IMPROVING THE ALLOCATIVE EFFICIENCY OF MALAWI'S HIV RESPONSE

Findings from a Mathematical Modeling Analysis

POLICY BRIEF:

IMPROVING THE ALLOCATIVE EFFICIENCY OF MALAWI'S HIV RESPONSE

Findings from a Mathematical Modeling Analysis

This page is for collation purposes only.

TABLE OF CONTENTS

FIGURES

TABLES

Malawi has made enormous strides in reducing new HIV infections and AIDS-related deaths over the last 15 years, largely due to sexual behavior change and increased treatment uptake.[i] However, there are still ~33,000 new HIV infections and ~15,000 AIDS-related deaths annually.[ii] Malawi has set the ambitious goal to end AIDS by 2030 and has aligned its national strategic plan with global goals and targets including 90-90-90 fast-track targets for HIV treatment, targets towards the virtual elimination of mother-to-child transmission and reducing new HIV infections. This study examined the alignment between resource allocation and programmatic need to determine whether improvements in epidemiological outcomes are possible through better resource targeting. Through formal epidemiological and resource optimization, it was identified that Malawi allocates resources to districts with high HIV epidemic burden and program areas including antiretroviral therapy (ART), prevention of mother-to-child transmission (PMTCT), health-facility based HIV testing services (HTS), voluntary medical male circumcision (VMMC) and condom programs that can yield large impact. However, by further increasing the allocation of existing HIV resources to districts with high HIV prevalence and programs with highest impacts, it is possible to obtain further reductions in annual infections and deaths even if the total budget remains stable.

KEY POLICY MESSAGES

Combined with necessary increases of programs to increase viral suppression and testing, the total additional cost beyond current funding required to meet 90-90-90 targets is estimated to be approximately US$60 million per year.

► Treatment scale-up, should remain an important priority in Malawi's HIV response but will cost additional funds, unless implementation efficiency gains can be realized. Based on average national ART unit cost of approximately US$130 and a population of 1 million PLHIV (estimated to remain relatively stable), getting 81% of PLHIV on treatment will require annual investments of approximately US$105 million until 2030, representing an increase of US$15 million per year over the current treatment budget. Combined with necessary increases of programs to increase viral suppression and testing, the total additional cost beyond current funding required to meet 90-90-90 targets is estimated to be approximately US$60 million per year. By 2020, this is within Malawi's projected HIV budget.

► Given that Malawi's health spending is already high – 16.8% of all government spending in 2014 against a regional average of 9.8%, there is very limited fiscal space for additional domestic health spending.

► Viral load testing should continue to be provided and adherence support be scaled up. Adherence support interventions are especially important for HIV+ pregnant women who stop taking treatment after childbirth. While these programs are critical for maintaining and monitoring viral suppression, the share of HIV budgets required for these interventions compared to the share of treatment is relatively high in Malawi. In many countries, it is typical for the unit cost of a viral load test to be less than 5% of the annual

cost of treatment; in Malawi, it is around 20%. While this is largely a consequence of the low treatment cost in Malawi, further cost reductions in VL testing are desirable, both through enhanced price negotiation and minimizing in-country costs. Since Malawi achieved 90% viral suppression at the time of the Malawi Population-based HIV Impact Assessment (MPHIA)[iii] when viral load monitoring was still being scaled up and only provided every two years, the epidemiological benefit of annual viral load testing is expected to be small.

► Health-facility based HIV testing modalities including provider- and client-initiated testing are projected to remain the largest source of new HIV diagnoses in optimized allocations because of the large volumes of people tested and the low unit costs. Available data suggests that alternative community-based testing approaches have produced lower yield than facility-based testing in Malawi.[iv] Similarly, proposed strategies of testing adolescents and young people are likely to produce relatively low yield due to the low HIV prevalence in that age-group. Alternative outreach modalities for HIV testing will only be cost-effective if they focus on populations where high yield can be expected. This includes populations with highest HIV incidence and prevalence such as female sex workers and women and men aged 25-49 in high HIV prevalence districts.

Figure 1: HIV treatment cascade in Malawi, for 2016 and 2030 with current allocation of resources, and 2030 with optimized allocation of resources.
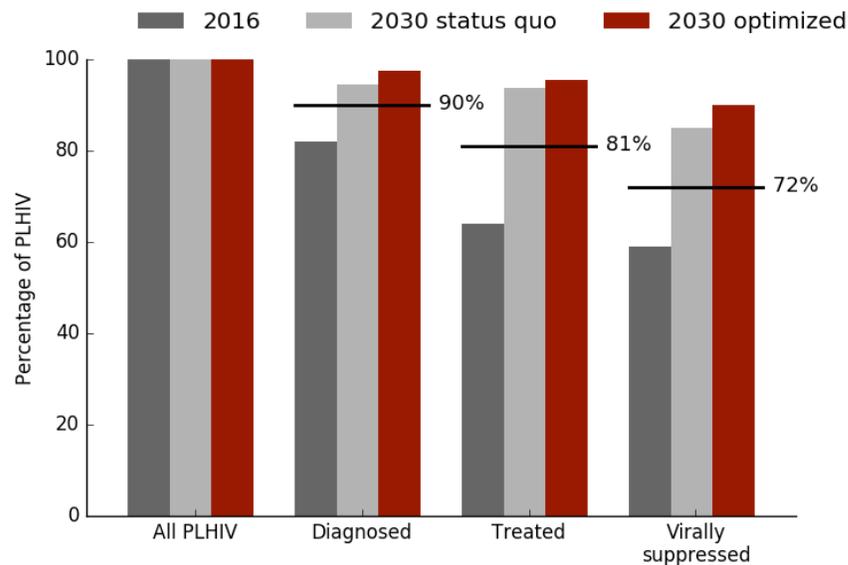
Source: Estimates from Optima Model 2016), and MOH routine data.

► Voluntary medical male circumcision (VMMC) continues to be part of optimized allocations in a majority of districts, but the total allocation for VMMC in the optimized budget is lower than in the costed NSP. Considering actual costs per VMMC from past implementation experience, VMMC is no longer cost-effective in seven districts with relatively lower HIV prevalence. The relatively largest allocations to VMMC are proposed for districts with high HIV prevalence in Southern Malawi. If HIV incidence continues to decline due to increased viral load suppression as projected in our model, the role of

long-term benefits of VMMC declines. In this context, it may be more cost-effective to focus on adult men from age groups with high HIV incidence or young adult men transitioning into age groups with high HIV incidence, while considering that operationally adult men may be more difficult and expensive to reach than adolescents.

► Condoms should remain available nationally and their promotion be enhanced, particularly among priority populations engaging in casual partnerships and in key locations. Due to their low unit cost and their relatively high use in casual sexual relations, condoms remain part of optimized allocations and a moderate increase of investment is proposed with a focus on high HIV prevalence districts, mostly in the Southern parts of the country. Public sector condoms are also partially used by key populations including sex workers and among sero-discordant couples.

► Additional investment is required to reduce new infections associated with female sex workers (FSW), for whom HIV prevalence, while declining, is estimated to be greater than 60%. Comprehensive FSW prevention packages (consisting of testing, linkage to care, condoms, and community support) should be made available to as many FSW as possible. In the context of model-estimated HIV incidence of 4.6% per year among sex workers, PrEP could be cost-effective in this population in Malawi while considering that risk among FSWs varies. However, PrEP for FSW would only be cost-effective if high uptake, retention and adherence can be achieved in real-life implementation. Importantly, PrEP would not be cost-effective if it led to a reduction in condom use rather than providing additional protection for FSW who do not use condoms consistently.

► The current package of services for adolescent girls and young women is considerably substantially less cost-effective for preventing HIV infections and deaths than other interventions included in the model. This is mainly due to the high unit cost of the comprehensive package of services for adolescent girls and young women, which includes several interventions with low potential for HIV prevention impact. In line with the approach applied for all other interventions, non-HIV benefits of programs for AGYW were not quantified in the model. The cost-effectiveness of programs for AGYW may be improved by focusing only on AGYW at the highest risk if it were programmatically feasible to identify and enroll this sub-group.

► The most important criterion for allocating HIV resources across districts is the estimated number of PLHIV. This is already taken into account in national planning. However, shifting even more of the existing funds towards high-prevalence 'hotspot' districts in the south – Blantyre, Zomba, and Thyolo – is estimated to nationally, prevent 7% more infections and deaths by 2030. High HIV prevalence is a source for more new infections leading to even higher prevalence, and breaking this cycle will require even more additional investment in these districts with high HIV prevalence.

► Given the geographical diversity in optimized allocations, Malawi's HIV response could be organized using a combination of nation-wide programs and location-specific packages. Nation-wide programs should include health-facility-based HIV testing, ART, PMTCT, adherence support, VL testing and condom distribution and promotion. The provision and intensity of other primary prevention programs and other HIV testing modalities should be guided by developing differentiated additional packages for medium and high-

HIV prevalence locations. Detailed district-level allocations presented in this report (Figure 10) can broadly guide sub-national packages. For management purposes, standardized packages for clusters of districts may be elaborated. One example for such a differentiated strategy is the Kenya HIV Prevention Revolution Roadmap.[v] For example, based on model outputs, medium HIV prevalence settings (which may be defined as approximately >5%, <10% adult HIV prevalence), the package could be expanded to include targeted VMMC plus enhanced demand generation for condoms and HTS focused on priority populations within the general population. In addition, in high-HIV prevalence locations (>10% HIV prevalence), VMMC could be scaled up and intensive demand generation for all core HIV services should be provided for the respective priority populations within the general population. Programs for sex workers could be geographically targeted to key locations ('hotspots') across the country.

► **Approximately one third of HIV spending in the 2016–17 HIV response budget** was allocated to various cross-cutting, care, support, management and other costs, which could not be included in the mathematical optimization analysis. Although some of these expenses are necessary to complement core HIV services, further implementation efficiency analysis is needed to realize potential savings in these spending categories. Any savings could be reinvested into core HIV prevention, diagnosis, and treatment programs identified as cost-effective in this study.

► If the current resource envelope were allocated optimally, **HIV-related deaths and new HIV infections could be reduced by up to 27% and 17%, respectively, and the number of people living with HIV will decrease more quickly.** Annual new infections and deaths have both already decreased by more than 60% from their peaks in the early 2000s, but further reductions are possible. If the current allocation of funds were to continue, the number of PLHIV would stay relatively constant even with continued expansion of treatment. A constant or increasing number of PLHIV would imply a substantial long-term financial commitment for the country.

1 DISEASE BURDEN AND HEALTH FINANCING CONTEXT IN MALAWI

Despite the challenging macro-economic environment, Malawi has made considerable progress in relation to a number of human development indicators.

Malawi is one of the countries with lowest national income: In 2015, Malawi's gross national income of US$350 per capita remains among the lowest in the world and annual GDP growth of 2.8% in 2015 remained below the average of low income countries.[vi] Despite the challenging macro-economic environment, Malawi has made considerable progress in relation to a number of human development indicators. Life expectancy at birth increased from 44.1 in 2000 to 62.7 years.[vii] Although Malawi's population grew from 11.2 million in 2000 to 17.2 million in 2015[viii], fertility rates declined from 6.3 children per woman in 2000 to 4.4 children per woman in 2015.[ix] Considerable investments made in the health sector contributed to achievement of MDGs on infant and under-five mortality as infant mortality declined from 143 per 1000 live births to 43 between 1990 and 2015 and under-five mortality from 242 to 64 per 1000 live births.[x] Pregnancy related mortality increased in the 1990s due

to HIV/AIDS from 615 in 100,000 live births in 1992 to 1,123/100,000 in 2000 and since then declined to 497/100,000 in 2015.[xi]

Health expenditure is high relative to country income status, but inadequate, in absolute terms, to improve and sustain a functioning health system: Overall revenues and grants in Malawi are estimated at 32.3% of GDP, and government expenditures at 38.0% of GDP, leaving a substantial deficit contributing to increasing public debt. Domestic revenue is estimated at 26.9% of GDP. Malawi's total government revenue as a percentage of GDP is estimated at 21.4%. [xii] Although overall fiscal performance can be improved and revenue collection can be enhanced, Malawi's general government health expenditure is already relatively high compared to other African countries. Government health spending accounts for 16.8% of total government spending, the highest value among 52 African countries, which spent a median of 9.8% on health in 2014 (Figure 2). Compared to the median of the same 52 African countries, Malawi also ranks high on government health spending in relation to GDP (6.0% in Malawi vs. 2.5% median) and total health expenditure as percentage of GDP (11.4% in Malawi vs. 5.6% median). However, total health expenditure *per capita* in Malawi was still relatively low at US$29 versus US$58 in the median of 52 African countries in 2014 (Figure 3). Even when adjusting for purchasing power, health expenditure per capita in Malawi remains far below the regional median.

In numeric terms Malawi spends less than half of the estimated US$86 per capita required for a functional health system in low income countries[xiii]. While recognizing that there is no magic number for a health spending target[xiv], this suggests that despite considerable investment in relative terms, a funding gap in health remains in absolute terms. Different options for increasing health financing through domestic sources are currently being explored elsewhere, including earmarked financing through fuel and motor vehicle insurance levies as well as introducing a national health or a purchasing agency for health services. [xv, xvi]

Figure 2: Government and total health expenditure in Malawi and in the African Union (median), in 2014
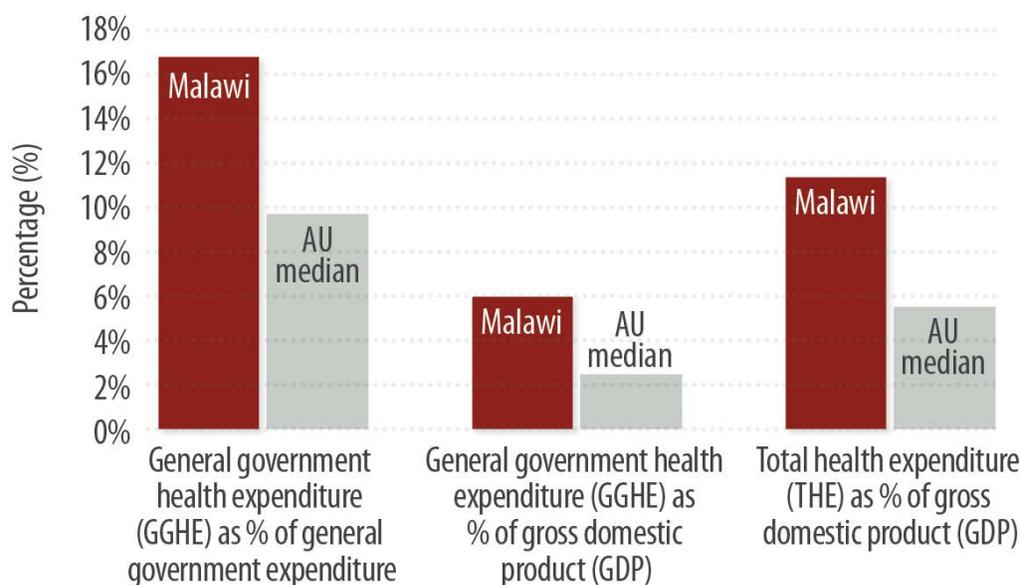
Source: World Health Organization. Global Health Expenditure Database 2014. Geneva 2016. (last accessed 20 October 2016)

Figure 3: Total health expenditure in Malawi and in the African Union (median), 2014.
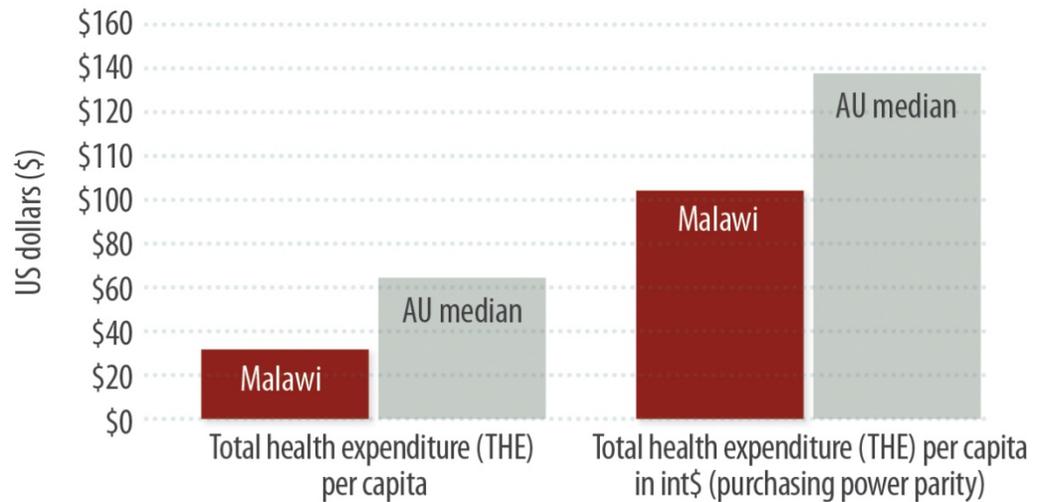
Source: World Health Organization. Global Health Expenditure Database 2014. Geneva 2016.

HIV disease burden in Malawi and expenditure on HIV: Malawi's overall burden of disease remains dominated by infectious diseases and child health causes. HIV accounted for 17% of disability adjusted life years (DALYs), 19% of years of life lost (YLL) and 19% of deaths in Malawi according to the 2015 Global Burden of Disease Study (Figure 4). Annual HIV spending of US$184 million represented 38% of Malawi's total health expenditure in 2014.

This level of spending roughly corresponds to the contribution of HIV to disease burden before large-scale antiretroviral therapy (ART) was available and when more than a third of deaths in Malawi were AIDS-related.[xvii] Between 2005 and 2015, investment into HIV programs has made a substantial impact on reducing the contribution of HIV and AIDS to disease burden. The share of domestic public HIV spending remained relatively low at US$26 million[xviii], which represents 10% of total government health spending and 14% of total HIV spending from all sources, suggesting continued high dependence on external funding.

Figure 4: **Contribution of HIV and AIDS to overall disease burden in Malawi (in percent) and HIV spending as a proportion of total health spending (in percent)**
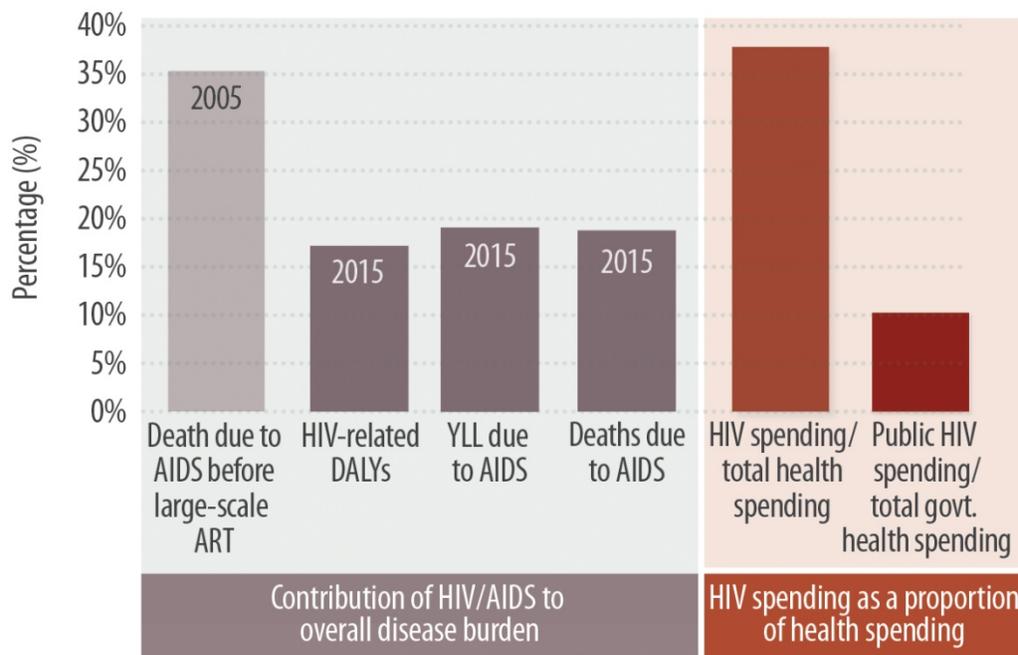
Sources: Prepared by authors based on: Institute of Health Metrics and Evaluation. Global Burden of Disease Study 2015. Washington 2016; World Health Organization. Global Health Expenditure Database 2014. Geneva 2016. Government of Malawi. Malawi AIDS Response Progress Report 2015. Lilongwe 2015.

The health sector in Malawi will need long-term financial and technical support: The scale of the financing gap in the health sector justifies Malawi seeking continued and expanded external support for different health priorities. At the same time, there is also pressure on Malawi to both increase its share of domestic HIV financing as part of the global efforts to increase HIV program sustainability and to increase efficiencies within the program. Through a combination of improved efficiency and continued efforts to enhance domestic investment into health and HIV, Malawi can sustain and improve its position in attracting continued external support, which will continue to be required towards reducing the health financing gap. The funding gap on health is likely to affect other development outcomes including economic productivity, and hence, investing in health remains essential for overall achievement of development outcomes.

> The funding gap on health is likely to affect other development outcomes including economic productivity, and hence, investing in health remains essential for overall achievement of development outcomes.

2 HIV EPIDEMIC AND INVESTMENT CONTEXT

2.1 Malawi's HIV epidemic: past, present, and future

Malawi has a considerable burden of HIV, with a currently estimated 1.1 million people living with HIV (PLHIV), HIV prevalence of 1.2% among children aged 0-14 years and 10.7% for people aged 15 years and older.

New HIV infections have significantly slowed down: The number of new HIV infections has decreased by ~70% from a high-transmission period — 80,000 to 90,000 new infections between the early 1990s and 2005 — to 33,000 in 2016 according to Optima estimates. Reasons for the HIV incidence decline include behavior changes and in recent years increasing uptake of antiretroviral therapy.[xix] If current conditions continue (including continued treatment scale-up towards 90-90-90 while keeping other interventions constant), incidence will be further reduced by half by 2030, to 13,000. HIV-related deaths reached their peak in approximately 2004, at 65,000 per year, decreasing by ~80% to 11,000 currently. Like new infections, treatment scale-up is expected to produce further significant reduction in deaths, to 3,000 per year by 2030. This suggests that substantial gains are made by current investment. The global target[xx] of a 90% reduction[1] in new HIV infections by 2030 relative to 2010 would not be achieved with current levels of investment (2016-17 NSP budgets). These results are shown in Figure 5.

> The number of new HIV infections has decreased by two thirds from a high-transmission period— 80,000–90,000 new infections between the early 1990s and 2005—to 33,000 in 2016 according to Optima estimates.

Figure 5: Projected trends of new HIV infections (A.) and HIV-related deaths (B.) from 1990 to 2030 and estimated numbers of new infections (C.) and HIV related deaths (D.) in 2016

A.

---
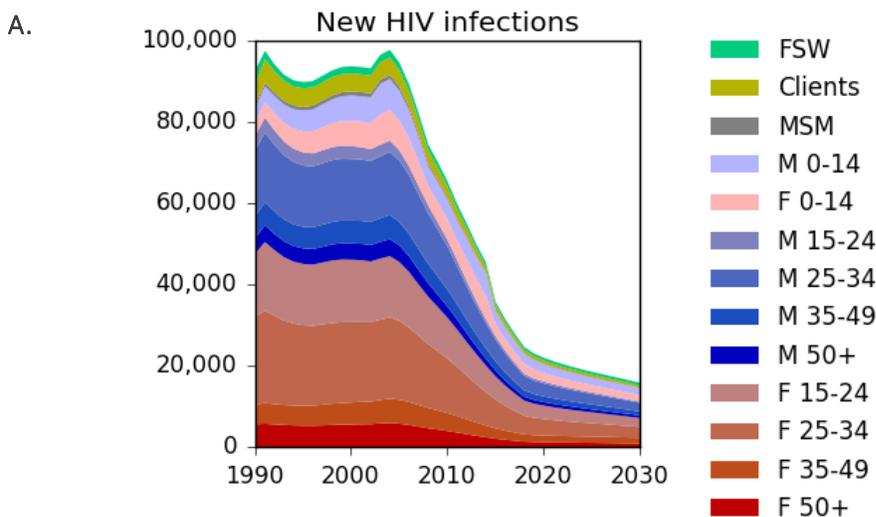
1 The Sustainable Development Goals set out the objective to end the epidemics of AIDS, TB and Malaria by 2030. As part of its Fast-Track strategy, UNAIDS defined 'ending AIDS' as fewer than 500,000 new HIV infections and 500,000 AIDS related deaths by 2020 and fewer than 200,000 new infections and 200,000 deaths by 2030. For new infections, this is equivalent to a 90% reduction between 2010 and 2030.

B.

HIV-related deaths

Legend:
- FSW
- Clients
- MSM
- M 0-14
- F 0-14
- M 15-24
- M 25-34
- M 35-49
- M 50+
- F 15-24
- F 25-34
- F 35-49
- F 50+

1990 2000 2010 2020 2030
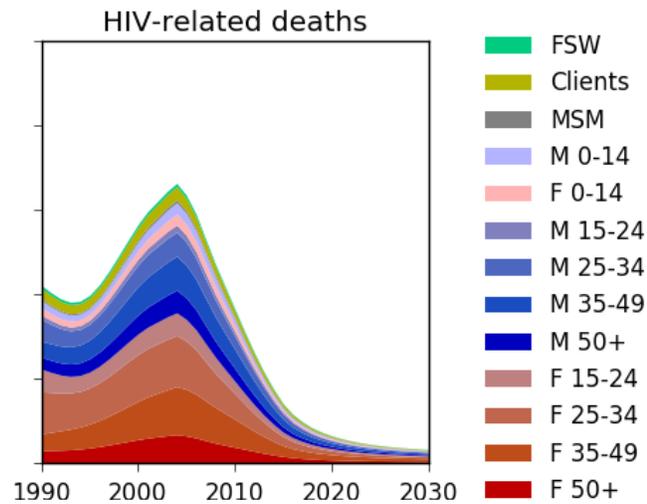
C.

Proportion of new HIV infections, 2016

6.0% 3.5%
7.2% 9.0%
9.0%
19.3%
14.8%
15.7%
4.0% 6.3%

Legend:
- FSW
- Clients
- MSM
- M 0-14
- F 0-14
- M 15-24
- M 25-34
- M 35-49
- M 50+
- F 15-24
- F 25-34
- F 35-49
- F 50+
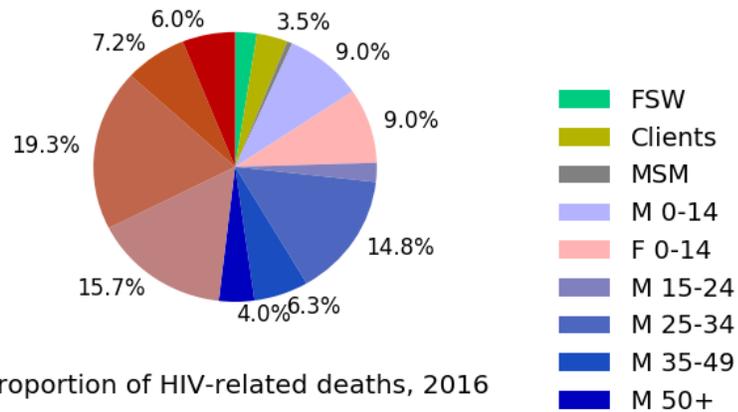
D.

Proportion of HIV-related deaths, 2016

11.2% 5.1%
3.8%
3.7%
2.7%
18.5%
8.5%
12.8%
14.7%
7.8% 8.7%
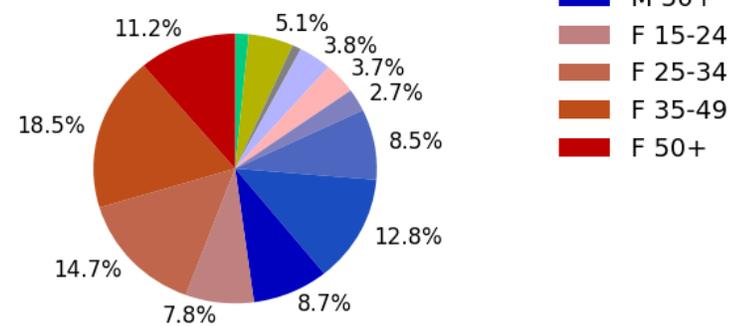
Source: Estimates from Optima-HIV Model 2016)

Note: Population groups are defined as follows: FSW, female sex workers; Clients, clients of sex workers; MSM, men who have sex with men; M, male; F, female.

Resultant slow decline in future PLHIV: Within the context of significant reductions in new HIV infections, projections reveal that continuing the status quo, including ART scale-up towards 90-90-90, will lead to an expected slow decrease in the number of PLHIV in Malawi, reaching 930,000 by 2030. Over the same period, HIV prevalence is projected to decrease to 3.4% overall (6.0% in adults and 0.5% in children) in a context of continued population growth.

Geographic distribution of HIV prevalence and PLHIV: Malawi's HIV epidemic is geographically diverse with a more than 6-fold difference in HIV prevalence between the districts with lowest and highest prevalence values. Malawi's HIV disease burden is most significant in the south (Figure 6), with adult HIV prevalence ranging from 2.2% in Chitipa in the north to 13.6% in Mulanje in the southeast. Within the central and southern regions, PLHIV are concentrated heavily in cities, with Lilongwe and Blantyre both having over 140,000 PLHIV – *together comprising almost one-third of the total PLHIV in Malawi.*

Figure 6: **Geospatial distribution of HIV prevalence (left) and number of people living with HIV (right)**
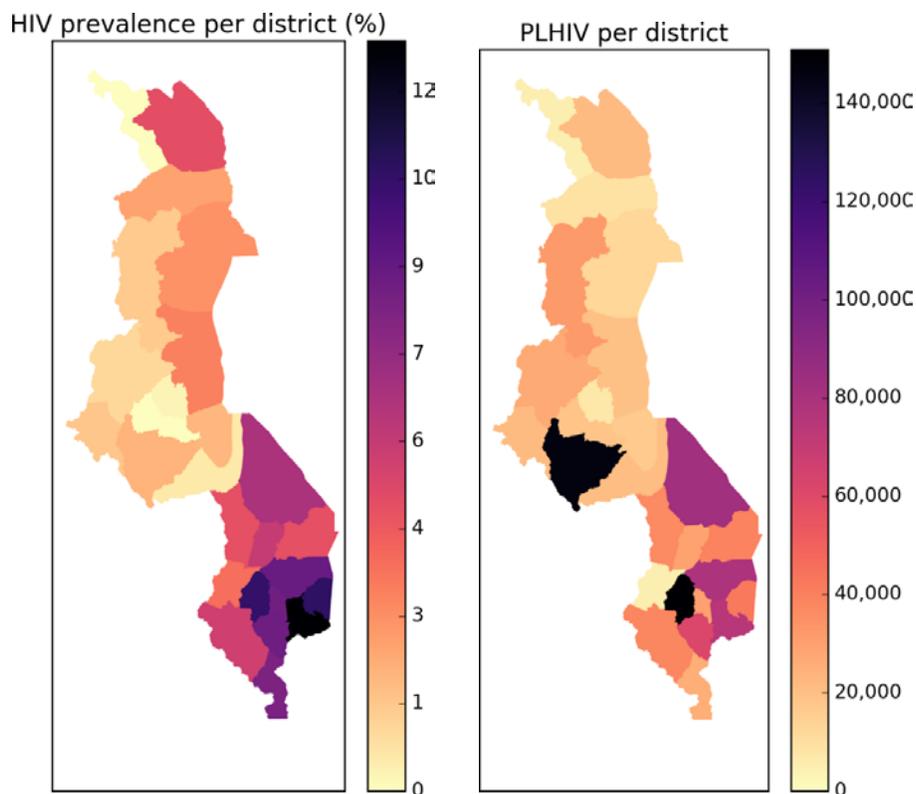
Source: Estimates from Optima HIV model (2017)

District	HIV prevalence	Number of PLHIV	District	HIV prevalence	Number of PLHIV	District	HIV prevalence	Number of PLHIV
Balaka	7.2	29,600	Lilongwe	4.0	60,000	Nkhotakota	5.1	20,100
Blantyre	10.9	44,600	Lilongwe City	7.9	86,500	Nsanje	9.1	26,200
Blantyre City	11.6	106,300	Machinga	6.3	39,800	Ntcheu	6.3	37,200
Chikwawa	7.0	38,500	Mangochi	7.9	83,000	Ntchisi	2.6	7,700
Chiradzulu	9.4	30,400	Mchinji	3.6	22,100	Phalombe	11.0	42,300
Chitipa	2.4	5,300	Mulanje	12.9	74,600	Rumphi	4.4	9,400
Dedza	2.8	21,400	Mwanza	5.5	5,800	Salima	3.9	17,000
Dowa	2.4	18,800	Mzimba	3.5	32,500	Thyolo	9.4	61,800
Karonga	6.4	22,300	Mzuzu City	3.5	8,400	Zomba	9.6	64,700
Kasungu	3.2	27,500	Neno	7.8	12,300	Zomba City	9.6	14,100
Likoma	5.3	600	NkhataBay	4.8	13,200			

2.2 HIV investment and results

Aggressive scale up of HIV testing and early ART: Over the last 15 years, Malawi has aggressively scaled up HIV testing and (since 2004) HIV treatment. A significant part of Malawi's HIV treatment scale-up has been through Option B+ (putting all HIV+ pregnant women, upon HIV + diagnosis, on lifelong ART). This strategy has contributed substantially to the achievement of almost 730,000 PLHIV being on treatment (early 2017). This number is projected to increase to over 800,000 by 2030, according to model-based estimates provided by the Malawi Ministry of Health. The proportion of PLHIV who are diagnosed in Malawi is 82%, which is one of the highest globally and close to the first of the three 90s.

As a result of this focus on HIV testing and ART, good progress on ART treatment cascade, but some opportunities for improvement remain: Malawi's HIV care and treatment cascade (Figure 7) is progressing towards 90-90-90 targets set for 2020 and in early 2017 progress stands at an impressive 82-89-91. This means that 82% of PLHIV are diagnosed against a 2020 target of 90%, 89% of the diagnosed PLHIV are on ART and 91% of the people on ART are virally suppressed. If the total number of PLHIV are taken as the denominator, 90-90-90 means 90% of all PLHIV diagnosed, 81% (90%*90%) of all PLHIV on ART and 73% (90%*90%*90%) of all PLHIV virally suppressed. In Malawi, 73% of all PLHIV are estimated to be in treatment (compared to a target of 81%), and 66% are virally suppressed (compared to a 2020 target of 73%). However, these gaps towards 2020 targets for treatment and viral suppression are a result of 82% of PLHIV being currently diagnosed versus a 2020 target of 90%. Given the large percentage of PLHIV already diagnosed, one challenge in Malawi between 2017 and 2020 will be to find new HIV testing strategies to test those who perceive themselves at low risk. Over time and as the most sick self-identified by arriving at health facilities seeking care and through PMTCT, the yield from HIV testing has decreased from 15.8% (1:6) in 2008 to 4.5% (1:22) in 2016.

> Given the large percentage of PLHIV already diagnosed, one of the largest challenges in Malawi is to find new HIV testing strategies to test those who perceive themselves at low risk.

Figure 7: Estimated number of PLHIV at each stage of the HIV care cascade: undiagnosed, diagnosed, in care, on treatment, and with viral suppression
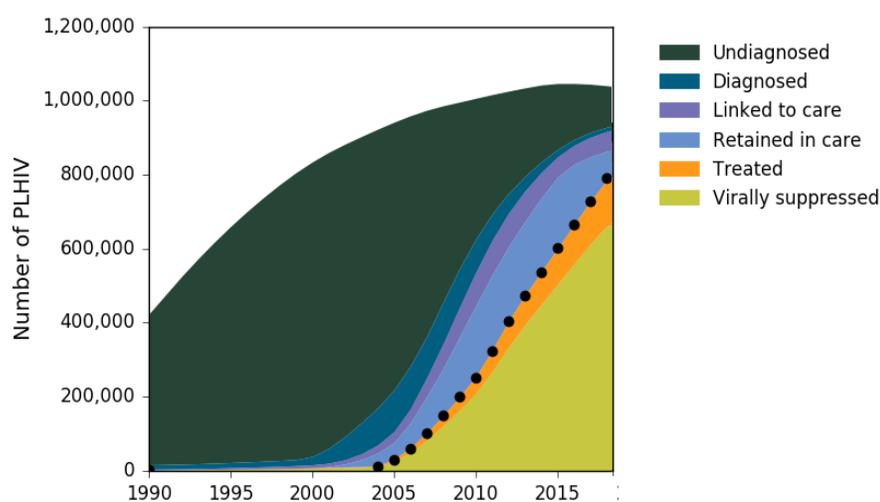
Source: Estimates from Optima-HIV Model (2016) and HIV treatment estimates from MOH.

HIV financing trends and allocations broadly reflect the priority given to HIV treatment:
According to Malawi's costed operational plan, treatment—including adult and pediatric ART and prevention of mother-to-child transmission—accounts for 30% of Malawi's 2016 funding allocation of US$254 million (Figure 8). Programs aimed at increasing viral suppression (adherence programs, viral load testing, and CD4 testing) comprise 5% of the budget. HIV testing and counseling services across eight different modalities together accounted for 2% of the budget. Non-biomedical comprehensive harm-reduction-focused prevention programs (for female sex workers, men who have sex with men and other populations) accounted for a further 4%. Voluntary medical male circumcision accounts for 8% of the budget.

The remaining 50% is comprised of other cross cutting costs including creating an 'enabling environment', services for orphans and vulnerable children, management, infrastructure, monitoring and evaluation, education and empowerment for young women, and other HIV care. Some of these other interventions indirectly support HIV diagnosis, prevention and treatment, while others are cross-cutting and wider health system costs that would be necessary even if the absence of HIV in Malawi (e.g., STI treatment or blood safety funding). As the impact of these areas of spending on HIV incidence and deaths cannot be directly quantified in the same ways as it can be for core prevention and treatment programs, these spending categories are not included in the mathematical optimization. This does not imply that these spending categories are less important or more important than other programs—it only implies that it is not possible to mathematically optimize resource allocation to these program areas (or to decide if these funding areas should be included); different approaches and assumptions are needed, which is discussed later on in the policy brief.

Figure 8: Malawi's 2016 budget allocation, according to its costed 2015 operational plan
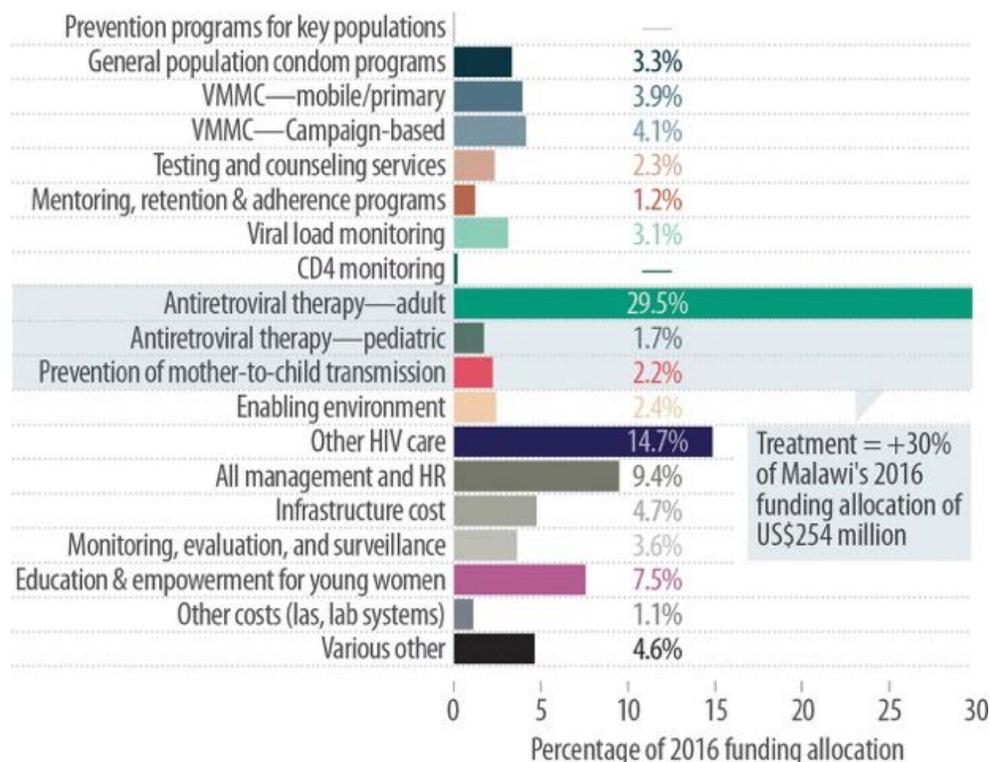
2.3 Age structure of the epidemic

The age structure of Malawi's HIV epidemic is shown in Figure 9. New infections (both received and caused) show a significant age effect, such that infections occur later in men on average than women, as a consequence of sexual mixing patterns. A significant contributor to overall infections is still mother-to-child transmission (MTCT), despite Malawi's high coverage of prevention of mother-to-child transmission (PMTCT). While appearing high at approximately 5,000 HIV+ cases of MTCT per year, this rate is actually 90% below what it would be in the absence of Malawi's high rates of PMTCT coverage. In terms of infections transmitted, clients of sex workers – who transmit HIV to sex workers and other regular and casual partners – and older men have a disproportionate impact through their partnerships with younger women.

The distribution of PLHIV who are not aware of their status and HIV-related death over age follows a roughly similar pattern, and both of these are broadly reflective of overall numbers of PLHIV, although with some time delay, especially in the latter case.

Figure 9:   **Age structure of the epidemic**
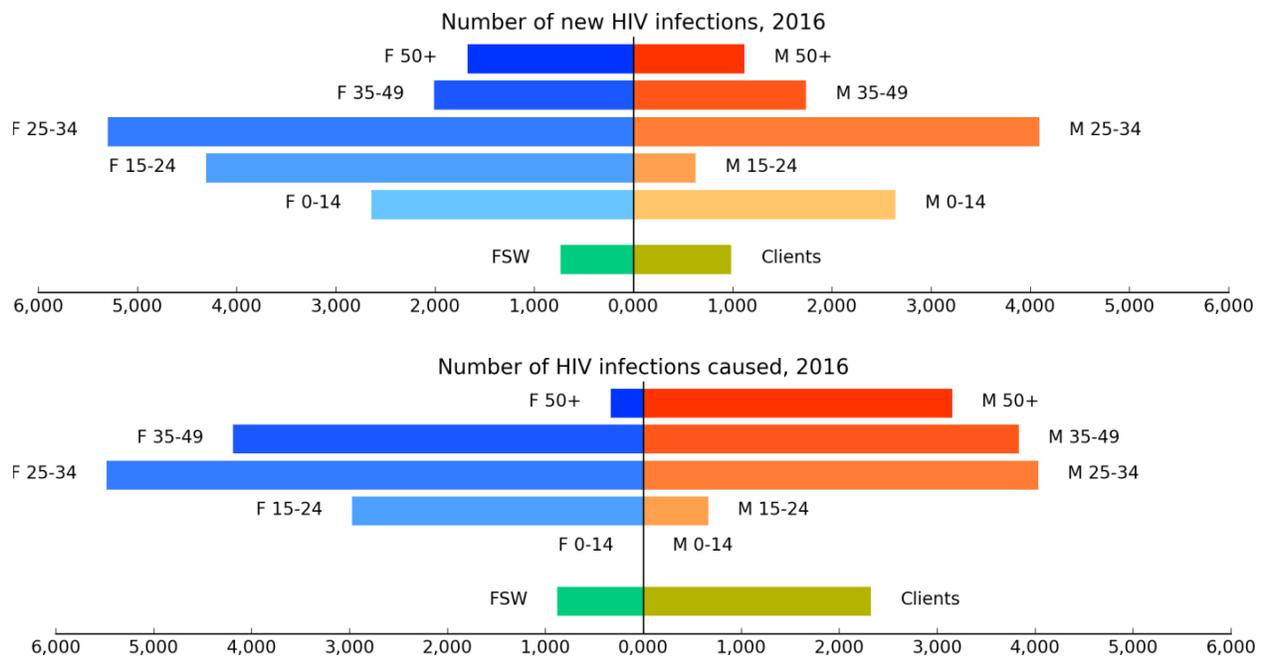
Figure 9:   Age structure of the epidemic (Continued)
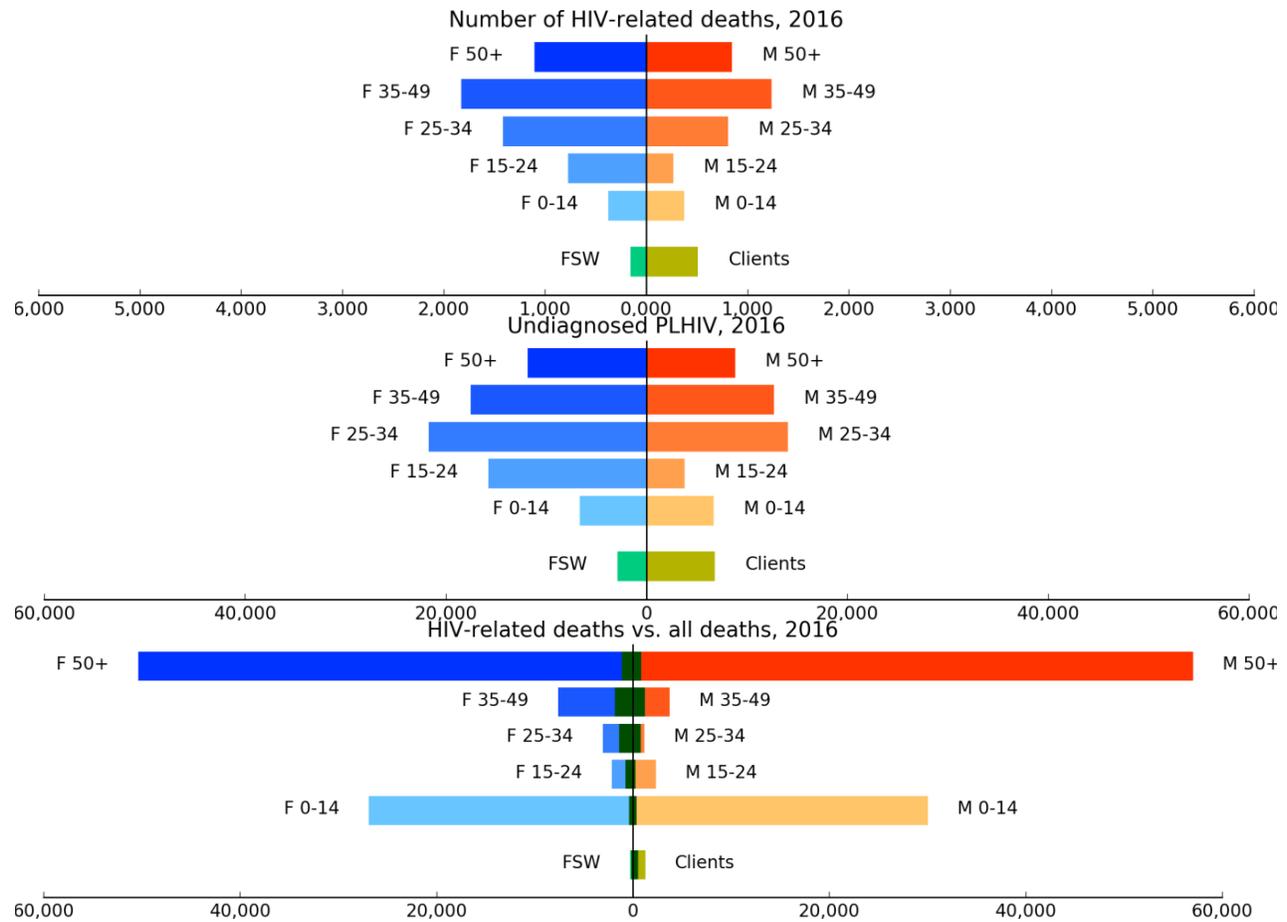
3   METHODS: IMPROVING HIV ALLOCATIVE EFFICIENCY USING THE OPTIMA HIV MODEL

The Optima HIV model was used in this analysis. Optima HIV uses HIV epidemic modeling techniques and incorporates data on biological transmission probabilities, CD4 progression, actual HIV prevalence and related data, sexual behaviour, program funding allocations, program coverage, and sexual mixing patterns. Data and costs relating to programs are used in an integrated analysis, with a mathematical optimization algorithm, to determine an optimized distribution of investment under defined scenarios. Optima HIV is calibrated to HIV prevalence data points available, for sub-populations (e.g. FSWs, MSM) at specific time points and specific geographical locations. It is also calibrated to data points on the number of

Optima-HIV uses HIV epidemic modeling techniques and incorporates data on biological transmission probabilities, CD4 progression, actual HIV prevalence and related data, sexual behaviour, program funding allocations, program coverage, and sexual mixing patterns.

people on ART. Data inputs, assumptions and calibrations were conducted in consultation with experts on the Malawian epidemic. To assess how incremental changes in spending affect HIV epidemics and thus determine the optimized funding allocation, the model uses relationships between the cost of HIV intervention programs, the coverage level attained by these programs, and the resulting outcomes. Using the relationships between cost, coverage and outcome - in combination with Optima-HIV's epidemic module - it is possible to calculate how incremental changes in funding allocated to each program, will impact overall epidemic outcomes. Finally, by using a mathematical optimization algorithm, Optima-HIV is able to determine the "optimal" allocation of funding across different HIV programs.

We applied two different scenarios in our optimization analyses:

1. An optimization analysis where the funding for the 8 cross-cutting and other cost areas were treated as fixed costs to the program and not optimized. This resulted in the amount available for core HIV programs in the optimization analysis: US$182.3 million.

2. An optimization analysis where the team made assumptions about reductions to the funding allocations to the 8 cross cutting and other cost areas and how the savings generated through these reductions could be used to support wider program areas. In these assumptions, we assumed a combination of changes: (a) technical efficiency gains of 5% to 15% (as deemed feasible) in some of the 8 areas and (b) removal of funding for non-HIV related expenditure from the HIV-specific budget. In this second scenario, this meant that an additional US$25.7million from cross-cutting and other costs became 'available' to allocate into the pool of funding available for optimized allocations to the different core HIV services. This resulted in the amount available for core HIV programs in the optimization analysis: US$208 million.

Table 1:   Amounts used in the two optimization analyses

	Scenario 1: Optimizing 2016–17 national strategy budget	**Scenario 2:** Optimizing 2016–17 budget with reduced cross-cutting costs
Core HIV services (included in mathematical optimization	$182.3 million	$208.0 million
Cross-cutting and other (not included in mathematical optimization)	$71.8 million	$46.1 million
Total HIV response cost	**254.1 million**	**$254.1 million**

Source: Authors.

4 KEY FINDINGS AND RECOMMENDATIONS

For the most part, the 70% of Malawi's HIV response funding allocated directly to programs, are allocated efficiently: In general, Malawi's HIV resource allocation is already well targeted in terms of the allocation of funds to different HIV programs nationally, to HIV service delivery modalities, as well as the allocation of funds to districts.

Achieving the same programmatic coverage levels for lower cost may be possible by redistributing funds towards the most cost-effective HIV service delivery modalities, including female sex worker programs, primary-care- and high-volume campaign based voluntary medical male circumcision for adolescents and adults, and client-initiated HIV testing and counseling.

Small reallocations of funding can result in reductions in new infections over the period 2017-2030. The analytical optimal allocation of resources is shown in Figure 10. This shows the need to further increase effective ART coverage through additional investment in high-yield HIV testing, while sustaining viral load monitoring, adherence support and focused HIV prevention programs including condom promotion, FSW programs and geographically targeted VMMC programs.

There is a need to shift a proportion of funding towards higher HIV prevalence districts in the south, particularly for facilitating maintained viral suppression as well as prevention programs. Finally, achieving the same programmatic coverage levels for lower cost may be possible by allocating funds towards the most cost-effective HIV service delivery modalities. Female sex worker programs and general population condom programs target condom use in non-regular partnerships, were more cost-effective modalities than programs for AGYW relative to increasing condom use. Health facility-based HIV testing and counseling remain the most cost-effective testing modalities due to high volumes and low cost compared to current alternative outreach modalities, which produce lower HIV testing yield. We project that if funds were reallocated across programs (and appropriate service delivery modalities) and the right emphases across districts, then over the period from 2017-2030, an additional 40,000 infections (from 230,000 to 190,000) and 21,000 deaths (from 76,000 to 55,000) could be averted, corresponding to 17% and 27% decreases, respectively.

Even bigger gains would be possible if Malawi were to reallocate the $25.7m of funds identified from the 50% allocated to cross-cutting, supportive and management type of allocations to direct HIV service delivery. If this is possible, then 57,000 (from 230,000 to 173,000) new HIV infections and 25,000 (from 76,000 to 51,000) AIDS-related deaths could be averted by 2030 by moving an additional US$25.7 million into core HIV services annually. Such an additional investment would imply substantial long-term savings, as 201,000 new infections averted would translate into an estimated US$ 1.6 billion saved in life-time cost of treatment and associated health care. If we consider the current value of this future cost averted (assuming 3 % discounting), the cost reduction is still US$ 1.1 billion – in other words equivalent to a US$1.1 billion reduction in current debt.

Figure 10: **Shifts in annual funding in each district and program from current (left bar in pair) to optimal (right bar in pair) for programs other than ART and fixed costs.**
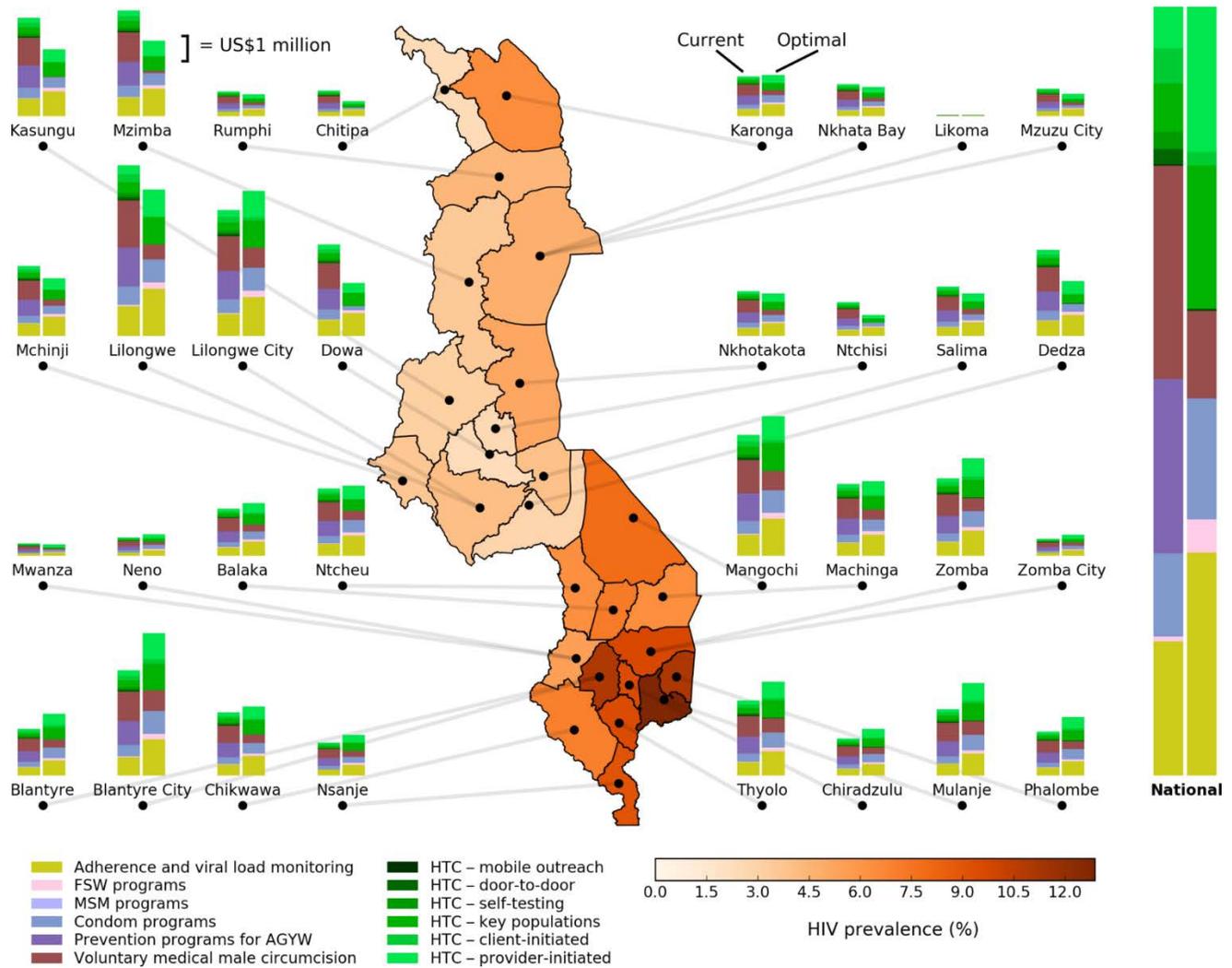
Source: Authors

4.1 Continue to scale-up HIV diagnosis and treatment for viral suppression, which will require additional funding, unless efficiency gains in the non-program costs can be realized

This analysis assumes that ART coverage will continue to increase at current rates towards 90-90-90 goals to address the continued need of PLHIV. This increase, which is achievable with the budget projected for 2019–20, is critical for maintaining Malawi's success in reducing new infections and deaths. As shown in Figure 11, maintaining the current number of people on treatment with no further increases beyond the current number (730,000 PLHIV on treatment) will lead to gains leveling off. Thus, continuing treatment expansion should remain

Based on an average national ART unit cost of US$132 and a population of 1 million PLHIV (estimated to remain relatively stable), getting 81% of PLHIV on treatment will require annual investments of approximately US$105 million until 2030.

an important priority. Based on an average national ART unit cost of US$132 and a population of 1 million PLHIV (estimated to remain relatively stable), getting 81% of PLHIV on treatment will require annual investments of approximately US$105 million until 2030, not including management and other associated costs.

Figure 11:   **Projected epidemic trends in new HIV infections (left) and HIV-related deaths (right) assuming no new people go on treatment, assuming current ART scale-up, or assuming current ART scale-up plus an optimized budget.**
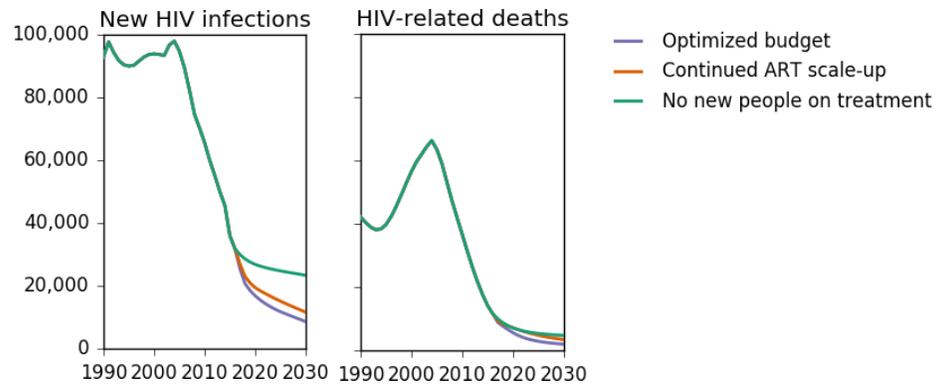
Source: Authors

With treatment scale-up continuing to address the flow of demand, of considerable importance is achieving viral suppression of those on treatment. In Malawi, ART initiation and monitoring – with the ultimate goal of viral suppression – primarily involves viral load monitoring and adherence/retention programs. Routine CD4 testing was already stopped in Malawi in 2016 and is only provided in the context of investigations for opportunistic infections in line with WHO guidance. Viral load monitoring is the most effective and internationally accepted means of identifying treatment failure. However, with a unit cost of US$23 per test—equivalent to 2 months' supply of ART—viral load monitoring constitutes a significant burden on Malawi's HIV response sector. Malawi's treatment costs are among the lowest in the world, and much of its success so far in dealing with its epidemic is attributable to the fact that large numbers of people have been put on treatment relatively cheaply. There is a need to try to reproduce the cost reduction success with viral load monitoring, such that the proportional cost of conducting viral load testing in Malawi is comparable to that of other countries. Malawi achieved 90% viral suppression at a time of MPHIA when viral load monitoring was still being scaled up and only provided every two years. More frequent (annual) viral load testing would have individual clinical benefits and increase transition from patients to second line regimens.[xxi] This was shown to have a moderate effect on mortality among these patients elsewhere[xxii], while epidemiological benefits on transmission would likely be very limited. One opportunity for reducing cost of viral load testing, which was explored in Malawi was pooled testing. In this approach, blood samples from five clients are pooled and one test performed. Only if increased VL was detected, the samples for all five clients are tested individually.[xxiii] Optimization analysis could be performed to determine how many tests need to be pooled to achieve optimal cost reductions.

Notably, linkage to care and initiation on treatment are the most cost-effective interventions along the treatment cascade.

Notably, linkage to care and initiation on treatment are the most cost-effective interventions along the treatment cascade. This is because even though diagnostic testing is the furthest from the 90-90-90 targets, there are still a number of people who are currently diagnosed and in care who are not on ART. However, while this reflects a current short-term priority,
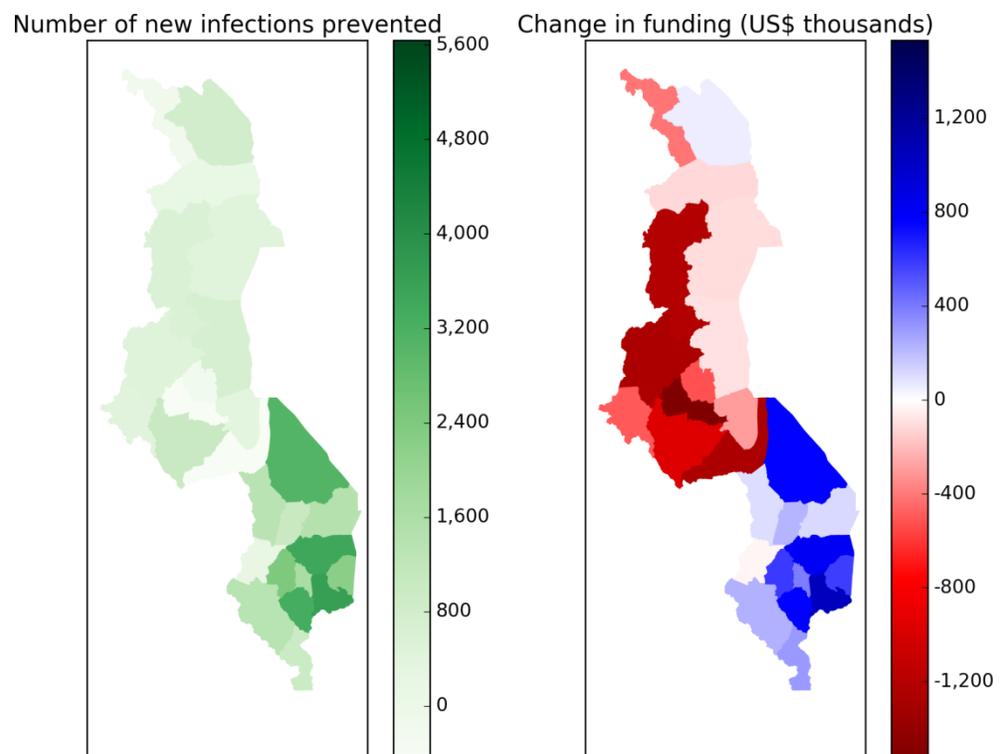
18

The largest increase in funding to a single district due to an optimized allocation would be to Blantyre City, which would receive an additional US$1.5m annually (from US$4.5m to US$6m). This is also the district which could be expected to achieve the largest number of additional averted infections and deaths by 2030 (6000 and 2500, respectively). The largest decrease in funding to a single district would be to Dowa, which would see its annual budget decrease by US$5.2m (from US$7.5m to US$2.3m). It is also the only district in the optimal allocation to record an increase in infections and deaths over the optimization period (1,500 new infections and 400 new deaths, respectively). But this trade-off would ultimately be of greater benefit for reducing the numbers of infections and deaths overall across Malawi. In other words, this trade-off saves more lives in Malawi overall.

As shown in Figure 14, if the current volume of HIV resources were to be optimally allocated for greatest national epidemiological reductions then the funding for each program in each district is largely as would be expected from a combination of the national-level program results and the district-level results. Certain districts might have slightly different epidemics — such as a concentration of female sex workers and men who have sex with men in the larger cities — which influence generalizable trends. Available data were often not granular enough to analyze these trends in much greater detail at district-level. Thus, additional input from district-level experts would be advisable in deciding on final funding allocations.

Figure 13: **Estimated current and optimal funding (of non-ART and fixed costs) of each district in Malawi as a function of prevalence, showing a shift away from low-prevalence districts and towards high-prevalence districts**
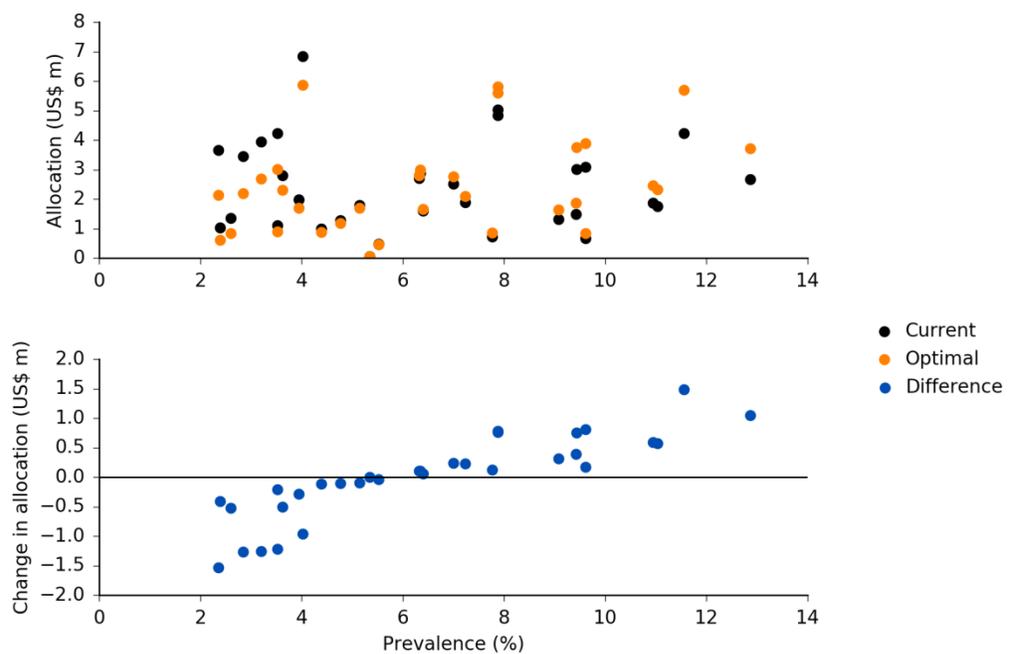
Source: Authors

It is clear that not only cost effectiveness determines program allocations. Other local factors, including equity and other considerations, are important too.

Figure 14: **Full comparison of current (top bar in each pair) and optimal (bottom bar in each pair) allocations for each program in each district for programs other than ART and fixed costs**

Source: Authors
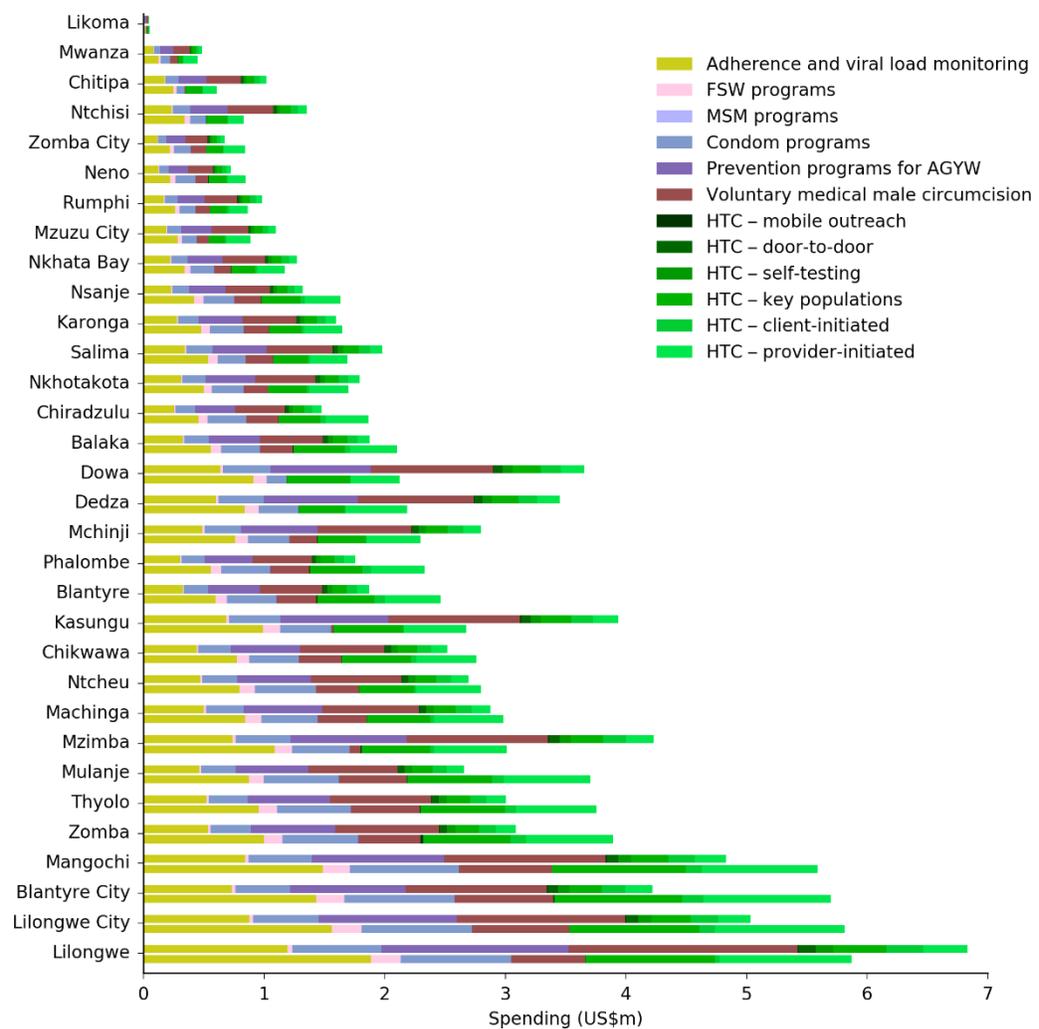
4.3 Choosing the most relevant service delivery modalities for given cost

The yield of HIV testing in Malawi declined from 1:6 (one HIV positive person identified through 6 HIV tests) in 2008 to 1:22 in 2016. While this appears to be a major reduction, it still represented an HIV prevalence of 4.4% among all people tested and led to 150,000 new diagnoses in 2016.[xxiv] This is higher than expected with random selection in an adult population with HIV prevalence of 10% of which more than 75% were already diagnosed.

Currently at least eight different service delivery modalities for HIV testing and counseling are provided in Malawi. As noted above, given that there are already more than 80% of PLHIV who are diagnosed, HIV testing should now also focus on reaching population groups with previously lower HIV testing uptake. For example, the proportion of men tested in the year

prior to the survey increased from 31% to 42% between 2010 and 2015 Malawi DHS rounds. However, despite testing around a third of the male population every year the proportion of men ever tested for HIV only increased from 51% to 68% over five years, an average increase of only 3.4% per year. Therefore, it is now important to also consider the yield of HIV testing, which is the proportion of new HIV positive diagnoses in all HIV tests.

Substantial variation in the costs of different testing modalities exists. However, there are limitations in terms of their interchangeability, since they typically target different populations. There is evidence that certain kinds of testing tend to have lower wastage and greater follow-up and linkage-to-care rates than other kinds of testing programs. New modalities such as self-testing may be useful in reaching other populations including men who were previously not reached by conventional programs (such as provider-initiated testing and counseling). Thus, the overall efficacy of a testing program, and not simply the material and personnel costs of administering a single test, needs to be taken into account. In light of these considerations, we found that health facility-based provider-initiated and client-initiated testing were the most cost-effective modalities (Figure 15). Notably, only provider-initiated, client-initiated, and key population testing feature in the optimal mix based on current model assumptions. However, this result requires considerable nuancing, since while conservative assumptions about maximum saturation yield of coverage were made with respect to each testing program, local variation may mean that not all testing modalities are available in all locations. Thus, the recommendation is two-fold:

► Sustain client- and provider-initiated testing in health facilities. Ensure high testing coverage among women who continue to represent the majority of new HIV infections and the majority of the undiagnosed population;

► Focus scale up of additional HIV testing modalities on men including through self-testing, outreach to places frequented by men in high-HIV incidence settings. Consider modalities to enhance invitation of male partners of pregnant women and male partners of female family planning clients.

In order to reach men through provider-initiated testing, mechanisms to enhance male involvement including active invitation of male partners of female clients of HIV and reproductive health services may be helpful, building on good practices from other countries such as Rwanda. A recent RCT conducted in Malawi suggests that active tracing of male partners of pregnant women – in addition to invitation - significantly increased uptake of couple HIV testing and counseling.[xxv] Invitations of male partners are already being provided in Malawi. Acceptability and scalability of adding tracing of male partners would need to be further assessed considering the additional yield and additional cost. Other location-specific HIV testing modalities to reach men, particularly those at higher risk, need to be explored to increase HTS uptake among men. New modalities need to be assessed not only in terms of yield, but in terms of additionality, i.e. whether they reach new clients unlikely to be reached by other systems or whether they replace existing, potentially cheaper modalities for diagnoses. Such analyses were beyond the scope of this study.

The role of index partner HIV testing has been explored in recently published trials.[xxvi], [xxvii] Since index partner testing is a strategy that may apply to all testing modalities, it was not included separately in the model. Malawi is already providing family referral slips to all index HIV testing clients for sexual partners and any children under 5 regardless of test result and

therefore the main potential benefit of an index partner testing approach would be the notification and enhanced follow up of other sexual partners. Under current conditions, our model suggests that the size of the undiagnosed HIV positive population will decline faster than the number of new HIV infections. Therefore, the proportion of recently infected PLHIV among all undiagnosed PLHIV is likely to increase. It is in this context that index partner testing could play a role in Malawi. Available data suggests that careful considerations of additional workload and cost are required to assess the feasibility of scaling up index partner testing in Malawi. Enhanced follow up may be time-consuming and entail additional costs for communication and outreach. In 2016, 3.4 million HIV tests were performed in Malawi yielding 150,000 HIV positive results. The number of positive diagnoses is projected to decline and not all people diagnosed will require index partner testing, because some will have a known HIV positive partner. This suggests that relative to a burden of performing more than 3 million tests, the procedure of index partner testing for the decreasing number of people diagnosed HIV positive is likely to become increasingly feasible over time. The cost-of index partner testing was not assessed as part of this study and would be key to understand feasibility of scaling up.

Figure 15: **Comparison of current and optimal allocations in two subcategories of HIV spending: testing (left) and prevention (right)**
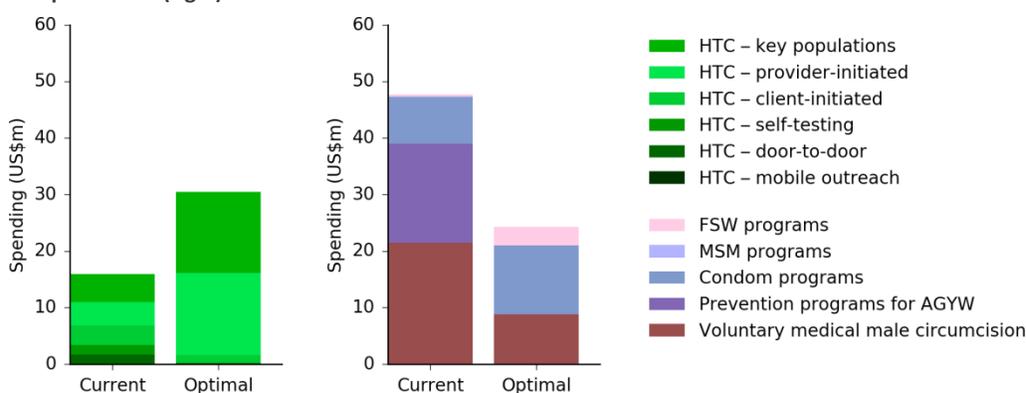
Additional analysis of data from the Malawi Demographic Health Survey provides insights on the profile of men who never tested for HIV and where the gaps are in ensuring high testing coverage (Figure 16). A considerable proportion of men who never tested are at low risk (age group 15–19 and those who never had sex). When excluding these men from the analysis, our rapid review of DHS data suggests that the majority of men at risk of HIV who never tested have primary education, are from rural areas in the Central and Southern region, are never married but had sex, and are in the age groups 20–24 and 40–49. In addition, more systematic secondary analysis of the 2015 Malawi DHS could be conducted to determine the demographic profile of people living with HIV who never tested for HIV and thereby inform focus of such strategies.

Figure 16:   Proportion of men ever tested for HIV in Malawi. Source: Malawi DHS 2015-6
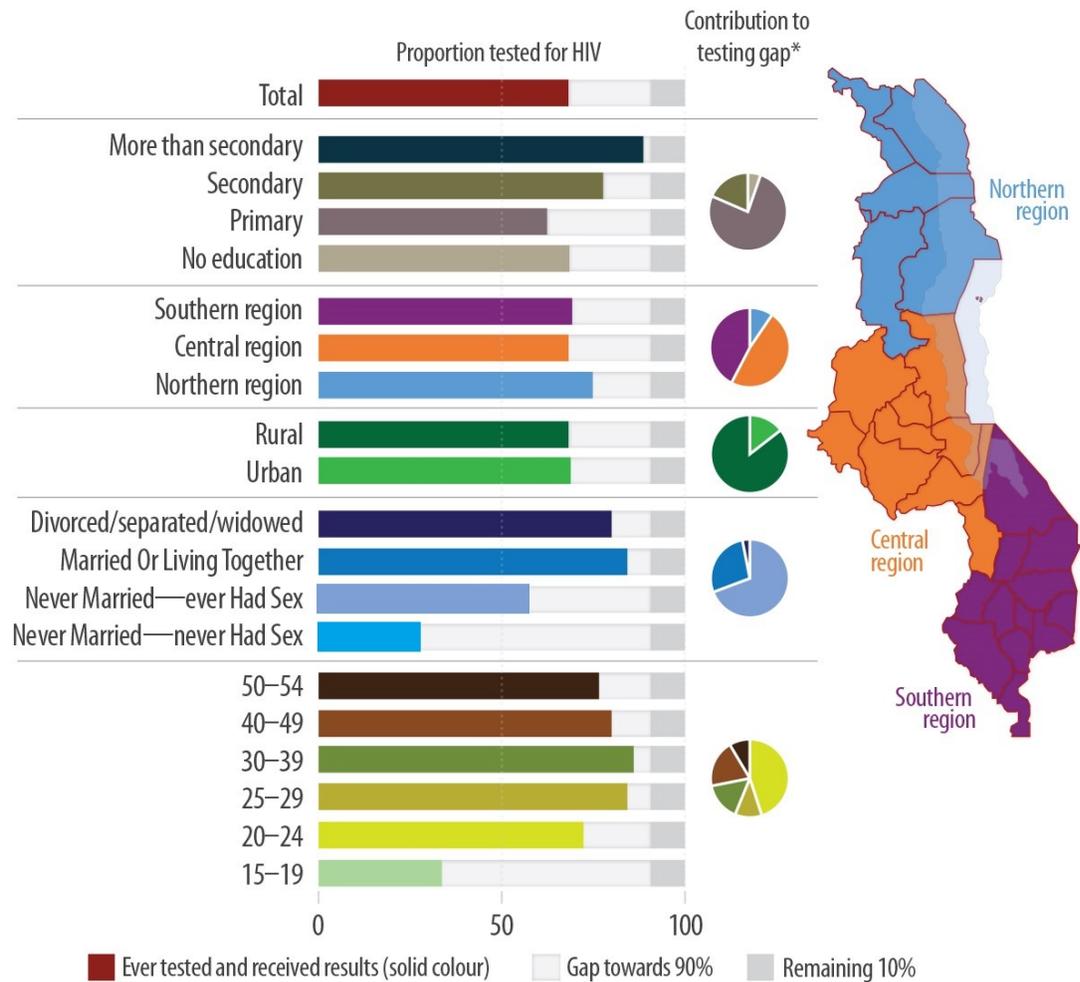
Source: Authors based on DHS 2015-6

Additional analysis of MPHIA data was carried out to establish a demographic profile of people living with HIV who were not aware of their positive HIV status. Among young people 15-24 living with HIV a relatively large proportion is undiagnosed as shown in part a. of Figure 17. However, the far more important finding is shown in part b. of the Figure, which shows a breakdown of the total undiagnosed population by sex and age. Approximately 70% of the undiagnosed respondents living with HIV were in the 25-49 age group, 18% among young people and 11% among the population aged 50+. Considering that population sizes of the groups – 3.3 million aged 15-24, 4.2 million aged 25-49 and 1.1 million aged 50+, this suggests that HIV testing yield could be expected to be around 3 times higher among the population aged 25-49 than among the population 15-24. This analysis is supported by Optima model projections, which produced a similar breakdown of the undiagnosed population (Figure 17).

Figure 17: People living with HIV who are undiagnosed by age and sex (MPHIA 2015–16)

A. Proportion of PLHIV undiagnosed within different age groups

Percent

Males 15-24, (n=28)
Females 15-24, (n=73)
Males 25-34, (n=74)
Females 25-34, (n=138)
Males 35-49, (n=96)
Females 35-49, (n=105)
Males 50+, (n=32)
Females 50+, (n=37)
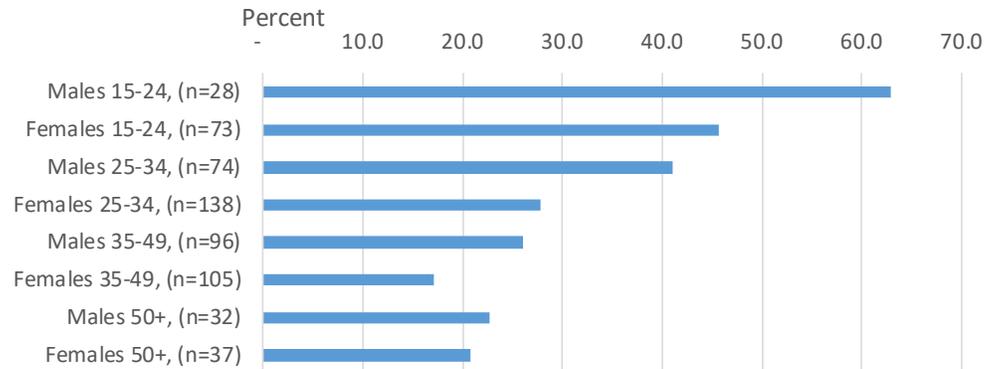
B. **Distribution of undiagnosed people living with HIV by age and sex**

Males 50+ 5%
Females 50+ 6%
Males 15-24 5%
Females 15-24 13%
Males 25-34 13%
Females 25-34 24%
Males 35-49 16%
Females 35-49 18%
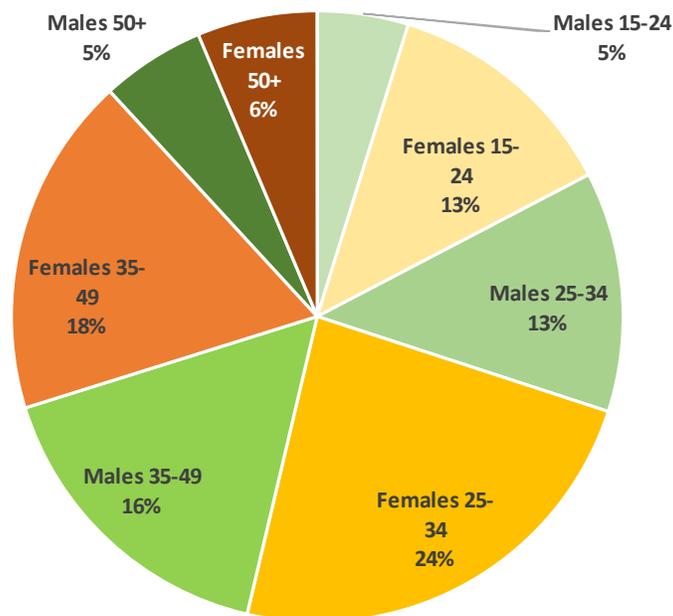
These analyses suggest that the key to achieving the first 90 in Malawi is testing of sexually active adults rather than primarily focusing on younger populations or other sub-groups. While the age- and sex distribution of the population not yet diagnosed is not even, this does not support any specific narrow focus on testing only selected slices of the population, neither female nor male, neither young people nor adults. Although more men are undiagnosed in all age groups, 61% of the undiagnosed population in MPHIA were females. Nevertheless, some considerations on prioritization are useful. Diagnosis and treatment among men is important to enhance viral suppression and reduce high HIV incidence among females. The overwhelming majority of male-to-female transmission is from men aged 25+ and SW clients to sexually active females of all ages. The combination of lower HTS and ART uptake than females, high contribution to transmission and their large share among undiagnosed male populations, makes men 25+ epidemiologically particularly important. Diagnosing the just over 40,000 undiagnosed PLHIV among men 25+ and SW clients should be

one key priority of HIV testing and community-based demand generation for HTS, ART and other prevention services (but not their exclusive focus).

4.4 Considering a differentiated approach to HIV prevention

In the optimal allocation, we found that a differentiated approach to non-ART based prevention programs is likely to be most cost-effective (Figure 18) and that service packages require consideration of location and population. The provision and intensity of other primary prevention programs could be guided by developing differentiated packages for lower, medium and high-HIV prevalence locations. In lower HIV prevalence locations (<5 % adult HIV prevalence), the focus would be primarily on condom distribution and promotion – in addition to the nation-wide packages for HTS, ART, PMTCT and adherence support. Our analyses suggest that general population condom programs remain part of the mix of cost-effective interventions nationally and allocations increase moderately. Continued nation-wide condom programming will also realize non-HIV benefits such as STI prevention and contraception, primarily among young and unmarried people. In medium HIV prevalence settings (>5%, <10% HIV prevalence), the package could include VMMC with a focus on 20-29 year olds – a population where impact would be relatively immediate – plus enhanced demand generation for core HIV services (condoms, VMMC, PMTCT, HTS, ART) focused on priority populations. In addition, in high-HIV prevalence locations (>10% HIV prevalence), VMMC could continue to be provided at scale and intensive demand generation enhancing HIV risk perception and promoting uptake of core HIV services should be provided for the respective priority populations.

In terms of priority populations, optimal spending of current funding envelopes would involve substantial scale-up of programs for FSW, from US$500,000 to US$2.3 million, with district-level funding proportional to the estimated FSW population size. Programs for men who have sex with men, which at the time of the study just received $43,000 in funding, were less cost-effective. Available data suggests that HIV prevalence among MSM in Malawi is similar to men in the general population, but unit cost for the service package for MSM was estimated at around U$59 versus US$ 5.6 for condom distribution in the general population. Beyond this assessment of cost-effectiveness a number of other considerations need to inform programming for MSM including the potential for rapid changes in epidemiology of HIV in MSM communities and aspects of stigma and discrimination, which MSM may face when accessing services. Assessing the best modalities for dedicated programs for men who have sex with men was beyond the scope of this study and the feasibility and effects of dedicated programs for this population, particularly in urban locations, would need to be further explored in a separate assessment.

Figure 18: Overall national changes in funding from current conditions (top) to the optimal allocation (middle), as well as the change in each program (bottom) for selected components of the HIV response assuming a reallocation of US$25.7 million of potential efficiency gains from cross-cutting costs
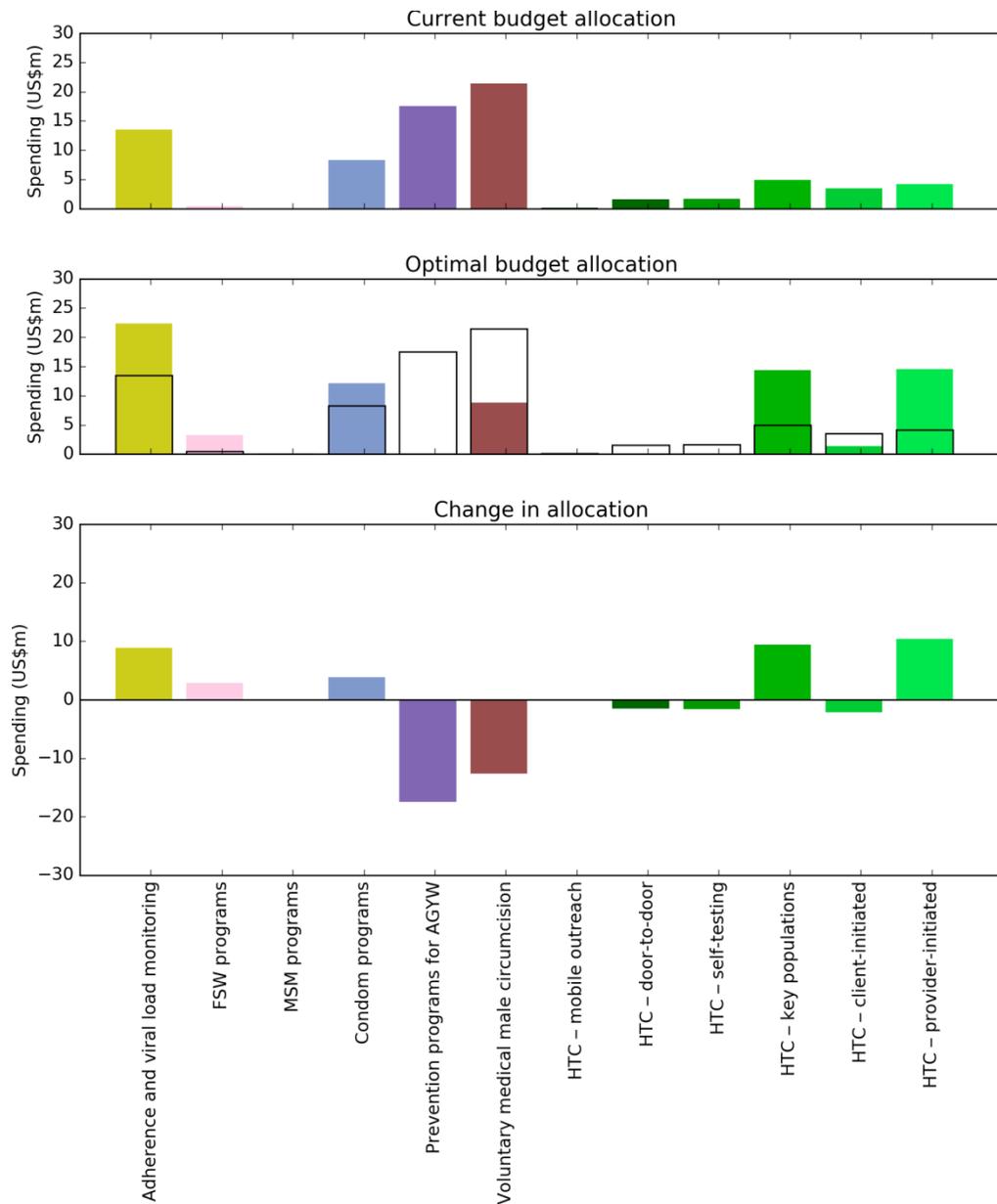
Source: Authors.

4.5 Prioritize interventions with proven effectiveness

A significant proportion of Malawi's current budget, US$18.4 million, is allocated to programs for adolescent girls and young women (AGYW). Corresponding to the DREAMS package of interventions, this program covers a wide range of prevention and empowerment packages,

including condom distribution, HIV testing and counseling, community mobilization and normative change, school-based prevention, post-violence care, increased contraceptive method mix, social asset building, parenting/caregiver programs, educational subsidies, and combination socio-economic approaches. The estimated current unit cost for the full intervention is US$189 per young woman per year (considering weights for services, which are only required by some young women or which are provided to the wider community).

According to Optima HIV estimates, over the period 2017-2030, the AGYW intervention averts 200 deaths, 2500 new infections, and 3600 DALYs. This corresponds to an incremental cost-effectiveness ratio (ICER) of US$67,000 per DALY averted. By comparison, the general population condom program is estimated to have an ICER of US$4100 per DALY averted. Since many or perhaps most of the benefits of the DREAMS intervention fall outside the sphere of HIV, options for cross-sectoral funding of this program should be explored. The proportion of the unit cost of the DREAMS intervention that would make it competitive with other programs is US$12 per person per year, suggesting that ideally other funding sources would be provided to cover the remaining US$177 per person per year unit cost.

A second novel intervention being explored for scale-up in Malawi is pre-exposure prophylaxis (PrEP). The primary drivers of cost for PrEP are (a) the commodity cost, and (b) the cost of regular HIV testing. These give a total estimated unit cost of US$89 per person per (full) year of coverage, including distribution and programming costs. Maximum coverage targets were assumed to be 50% of FSW, 50% of eligible discordant couples (in which the HIV positive partner is not (yet) virally suppressed), and 10% of the highest risk AGYW. The annual cost of each of these programs is estimated to be US$400,000 for FSW, US$1.9 million for discordant couples, and US$19 million for AGYW. The impacts and cost-effectiveness of each PrEP scenario are shown in Table 2. Due to the relatively low unit cost, PrEP was found to be cost-effective for FSW (US$790 per DALY averted) and discordant couples (US$920 per DALY averted), but not for high-risk AGYW (US$10,100 per DALY averted). Further targeting of subgroups of AGYW, especially in high prevalence districts or who have other risk factors, may make PrEP cost-effective for AGYW.

Table 2:   Costs and impacts of PrEP (2017-2030)

	Average annual cost	Infections averted	Deaths averted	DALYs averted	ICERs
FSW	US$0.4m	5,900	370	6,600	US$790
Discordant couples	US$1.9m	24,000	1,500	27,000	US$920
AGYW	US$19m	22,000	1,400	25,000	US$10,100
FSW+couples+AGYW	US$25m	25,000	2,800	51,000	US$5,030

Source: Authors.

It is important to consider that our model analysis assumed high coverage for demonstration purposes. It is not clear if such high coverage levels are achievable and therefore real-world uptake and, consequently, impact may be substantially lower.

4.6 Critically evaluate the volume of funding allocated to cross cutting and other non-direct HIV service delivery areas

Malawi's spending on cross-cutting and management cost for its HIV response is particularly high and identifying any potential savings is essential.

The HIV response budget allocated to cross-cutting, support and other costs include a number of essential HIV care costs, which remain critical for a functioning HIV program. We conducted a comparative analysis of cross-cutting costs in Malawi and other countries in the region. When classified in the same way as other countries did, cross-cutting costs accounted for 23% of total HIV spending. The reason why this percentage is lower than cross-cutting cost in the Optima analysis, is that a range of non-ARV treatment and care cost have been treated as fixed/indirect cost in the Malawi Optima study, while they were classified as core treatment cost regionally. As a proportion of total HIV spending, cross-cutting cost in Malawi is below average in comparison to 9 other countries, but not the lowest. In addition, it needs to be considered that Malawi's 2016–17 HIV budget of US$254 million represents approximately 3.8% of the Gross Domestic Product (GDP), more than any of the other 9 countries has spent on HIV. Therefore, when considered in relation to GDP, Malawi's spending on cross-cutting and management cost for its HIV response is particularly high and identifying any potential savings is essential.

There are different options for reducing some cross-cutting and other costs. Our rapid and comparative reviews of these budgets only represents one possible option for identifying savings. The following are some observations on the cross-cutting and support budgets within the national strategy:

► Overall, Malawi's national strategic plan is well costed and includes highly relevant and important activities. The reason for presenting considerations on efficiency gains is that there are competing high priority HIV activities and budget constraints in fully scaling up core preventive, diagnostic and treatment activities.

► Malawi's HIV response budget includes a number of costs, which are health priorities in their own right, but not primarily HIV interventions. For example, STI treatment – including drugs and BCC on STIs - is classified as an HIV prevention intervention, although STI treatment would need to continue independently of HIV programs and even if Malawi achieved its aim of an AIDS free and HIV free generation. STI service provision can work synergistically with HIV programmes and just as all other sexual and reproductive health programmes contribute to identifying people at risk of HIV infections.

► Blood safety and family planning budget lines (including items such as procurement of injectable contraceptives in the context of PMTCT) within the national strategy do contribute to HIV outcomes. However, it could be argued that these activities would be more strategically financed and managed outside HIV budgets in the context of overall blood safety and family planning programs. Historically, some non-HIV budget lines have been included in HIV response budgets in many countries at a time of rapidly growing international HIV funding. Given the stagnating international HIV resources there is need to diversify resource mobilization for synergistic interventions such as STIs, blood safety and family planning.

► When considering all treatment and care costs, the cost per person on treatment increased from US$141 in 2012 to US$ 242 in the 2016–17 budget. This partially reflects new technologies such as viral load testing, but also a range of other cost items. The Malawi NSP assumes that budget lines for HIV care and mitigation including costs for opportunistic infections and community home-based care will further increase from 2015 to 2020. With optimized allocation of resources to treatment programs and increasing ART coverage, the need for care for opportunistic infections and home-based care could be expected to reduce over time. It is therefore important to continue reviewing other HIV care budgets periodically to explore if savings can be made.

► A number of cross-cutting activities contain training and outreach activities. These could be further reviewed for efficiency gains and level of priority. For example, in 2016–17, US$4.8 million are included for health worker training with one budget line specifying district level training for US$81 per person day. Another budget line foresees vocational training of 750 young people at a total annual cost of US$0.8 million. While highly desirable at individual level, it could be further explored whether this type of expense is in the comparative advantage of the HIV response, while also considering that population-level impact of this investment will be negligible given the relatively small number of beneficiaries.

► Considering the continued gaps in the HIV response, it would also appear justified to consider further reviewing the cost of meetings included in many budget lines of the national strategy such as management, monitoring, civil society or training budgets. Reductions of 15% in meeting and other administrative costs across different budget lines could be achievable through a combination of unit cost reductions and change of meeting modalities.

These considerations only summarize some options in relation to additional implementation efficiency gains and would need to be further reviewed by national experts for relevance and feasibility. Continued implementation efficiency analysis could be instrumental in further increasing focus of Malawi's already well prioritized HIV response.

5 CONCLUSIONS

Malawi has a high-burden generalized HIV epidemic, which is currently declining due to (a) substantial investments in treatment and prevention, and (b) a good allocation of resources across both programs and districts. Highest priority for Malawi is to continue treatment scale-up to continue to address need and to reach 90-90-90 targets and beyond. With increasing numbers of people on treatment (as well as with people being on treatment for longer periods of time) there will be a parallel need to scale up programs that aim to increase viral suppression. Geographically-targeted more to the southern districts, supplementary prevention programs including voluntary medical male circumcision remain part of optimized allocations but the overall investment should be reduced. Female sex worker programs require increased prioritization in key locations. The cost of viral load monitoring relative to treatment is high, suggesting the possibility of an important efficiency gain. As Malawi spends 23% of its HIV response budget on cross-cutting activities and other costs, an implementation

efficiency analysis and expenditure review of these costs might identify additional savings, which could be reinvested.

Additional gains can be achieved by moving funds towards high-prevalence "hotspots", as these have strongly self-sustaining epidemics.

While Malawi's geographical prioritization is very good, some additional gains can be achieved by moving funds towards high-prevalence "hotspots", as these have strongly self-sustaining epidemics. In particular, if there are no additional funds then current resources could achieve greater national epidemiological benefits if shifted slightly away from Dowa and rural Lilongwe and towards Thyolo, Blantyre, and Zomba. Finally, Malawi currently uses a wide mix of HIV testing and prevention programs. While some of these may be justified in particular contexts and to reach all people, with limited resources, the greatest impact can be achieved by using the most cost-effective delivery mechanisms with the highest yield. A thorough review of the funds spent on modalities with higher unit costs or lower effectiveness is recommended.

In addition to the efficiency gains identified for the HIV response in this brief, a range of efficiency gains could be explored across the health sector including: (a) evidence-informed prioritization, both geographically (districts) and by intervention, (b) results-based approaches to financing while considering disease burden and cost-effectiveness, (c) active performance management of facilities and other implementers at national and sub-national-level, (d) optimized use of facility and outreach capacities, (e) enhanced accountability in use of resources, and (f) optimized procurement while maximizing use of generic products.

REFERENCES

i   Imperial College London. A report to evaluate the evidence for behavioural change having affected the course of the HIV epidemic. Malawi country report. London, Lilongwe 2015.

ii   UNAIDS. 2016 Estimates. Geneva.

iii   Government of Malawi, ICAP. Malawi Population-Based HIV Impact Assessment, MPHIA 2015-2016. Lilongwe, 2016.

iv   Ministry of Health, HIV Department, Malawi. Quarterly report, Quarter 4/2016. Lilongwe.

v   Ministry of Health, Kenya. HIV Prevention Revolution Road Map. Count Down to 2030. Nairobi, 2014.

vi   World Bank. Malawi country data. Washington DC, 2016. Retrieved from: http://data.worldbank.org/country/malawi (last accessed on 21 October 2016)

vii   Ibd.

viii   Ibd.

ix   National Statistical Office (NSO) [Malawi] and ICF International. 2016. Malawi Demographic and Health Survey 2015-16: Key Indicators Report. Zomba, Malawi, and Rockville, Maryland, USA. NSO and ICF International.

x   World Bank. World Development Indicators. Washington DC, 2017. Retrieved from: http://wdi.worldbank.org/table/ (last accessed 3 July 2017).

xi   National Statistical Office (NSO) [Malawi] and ICF. 2017. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi, and Rockville, Maryland, USA. NSO and ICF.

xii   Health Financing in Malawi. Fiscal Space Analysis and Prospects for Introducing Earmarked Taxes for Health. Draft, September 2016.

xiii   Chatham House Report. Shared Responsibilities for Health A Coherent Global Framework for Health Financing Final Report of the Centre on Global Health Security Working Group on Health Financing. London 2014.

xiv   Jowett M, Brunal MP, Flores G, Cylus J. Spending targets for health: no magic number. Geneva: World Health Organization; 2016 (WHO/HIS/HGF/HFWorkingPaper/16.1; Health Financing Working Paper No. 1); http://apps.who.int/iris/bitstream/10665/250048/1/WHO-HIS-HGFHFWorkingPaper-16.1-eng.pdf

xv   Oxford Policy Management. Assessment of the feasibility and appropriateness of a National Health Insurance Scheme (NHIS) in Malawi. Phase 1 report – draft. Lilongwe 2016.

xvi   World Bank (2016). Health Financing in Malawi: Fiscal Space Analysis and Prospects for Introducing Earmarked Taxes for Health. World Bank: Washington, DC

xvii   Institute of Health Metrics and Evaluation. Global Burden of Disease Study 2015. Washington 2016;

xviii   Government of Malawi. Malawi AIDS Response Progress Report 2015. Lilongwe 2015.

xix   Imperial College London. A report to evaluate the evidence for behavioural change having affected the course of the HIV epidemic. Malawi country report. London, Lilongwe 2015.

xx   UNAIDS. Fast-track. Ending the AIDS epidemic by 2030. Geneva, 2014.

xxi   Keiser O, Chi BH, Gsponer T, et al. Outcomes of Antiretroviral Treatment in Programmes with and without Routine Viral Load Monitoring in Southern Africa. AIDS (London, England). 2011;25(14):1761-1769. doi:10.1097/QAD.0b013e328349822f.

xxii   Estill J, Egger M, Johnson LF, Gsponer T, Wandeler G, Davies M-A, et al. (2013) Monitoring of Antiretroviral Therapy and Mortality in HIV Programmes in Malawi, South Africa and Zambia: Mathematical Modelling Study. PLoS ONE 8(2): e57611. https://doi.org/10.1371/journal.pone.0057611

xxiii   Pannus P, Fajardo E, Metcalf C, et al. Pooled HIV-1 Viral Load Testing Using Dried Blood Spots to Reduce the Cost of Monitoring Antiretroviral Treatment in a Resource-Limited Setting. Journal of Acquired Immune Deficiency Syndromes (1999). 2013;64(2):134-137. doi:10.1097/QAI.0b013e3182a61e63.

xxiv   National AIDS Commission of Malawi. Global HIV and AIDS monitoring report for Malawi. Lilongwe, 2017.

xxv   Rosenberg NE, Mtande TK, Saidi F, et al. Recruiting male partners for couple HIV testing and counselling in Malawi's option B+ program: an unblinded randomised controlled trial. The lancet HIV. 2015;2(11):e483-e491. doi:10.1016/S2352-3018(15)00182-4.

xxvi   Cherutich P et al. for the aPS Study Group. Assisted partner services for HIV in Kenya: a cluster randomised controlled trial. Lancet HIV. 2017 Feb;4(2):e74-e82. doi: 10.1016/S2352-3018(16)30214-4. Epub 2016 Nov 30.

xxvii   Kahabuka C et al Addressing the First 90: A Highly Effective Partner Notification Approach Reaches Previously Undiagnosed Sexual Partners in Tanzania. AIDS Behav. 2017 Mar 15. doi: 10.1007/s10461-017-1750-5. [Epub ahead of print]