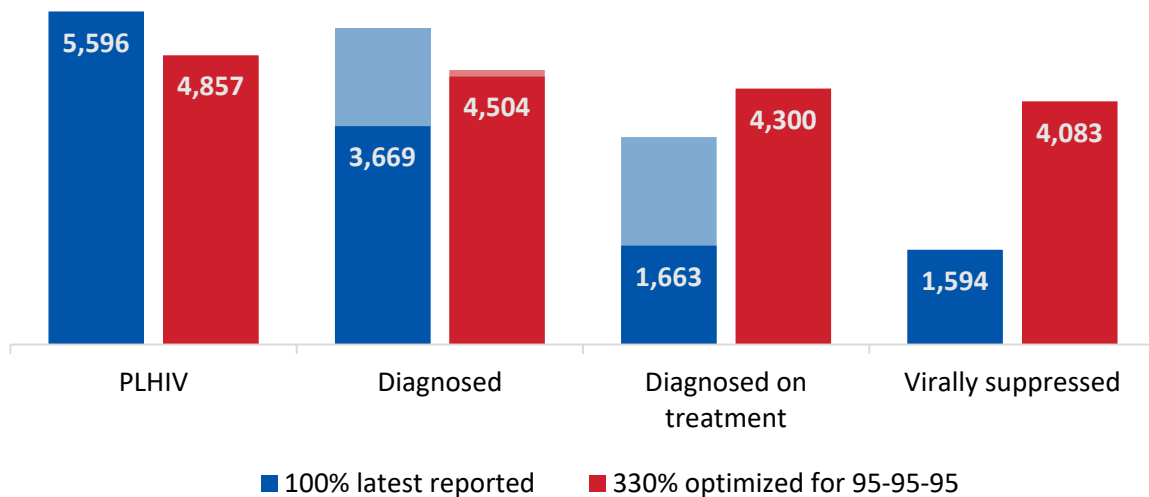


Figure A10. Optimized HIV budget level and allocation to best achieve 95-95-95 targets by 2030 – Moldova Right bank

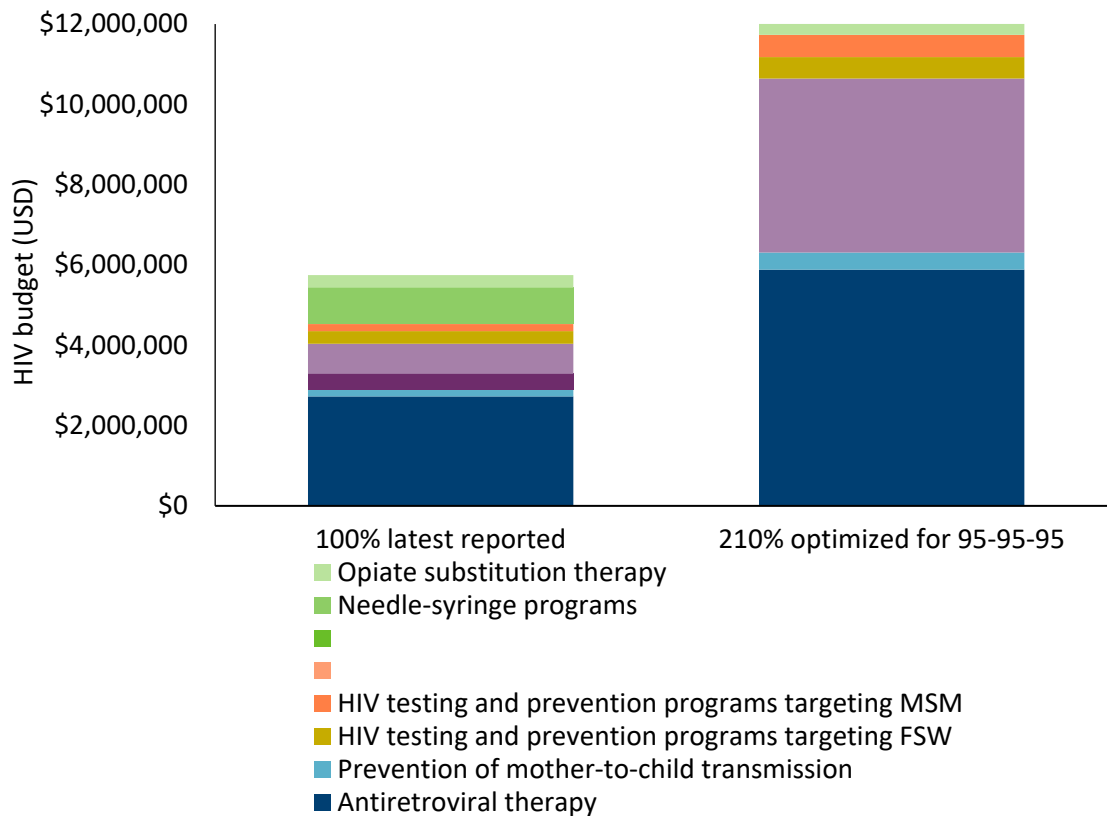


Figure A11. Optimized HIV budget level and allocation to best achieve 95-95-95 targets by 2030 – Moldova left bank

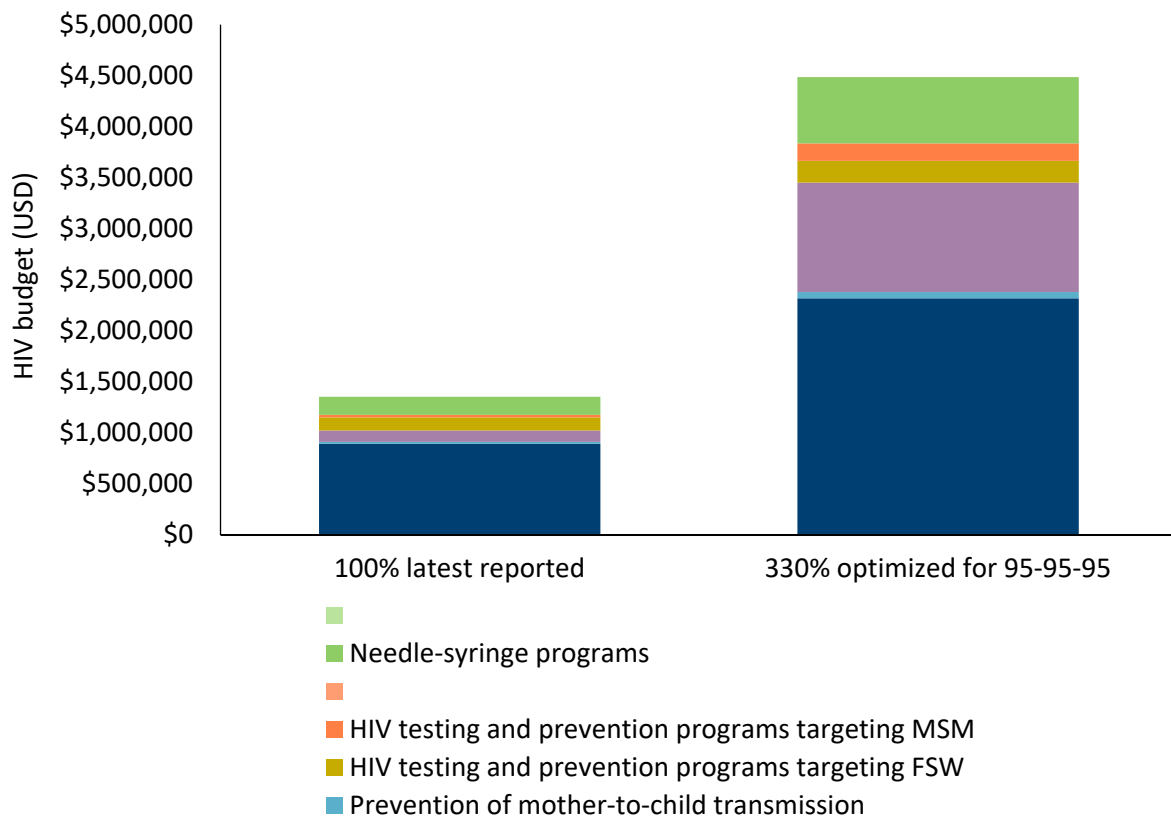


Figure A12. Estimated new HIV infections and HIV-related deaths under optimized allocation towards best achieving 95-95-95 targets by 2030 – Moldova Right bank

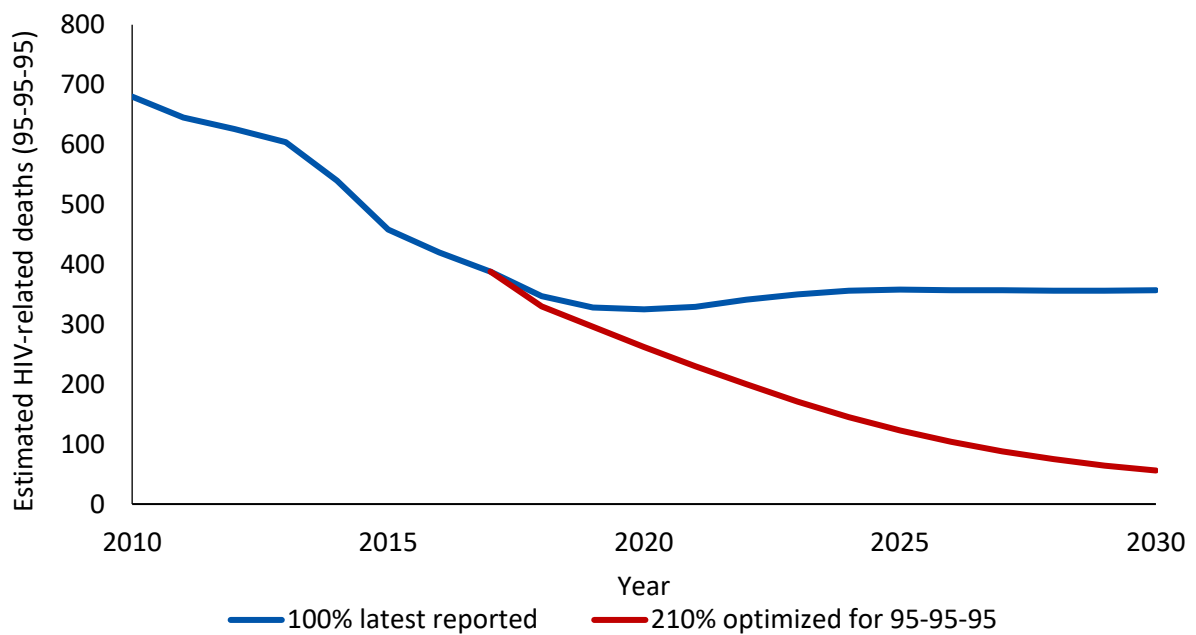
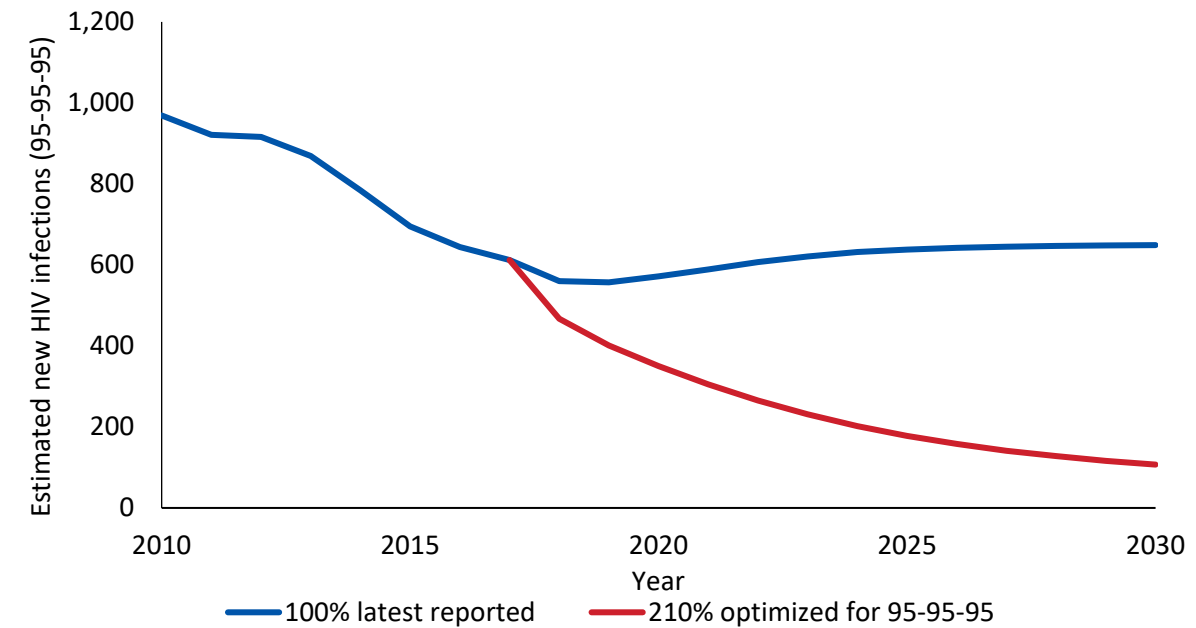


Figure A12. Estimated new HIV infections and HIV-related deaths under optimized allocation towards best achieving 95-95-95 targets by 2030 – Moldova Left bank

