

The Malawi Priorities Project

COST-BENEFIT ANALYSIS OF EXPANDING HIV PREVENTION AND TREATMENT SERVICES TO FEMALE SEX WORKERS IN MALAWI

A National Planning Commission Report with technical assistance from the Copenhagen Consensus Center and the African Institute for Development Policy



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Malawi Priorities: Background

Malawi Priorities is a research-based collaborative project implemented by the National Planning Commission (NPC) with technical assistance from the African Institute for Development Policy (AFIDEP), and the Copenhagen Consensus Center (CCC) to identify and promote the most effective interventions that address Malawi's development challenges and support the attainment of its development aspirations. The project seeks to provide the government with a systematic process to help prioritize the most effective policy solutions so as to maximize social, environmental and economic benefits on every kwacha invested. Cost-benefit analysis is the primary analytical tool adopted by the project. Cost-benefit analysis will be applied to 20-30 research questions of national importance. Research will take place over the course of 2020 and 2021.

Research questions were drawn from the NPC's existing research agenda, developed in September 2019 after extensive consultation with academics, think tanks, the private sector and government. This sub-set was then augmented, based on input from NPC, an Academic Advisory Group (AAG) of leading scholars within Malawi, and existing literature, particularly previous cost-benefit analyses conducted by the Copenhagen Consensus Center. The research agenda was validated and prioritized by a Reference Group of 25 prominent, senior stakeholders. The selection of interventions was informed by numerous consultations across the Malawian policy space, and one academic and two sector experts provide peer review on all analyses.

Cost-benefit analyses in Malawi Priorities consider the social, economic and environmental impacts that accrue to all of Malawian society. This represents a wider scope than financial cost-benefit analysis, which considers only the flow of money, or private cost-benefit analysis, which considers the perspective of only one party. All benefit-cost ratios (BCRs) reported within the Malawi Priorities project are comparable.

The cost-benefit analysis considered in the project is premised on an injection of new money available to decision makers, that can be spent on expanding existing programs (e.g. new beneficiaries, additional program features) or implementing new programs. Results should not be interpreted as reflections on past efforts or the benefits of reallocating existing funds.

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1. Introduction and context

1.1 The HIV and AIDS situation in Malawi

Malawi has made many notable accomplishments in addressing the burden of HIV and AIDS. According to the Global Burden of Disease new cases have been dropping considerably since a peak in 1993 of 130,000, down to an estimated 32,300 new cases in 2019 (IHME, 2020). The amount of disability-adjusted life years (DALYs) attributable to the HIV and AIDS has fallen by 70% since 2007 primarily from increasing ART coverage. However, as of 2017 HIV and AIDS is still the number one source of DALYs in the country, mostly due to legacy infections – more than 1 million Malawians currently live with HIV (IHME, 2017).

According to AIDSinfo/UNAIDS, 90% of people living with HIV (PLHIV) in Malawi know their status and have been initiated on ART. Over 95% of pregnant women living with HIV have been tested and are receiving antiretroviral therapy. With treatment goals having largely been met (ART adherence falls to 79%), stemming new infections remains one significant hurdle to placing HIV among the chronic, but manageable diseases.

While overall HIV incidence has declined considerably, now estimated at 2.28 overall per 1000 population, new infections are not generalized and appear to be concentrated around youth and women (AIDSinfo/UNAIDS). HIV incidence per 1000 population, for people aged 15-49, is 4.4. Just under one-third of all new HIV infections (14,000 out of 38,000) in Malawi in 2018 occurred among young people, aged 15-24. Just over half of new infections are women (20,000 of the 38,000), aged 15 and older; 9,900, for women aged 15-24.

Moreover, there is considerable heterogeneity of HIV prevalence by region and by gender. Women in urban settings and in the South still appear to be disproportionately affected. Among adults, the national prevalence is 8.8%; the urban estimate, 14.6%, whereas the rural prevalence is 7.4%. Adult women's prevalence is higher than the overall estimate: 10.8 vs. 8.8%. The women's urban prevalence is higher than the overall urban prevalence estimate: 17.8% vs. 14.6%. Furthermore, women have higher prevalence in all regions (North, Central, South), with the highest being in the South. Finally, the South has the widest gap in the gender prevalence estimate; 15.7% for women, 9.2% for men (Malawi National AIDS Commission, 2014).

This geographic variation could be attributable to the distribution and size of high-risk groups (HRG), potentially including female sex workers (FSWs). Palk and Blower (2018) identify a significant ($P < 0.001$) geospatial relationship linking the size of the HRG with HIV prevalence in Malawi: the greater the size, the higher the prevalence. Furthermore, the geographic variation in the size of the HRG can explain a substantial proportion (73% for women, 67% for men) of the geographic variation in epidemic severity in Malawi. Prevalence is highest in Blantyre and Zomba in the South, and Lilongwe in the Central region. Prevalence is also higher in urban centers than in rural areas. HIV prevalence in women can be expected to exceed the national average in districts where ~20% or more of women are in the HRG. The work of Bulstra et al. (2020) also suggests that high-risk dynamics (involving seasonal work and sex work) in these areas might be important factors in generating the geographical variance observed in HIV prevalence.

According to UNAIDS, there were approximately 36,000 female sex workers in Malawi in 2017, with an estimated HIV prevalence of 55% (UNAIDS, 2018). Another report notes prevalence among FSWs of 63% (NSO, 2014). It should also be noted that there is some overlap with incidence rates of youth, as 45% of FSWs are between the ages of 18 and 24, as reported in a survey undertaken by Twizelimana and Muula (2020). In another survey of 2,635 FSWs, the mean age of initial transactional sex was 18 (Malawi National AIDS Commission, 2018).

The analysis presented in this report suggests that interactions with FSWs contributes to around a fifteen percent of new cases in those aged 15 years and above, indicating that focusing on this specific group would lead to substantial reductions in HIV incidence going forward. However, FSWs face specific sociocultural barriers, which make stemming the onset of infections challenging. FSWs face multiple barriers to consistent condom use, including limited negotiation power with paying customers and non-paying partners, voluntary and/or accidentally condom's rupture, and refusal to use condoms because of sexual dissatisfaction (Twizelimana and Muula, 2020). Only 49% report condom use, mainly because clients refuse to use them. The risk of acquiring HIV for FSWs was 13 times higher than adult women aged 15-49 years (UNAIDS, 2018). The limited economic opportunities for adolescent and young women, the sub-optimal condom usage, and the migratory nature of FSWs provide the

context for the selection of interventions aimed at preventing HIV transmission among this high-risk group and their clients. This study presents a cost-benefit analysis of three interventions designed to improve HIV and AIDS services for FSWs. These are:

- 1. Comprehensive Ambipolar Package (CAP):** This intervention is ambipolar (“working in two directions simultaneously”) in that it addresses the challenge from both prevention and treatment side. It includes provision of Pre-exposure prophylaxis and ART counselling for FSWs, as well as semi-annual testing, case management and support services. The provision of Pre-exposure prophylaxis (PrEP) or anti-retroviral therapy (ART) based on the results of the test, would be provided through the health system.
- 2. ART counseling for FSWs living with HIV:** As above but with only ART counseling provided. However all FSWs would be targeted and tested, but only those who are living with HIV would be provided counseling.
- 3. Pre-exposure prophylaxis for FSWs who are HIV-negative:** This intervention would target and test all FSWs and provide those who are HIV-negative with PrEP.

This analysis considers the rollout of each intervention to 2030 using additional funds. Of the interventions considered CAP and ART counseling have similar benefit-cost ratios (BCRs) of 2.3 and 2.2 respectively at an 8% discount rate. However CAP has a much larger absolute impact avoiding around 63,200 infections, while ART counseling alone avoids 35,300 infections to 2030. These avoided infections would themselves lead to 13,300 avoided deaths and 6,200 avoided deaths as well as (undiscounted) ART savings totaling MWK 79 billion and MWK 41 billion respectively, up to 2040. The intervention that provides PrEP to FSWs has a slightly higher absolute impact than the ART counseling intervention avoiding 39,300 infections to 2030, which generates 8,900 avoided deaths and MWK 45 billion in avoided ART costs by 2040. However, the costs of this intervention are higher, leading to a BCR point estimate of 1.7, the lowest of the interventions studied. For all interventions savings in ART exceed donor or government outlays by 2040.

Sensitivity analyses confirm that PrEP as a stand-alone intervention is likely to be the least cost-effective of the three interventions. The sensitivity analyses also reveal that there is substantial overlap in the range of results between ART counseling and CAP suggesting that they are indistinguishable in terms of effectiveness when uncertainty is considered.

The findings of this paper suggest that *if additional funds are earmarked for HIV and AIDS services to FSWs* then a comprehensive package that provides both PrEP and ART counseling likely is the most effective use of resources and has the largest impact of the three interventions studied. However, the reported BCRs around 2 are relatively modest. Decision makers should also assess alternative options for providing HIV and AIDS services beyond the interventions analyzed in this report to ensure the impact of scarce resources are maximized. For example, a recent report by Optima (2020) which examines the entire HIV and AIDS funding envelope of USD 222m to 2025 notes ways in which both existing budget can be reallocated and additional funds can be deployed to maximize reduction in HIV infections. While that study does not contain a cost-benefit analysis, the information in that study could be analyzed with modest additional effort to facilitate comparisons to the findings contained here.

2. Research context and Intervention selection

The National Planning Commission (NPC), in collaboration with AFIDEP, and the Copenhagen Consensus Center (CCC) are conducting the Malawi Priorities project across 2020 and 2021. The Project is a research and advocacy exercise to identify the most effective ways to address the nation's challenges using the framework of cost-benefit analysis. The aim is to inform both short and long term development priorities for the country, acknowledging that there are insufficient resources to address all of Malawi's challenges and that maximizing outcomes requires careful, evidence-based consideration of the costs and benefits of all policies.

The starting point of all research questions is the NPC's existing research agenda, structured around the six thematic areas of Sustainable Agriculture, Sustainable Economic Development, Human Capital and Social Development, Sustainable Environment, Demography, Governance, Peace, and Security, and Human Capital and Social Development.

The NPC's research agenda was developed by the Commission in September 2019 after extensive consultation with academics, think tanks, the private sector and government. Consequently, the Commission's research agenda, *prima facie*, contains questions of national importance. As a first step, Malawi Priorities drew questions from the NPC research agenda that could be answered using a cost-benefit methodology. Then, additional research questions were added based on input from NPC, an Academic Advisory Group (AAG) of leading scholars within Malawi, and existing literature, particularly previous cost-benefit analyses conducted by the Copenhagen Consensus Center. This process of identifying research questions for investigation generated a total of 38 potential research questions across all 6 thematic areas.

The research agenda was validated and prioritized by a *Reference Group* of 25 prominent, senior stakeholders from government, civil society and the private sector. The outcomes of the Reference Group exercise were used to inform which research questions to prioritize and which interventions to focus on within those 38 potential research questions. The validation process finished in July 2020.

In May 2020, before the validation process was complete, the project began investigations on four research questions that were deemed to be of national importance, as determined by objective criteria and/or likely to yield interventions with high benefits relative to costs. In the case of the HIV and AIDS question, the decision to research this topic was made due to the disease being the largest source of DALYS in the country by some margin in 2017, the most recent year with available data in the Global Burden of Disease database at the time.¹ Additionally, specific reference was made to high-risk groups in the NPC's research agenda: 'to control HIV infection in HIV negative persons whose professions pose a greater risk of HIV infection', indicating that this was a focus area for the Commission. The exact research question was: *How does Malawi most effectively reduce the burden of HIV / AIDS? How can we control HIV infection in HIV negative persons whose professions pose a greater risk of HIV infection?*

When the Reference Group provided their feedback, the research question on HIV and AIDS was not highly ranked, coming in at 35 out of a possible 38 questions. Therefore, the project team decided to scale back resources devoted to this question, quickly finalizing the analysis that had already been completed. This meant refocusing the research question to FSWs only, where the most promising interventions were around pre-exposure prophylaxis and ART adherence counseling.² After research on the HIV and AIDS question had started, but before its ranking by the Reference Group was known, the project team completed a scan of all potential interventions in the space as part of the process of narrowing down on interventions for cost-benefit analysis. As noted above, this was meant to inform a broader examination of HIV and AIDS strategies but the broader analysis was not done due to the low priority ascribed to the question. Nevertheless, we include the outcome of this process for completeness in the appendix. By that point we had also done some preliminary analysis of VMMC (voluntary medical male circumcision). This analysis is also included in the appendix for transparency but we leave more definitive analysis for future research by other parties.

¹ In between starting this research work and finishing it, the 2019 Global Burden of Disease data was released. The new evidence indicates HIV and AIDS as the #2 source of DALYS in the country, behind maternal and neonatal disorders.

² A more thorough analysis of how to best prioritize resources for HIV/AIDS in Malawi is contained in Optima (2020).

3. Analysis

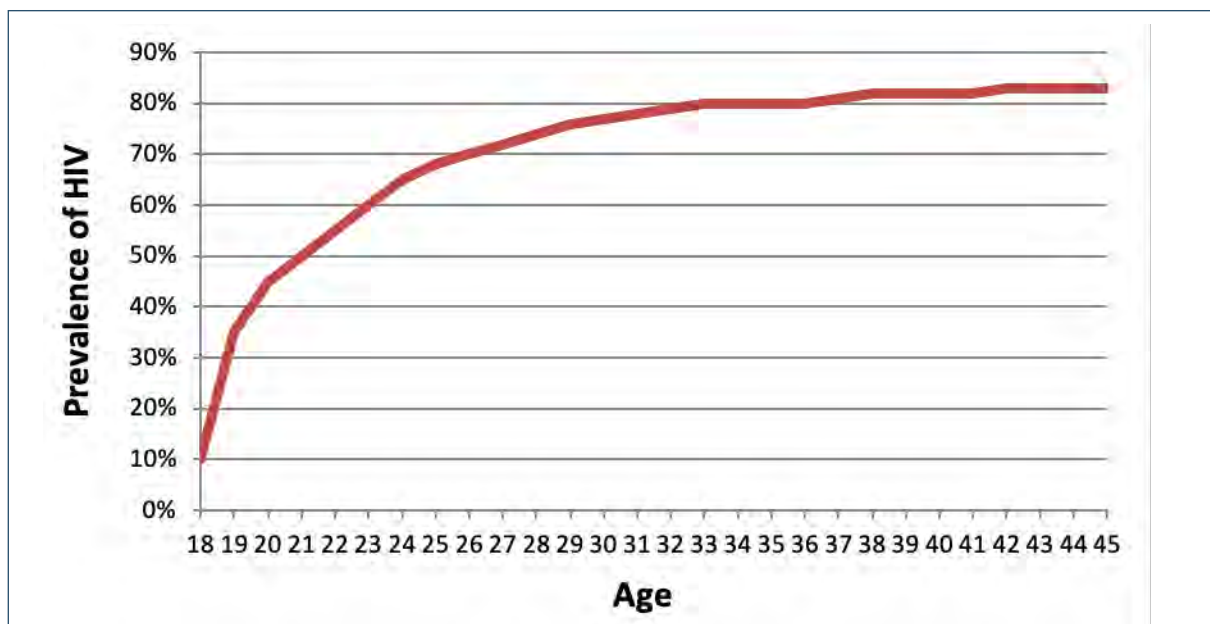
3.1 Contribution of FSW-interactions to new HIV infections

Before proceeding to the costs and benefits of the various interventions, we first assess the likely contribution of FSW interactions to the overall incidence of HIV in the country. To ensure comparability across sources we attempt to identify the % contribution for a reference year, 2014 where there is the most data available.

The PLACE (2018) estimates that there were 36,300 FSWs in 2017. Assuming that the number of FSWs grows in proportion to the size of the 18-45 y.o. cohort, we estimate that in 2014 the number of FSWs was approximately 32,750.

The Malawi Biological and Behavioural Surveillance Survey Report (NSO, 2014) notes that out of 670 female sex workers tested for HIV, 63% were found to be HIV positive with prevalence increasing with age. A study conducted at a similar time of 200 FSWs in Lilongwe showed an overall prevalence of 69% (Lancaster et al. 2016).³ Using the data from NSO (2014) we infer an approximate hazard function of contracting HIV over time, for a given sex worker who enters the profession at age 18. Assuming that women at this age have a HIV prevalence of 10%, the graph shows that the risk of infection rises fastest within the first two years, with prevalence increasing by 35 percentage points. After that there is a steady increase in risk, but at a decreasing rate over time. From age 30 onwards the prevalence is high at 77% but the chance of being newly infected in a given year, conditional on reaching this age, is low.

Figure 1: Age-specific prevalence of HIV as a % of all FSWs at that age (2014 data)



Using this function, and the distribution of FSWs by age from NSO (2014), we estimate that the number of FSWs who would have contracted HIV between 2014 and 2015 to be 1,870 or roughly 5.7% of the total FSW population. This is mostly concentrated in the younger age group (18-20) who are more likely to contract HIV.

FSW-interactions also generate infections in clients. The survey by the Ministry of Health (2018) reports that 8% of male clients of FSWs are HIV-positive. The Demographic and Health Survey 2015/2016 (NSO, 2017) notes that 7% of men aged 18-54 paid for sex in the last twelve months at the time of the survey, October 2015. Using gender-age disaggregated population data from IASA, this suggests around 227,000 men paid for sex in 2014 with 18,000 being HIV positive. The last step to determine annual incidence requires making an assumption about how many years these infections were accumulated. Here we assume that these infections occurred over 7.5 years, meaning that the annual incidence of male clients contracting HIV from FSW-interactions is 2,400. While there is substantial uncertainty

³ Malawi National AIDS Commission (2018) report notes a much lower prevalence among female sex workers of 36.1% but this is derived from self-reported data and is likely an underestimate.

around this assumption, below we document an alternative approach to estimating HIV-infection risk of male clients and note that the assumption of 7.5 years does not appear unreasonable.

Lastly, stakeholder consultations indicate that each newly acquired HIV infection by male clients leads to at least one new infection in that client’s partner or partners. Therefore we add an additional 2,400 infections to the tally.

In total we estimate that FSW-interactions contributed around 6,700 new HIV cases in 2014. In the same year there were 43,300 new cases of HIV in people aged 15 years and above according to the Global Burden of Disease (IHME, 2020). Therefore, a plausible point estimate suggests interactions between FSWs and clients contribute about a sixth (15.7%) of all new infections in people aged 15 years and above. This is supported by a recent study (Optima, 2020), which estimates that FSWs are responsible for 3% of all new infections, and clients 9% in individuals aged 15+ (private correspondence, Sherrie Kelly). Adding an additional transmission of 9% associated with partners of clients leads to infection proportion of 21% - not dissimilar to the estimates presented here. This underlies the importance of improving HIV health services and support for FSW, to further reduce the spread of HIV in the country.

Using the above figures, we estimate the number of new infections associated with each FSW living with HIV, focusing on those who are not on ART since these would be the ones with sufficient viral load to pass on the virus. Lancaster et al. (2016) surveyed a population of 200 FSWs in Lilongwe and noted ART adherence of 52% in 2014. Assuming that this was consistent with FSWs nation-wide implies that 9,900 FSWs were HIV-positive and not using ARTs in that year. Comparing this to the point estimate reported above for infections of clients and their partners, indicates that each HIV-positive FSW not on ARTs is associated with 0.5 new infections per year.

As a sensitivity analysis, we estimate this value using a different approach, looking at the risk of transmission from individual sexual exposures. A systematic review by Patel et al. (2014) notes that the risk of contracting HIV from insertive vaginal intercourse is 4 per 10,000, albeit with a wide confidence interval. Lancaster et al. (2016) note that the median number of clients per 7 days is 21 for an average of 3 per day.⁴ Therefore each year a FSW could expect to engage in roughly 1,095 sexual encounters which would lead to 0.39 infections per year in male clients, and 0.77 onward infections in total including male clients and partners. This figure is higher than the estimate figure above of 0.5, however for conservatism we adopt the lower figure for the following calculations.

3.2 A parsimonious model of FSW behavior

To estimate the impact of the interventions we develop a simple model that tracks the progression of FSWs from age 18-to-44 with annual time intervals (see Figure 2). Women enter the profession at age, $j=18, 19$ or 20 at year t , with an assumed HIV prevalence of 10%, roughly consistent with the population average in adults. HIV-negative FSWs can be on PrEP with probability, $P(\theta)$, while HIV-positive FSWs can be on ART with probability, $P(\alpha)$. FSWs who are HIV-positive but are not taking ART are assumed to have a short run annual elevated mortality risk of $P(\omega)$. For simplicity FSWs who are HIV-negative or are HIV-positive on ART are assumed to have zero elevated mortality risk. FSWs who are HIV-negative but not taking PrEP are assumed to have an age specific risk of contracting HIV $P(\beta_j)$. After $t=0$, each FSW has an age specific exit

Table 1: Key model parameters

Parameter	Baseline	PrEP only intervention	Adherence counseling intervention	Comprehensive Ambipolar intervention
$P(\alpha)$, the probability of being on ART	62% (PLACE, 2018)	62% (PLACE, 2018)	85% (Cowan et al. 2018)	85% (FHI360 demonstration project)
$P(\theta)$, the probability of being on PrEP	0% (assumed)	72% (FHI360 demonstration project)	0%	72% (FHI360 demonstration project)
$P(\omega)$, the short run annual risk of mortality, if HIV+ and not taking ART	0.7% (authors’ calculations based on Optima, 2019)			
$P(\beta_j)$, the probability of contracting HIV if not on PrEP	Varies by age based on NSO (2014) – see Figure			
$P(\chi_j)$, the probability of exit from being a FSW	Varies by age based on NSO (2014)			

⁴ A different study reports twice as large client frequency, across 190 FSWs from Blantyre and Mangochi (Project SOAR, 2019). There the average number of clients per day was reported as 6. Using this figure would increase the BCRs presented in this study.

probability $P(\chi_j)$ based on data from NSO(2014). The values for the key parameters are presented in Table 1.

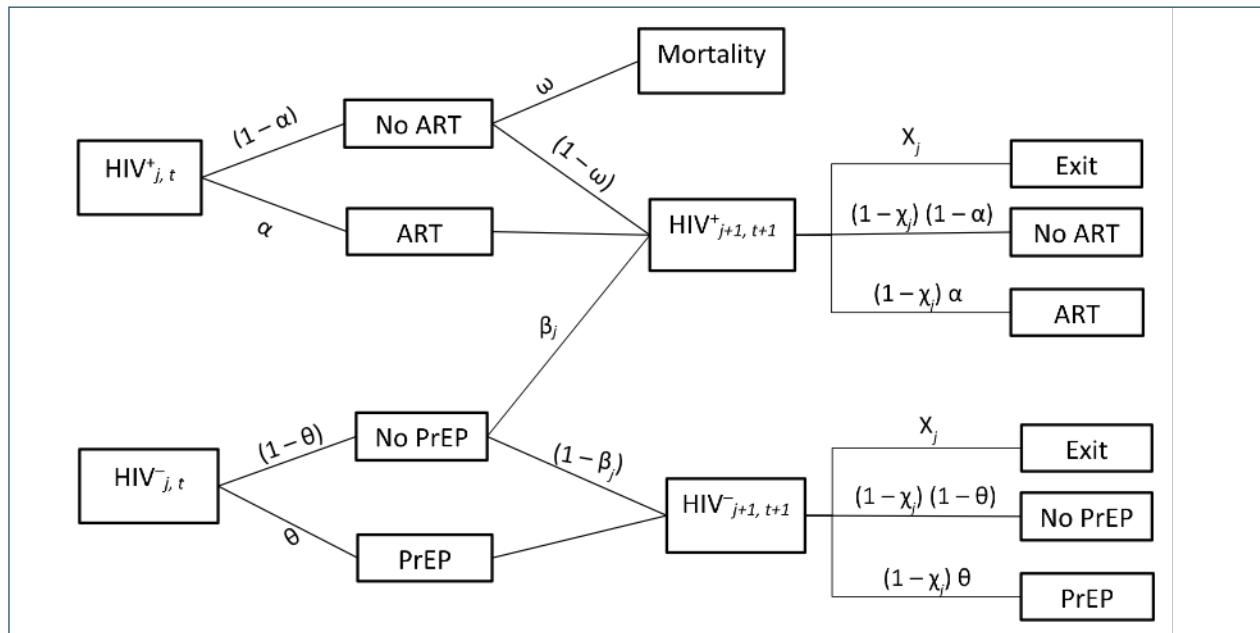
HIV-positive FSWs are on ART with a 62% likelihood as per PLACE (2018) and this rises to 85% - approximately the observed adherence rate from a similar program targeting FSWs in Zimbabwe (Cowan et al. 2018).⁵ HIV-negative FSWs are on PrEP with a 0% likelihood in the baseline, which rises to 72% in the intervention scenario, again as per FHI360 correspondence. The short run risk of increased mortality, if not taking ART is based on parameter values provided in Optima (2019). This is calculated by taking the years weighted average mortality risk within different CD4 ranges to 200 or more. Mortality risk increases substantially at lower CD4 counts but these are excluded because it requires more than 9 years transition to reach these levels, by which time many women would have stopped being FSWs. The model also assumes that FSWs exit the profession with a given probability determined by her age as inferred from the age distribution profile in NSO (2014).

Therefore in any one year, the model estimates the number of FSWs by age that fall into one of four states:

- HIV-negative not on PrEP
- HIV-negative on PrEP
- HIV-positive on ART
- HIV-positive not on ART

It is also assumed that each HIV-positive FSW not on ART generates 0.5 new infections in that year in clients and partners as noted above which are then added to the count of HIV infections. The interventions target all female sex workers estimated at 39,818 in 2020 rising to 54,469 by 2030. These figures are extrapolated from the 2017 figure of 36,300 FSWs reported in PLACE (2018), assumed to grow in proportion with growth in the broader female population aged 18 to 44.

Figure 2: Schematic of FSW model



Key outcomes of each intervention are presented in Table 2.

⁵ FHI360 had reported adherence rates of 98% but we adopt the rate of 85% to be conservative.

Table 2: Key outcomes across baseline and intervention scenarios

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of FSWs	39,818	41,065	42,351	43,677	45,045	46,456	47,958	49,509	51,110	52,763	54,469
BASELINE											
HIV prevalence among FSWs (excluding those no longer in profession)	23,855	24,602	25,372	26,167	26,986	27,831	28,731	29,661	30,620	31,610	32,632
FSWs taking PrEP	0	0	0	0	0	0	0	0	0	0	0
FSWs taking ART	14,705	15,165	15,640	16,130	16,635	17,156	17,711	18,283	18,875	19,485	20,115
INTERVENTION: PrEP											
FSWs taking PrEP	11,494	13,197	14,905	16,614	18,322	20,024	21,737	23,435	25,099	26,726	28,315
FSWs taking ART	14,705	14,015	13,346	12,699	12,080	11,493	10,952	10,455	10,017	9,643	9,334
Avoided HIV infections in FSW	0	1866	1892	1930	1972	2016	2068	2126	2188	2253	2320
Avoided HIV infections in clients and partners	0	351	700	1,047	1,390	1,728	2,062	2,388	2,702	3,003	3,289
INTERVENTION: ART Counselling											
FSWs taking ART	20,277	20,912	21,566	22,242	22,938	23,657	24,422	25,212	26,027	26,869	27,737
Avoided HIV infections in FSW	0	0	0	0	0	0	0	0	0	0	0
Avoided HIV infections in clients and partners	2,732	2,817	2,905	2,996	3,090	3,187	3,290	3,397	3,506	3,620	3,737
INTERVENTION: Comprehensive Ambi-polar package											
FSWs taking PrEP	11,494	13,197	14,905	16,614	18,322	20,024	21,737	23,435	25,099	26,726	28,315
FSWs taking ART	20,277	19,325	18,403	17,511	16,658	15,848	15,103	14,416	13,813	13,297	12,871
Avoided HIV infections in FSW	0	1,866	1,892	1,930	1,972	2,016	2,068	2,126	2,188	2,253	2,320
Avoided HIV infections in clients and partners	2,732	2,955	3,179	3,406	3,634	3,863	4,096	4,331	4,563	4,794	5,023

4. Cost-benefit analysis

4.1 General parameters

The period of analysis chosen is 2020-2030, with the intervention started in the first year, followed by 10 years of modeled impacts on HIV outcomes.

As with all analyses in the Malawi Priorities series we adopt three different discount rates: 5%, 8% and 14%. All figures are reported in 2020 Malawian Kwacha (MWK) unless otherwise indicated. An exchange rate between USD and MWK of 745 is used for 2020. The Gross Domestic Product (GDP) in 2020 is projected to be MWK 6.6 trillion, with a COVID-influenced 2% growth rate for 2020 based on analysis undertaken by the World Bank (World Bank, 2020). Projections for the next years are 3.3%, 4.0%, 5.0%. Thereafter, projections use the growth rates implied by GDP estimates in the IIASA database as discussed in Riahi et al. (2017). We use the SSP2 scenario and median estimate by Organisation for Economic Co-operation and Development (OECD) and the International Institute for Applied Systems Analysis (IIASA). Growth figures are only provided every 5 years, so we assume a constant growth rate figure per 5-year period.

The main cost parameters relate to i) intervention program costs encompassing testing, administration, case management and counseling ii) the direct costs of PrEP iii) indirect costs of accessing services. Intervention program costs are assumed to be MWK 74500 per FSW targeted based on FHI360 project (private correspondence, Melchiade Ruberintwari). Program costs are the same for each intervention and can be considered as the fixed costs associated with targeting a set number of FSWs. The costs of PrEP are assumed to be MWK 150,000 (USD 200) per person per year based on median results from other African countries (Walensky et al. 2016; Cremin et al. 2017; Meyer-Rath et al. 2017; Nichols et al. 2014). Beneficiary costs associated with accessing services are derived from Pinto et al., (2013) including direct costs of MWK 7728 per year for those on PrEP or additionally taking ART due to counseling, plus time costs of 48 hours per year monetized at estimated urban wage rates of MWK 960,000 in 2020 rising with income growth. There is also an assumed 4 hours of time cost per year for all FSW associated with testing twice annually.

For each intervention, the primary driver of benefits is avoided HIV infection which leads to three types of benefits: i) avoided lifetime ART costs to the health system ii) avoided patient healthcare costs associated with accessing ART care iii) avoided mortality. Lifetime ART costs are estimated at MWK 111,750 (USD 150) per year broadly following (Tagar et al., 2014) and are assessed against the proportion of individuals that would comply with ART. For FSWs this is 62%, and for the general population this is 89%. Individuals within the general population who would not otherwise comply with ART are assumed to have an annual mortality risk of 9.1% based on our calculations from Optima (2019). This is the long run time weighted average risk of mortality across different CD4 categories and includes elevated mortality risks for very low CD4 counts. Mortality benefits are monetized as per standard Malawi Priorities protocol, which follow the Guidelines for the Conduct of Benefit-Cost Analysis in Global Health and Development (Robinson et al. 2019, see appendix to this document for further detail). In 2020 each life year is valued at MWK 182,000 rising to MWK 291,000 in 2030, reflecting an increase in willingness-to-pay to reduce mortality risk commensurate with increasing economic growth. Years of life lost are estimated using Malawian life tables and assume that the 'typical' FSW contracts HIV at age 21, while the typical client or partner contracts HIV at age 30.

Two of the interventions (ART counseling and CAP) lead to greater use of ART by FSWs. However, these interventions result in reductions in ART use across the broader population due to the large number of avoided infections of male clients and partners. This result requires careful consideration of how this change is classified under a cost-benefit framework.

The two possible approaches of classification are:

1. Classify ART for FSWs as a cost, while ART avoided for the broader population as a benefit
2. Measure the net change in ART used across the whole-of-society, regardless of who consumes the treatment, and classify it as a cost if positive, and a benefit if negative (i.e. savings)

Our preferred approach is option 2. This is because this analysis considers a whole-of-society perspective. In this framing, ART usage decreases overall and the savings start immediately with the implementation of the intervention. The use of approach 2 is also supported by the fact that international donors finance 95% of Malawi’s HIV health services (UNAIDS, 2019). From the donor perspective, a reduction in overall ART used is clearly a benefit regardless of who is the ultimate beneficiary. Adopting option 1 requires a somewhat arbitrary cost and benefit classification based on who uses the ART, which does not seem to be defensible or reflect how financiers of the HIV program would think about the resources allocated to the broader HIV program.

4.2 Cost-benefit analysis of PrEP

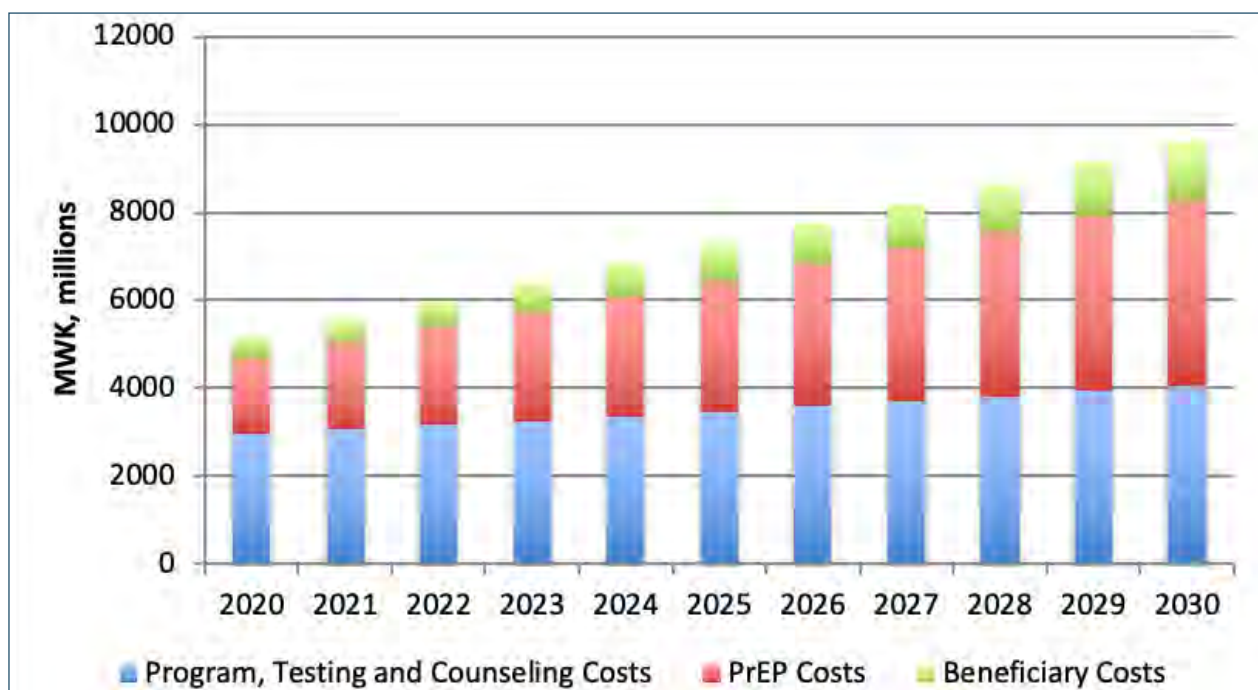
Pre-exposure prophylaxis is the use of anti-retroviral drugs in uninfected people to significantly reduce or eliminate the risk of contracting HIV during sex. The intervention is based on a demonstration project conducted in Malawi by FHI360 (private correspondence, Melchiade Ruberintwari). The program identifies FSWs and provides them with periodic testing, counseling for PrEP adherence and PrEP drugs for HIV-negative individuals. Costs and benefits are estimated against a baseline scenario where no FSWs are on PrEP which is essentially the current situation in the country.

The results are presented in Table 2. The intervention would increase the use of PrEP among FSWs rising from 11,494 in the first year to 28,315 by 2030. This increase reflects both the broader increase in the FSW population as well as lower prevalence within the beneficiary group meaning more are eligible for PrEP. The analysis shows that the intervention would avoid 1,866 FSWs contracting HIV in the second year rising to 2,320 by 2030. The intervention also reduces infections in clients and partners. This starts at 351 but rises quickly to 3,289 contributing more to the avoided infections caused by the intervention by 2030. This difference arises because of the underlying drivers of infections between FSWs and clients / client partners. In the former, infections are a function of the number of FSWs on PrEP in a given year, while the latter is a function of the pool of HIV infected FSWs not taking ART. A FSW who sustains a HIV negative infection status avoids transmission to clients and partners for every year in which she remains HIV negative. Total avoided HIV infections are 39,290 to 2030. Avoided deaths to 2040 are estimated at 8,883.

4.2.1 Costs of the intervention

The cost profile of the program is depicted in Figure 3. In the first year costs total MWK 5.2 billion with program costs (MWK 3.0 billion) comprising the majority. By 2030 total costs are estimated at MWK 9.6 billion, but programs costs are only MWK 4.1 billion slightly less than 50%. The greater contribution by PrEP over time reflects the success of the intervention in keeping FSWs HIV-negative. The total undiscounted costs are MWK 80.5 billion from 2020 to 2030.

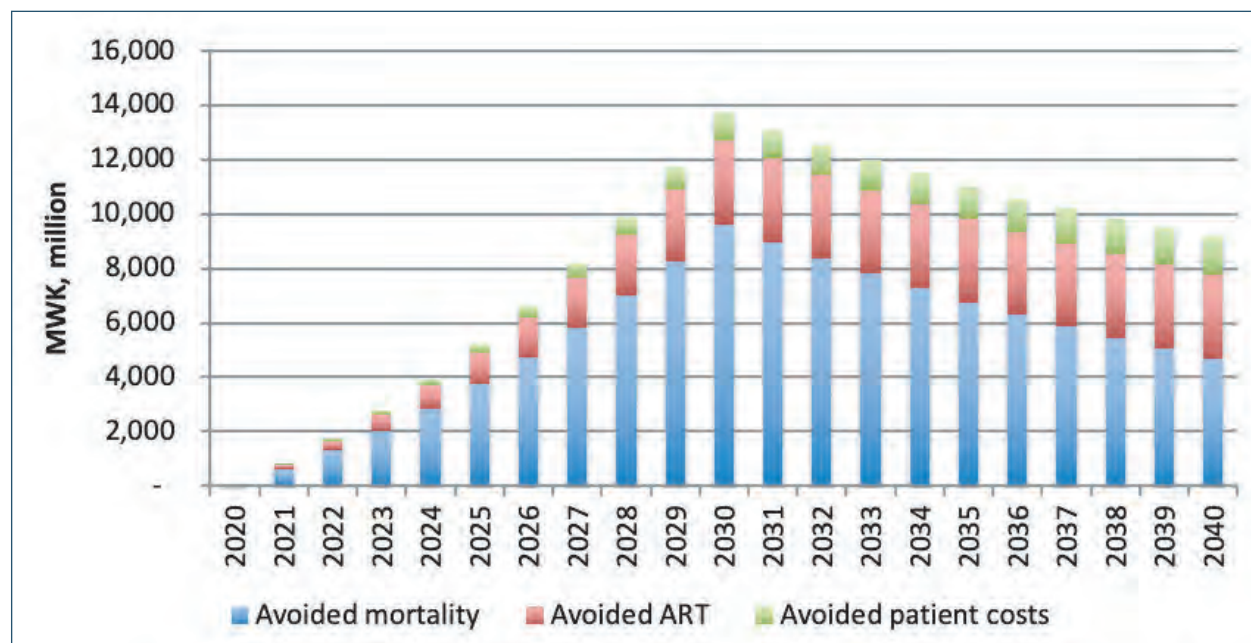
Figure 3: Estimated cost profile of providing PrEP to HIV-negative FSWs to 2030



4.2.2. Benefits of the intervention

The intervention will avoid 39,290 cases of new HIV cases in FSWs, their clients and their clients partners as noted in Table 2. This leads to a suite of benefits as outlined in Section 4.1. The benefit profile of the intervention from up to 2040 is presented below. The results indicate that avoided mortality represents the largest benefit stream, initially comprising up to three quarters of the total benefit. However, the contribution of this benefit reduces gradually over time due to fewer life years lost avoided as beneficiaries age and by 2040 comprises just over half the total benefit. Note that this benefit profile assumes that the real cost of ART stays constant over time.

Figure 4: Benefits of PreP Intervention



4.2.3. Summary

Adopting an 8% discount rate, the total benefits of the intervention are estimated at MWK 91 billion, while costs are estimated at MWK 54 billion for a benefit-cost ratio (BCR) of 1.7. Results at different discount rates are provided in Table 3.

Table 3: Summary of Costs and Benefits for PrEP intervention (2020-2030)

Discount Rate	Costs (MWK, millions)	Benefits (MWK, millions)	BCR
5%	61,973	143,620	2.3
8%	53,843	91,133	1.7
14%	42,018	46,105	1.1

4.3 Cost-benefit analysis of ART Adherence Counseling for FSWs

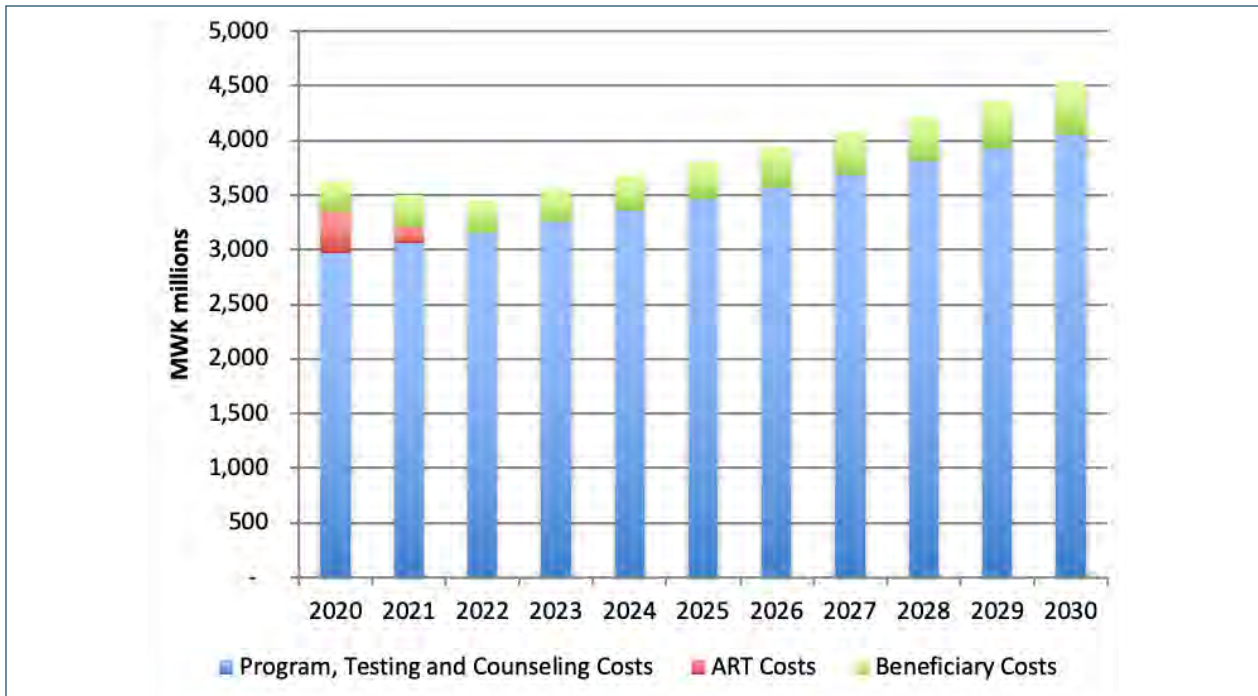
This intervention provides ART adherence counseling for identified HIV-positive female sex workers and is based on a project run by FHI360, already covering some 14,000 FSWs. The analysis here assumes a scale up of the program to cover all female sex workers and is assessed against a counterfactual where the program ceases.⁶ The impact of the intervention on new infections is presented in Table 2. The intervention reduces transmission to male clients and their partners leading to around 2,700 avoided infections in the first year rising to just over 3,700 by 2030. We assumed no change in HIV infection risk for HIV-negative FSWs. The total number of avoided infections over the time period is estimated at 35,278 to 2030. Avoided deaths to 2040 are estimated at 6,177.

⁶ It would have been preferable to assess the intervention against a counterfactual where the FHI360 program continues at 14,000 FSWs annually. However, recent surveys of FSWs ART adherence have not been conducted since the intervention has commenced and so we are unable to fully calibrate the baseline scenario with this increase in adherence factored in. As a simplifying assumption, we assess against a counterfactual of no program. Given the mechanics of the economic analysis, this does not impact the BCR.

4.3.1. Costs of the intervention

The cost profile of this intervention is presented below in Figure 5. The vast majority of costs are associated with programmatic costs, including counseling. The intervention leads to a net increase in ART costs in the first two years only. After that, ART savings are generated across the entire health system, so they are classified as benefits. Total undiscounted costs to 2030 are MWK 43 billion.

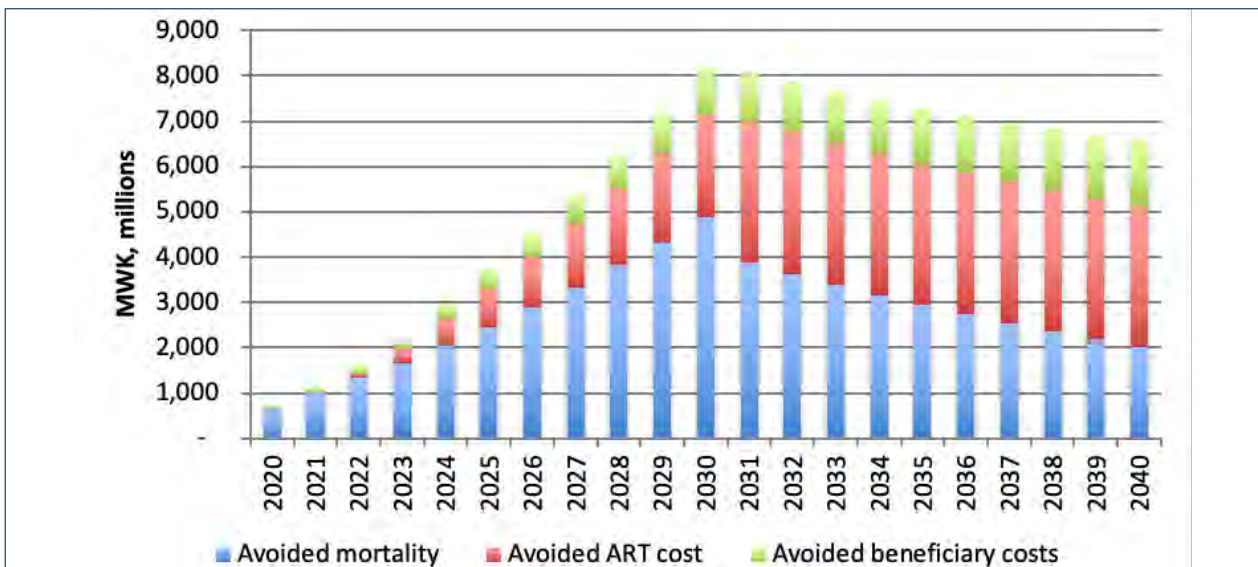
Figure 5: Cost of ART Adherence Counseling for HIV-positive FSWs



4.3.2. Benefits of ART Adherence Counseling

The benefits of the intervention to 2040 are presented in Figure 6. Initially, the largest benefit is avoided mortality. The importance of this benefit reduces over time as the beneficiary population ages (therefore lowering the number of avoided life years lost). By 2040, ART savings make up just under half of all benefits.

Figure 6: Benefits of ART Adherence Counseling



4.3.3. Summary

Adopting an 8% discount rate, the total benefits of the intervention are estimated at MWK 64 billion, while costs are estimated at MWK 29 billion for a benefit-cost ratio (BCR) of 2.2. Results at different discount rates are provided in Table 4.

Table 4: Summary of Costs and Benefits for ART adherence intervention

	Costs (MWK, millions)	Benefits (MWK, millions)	BCR
5%	33,462	101,772	3.0
8%	29,369	64,173	2.2
14%	23,376	32,655	1.4

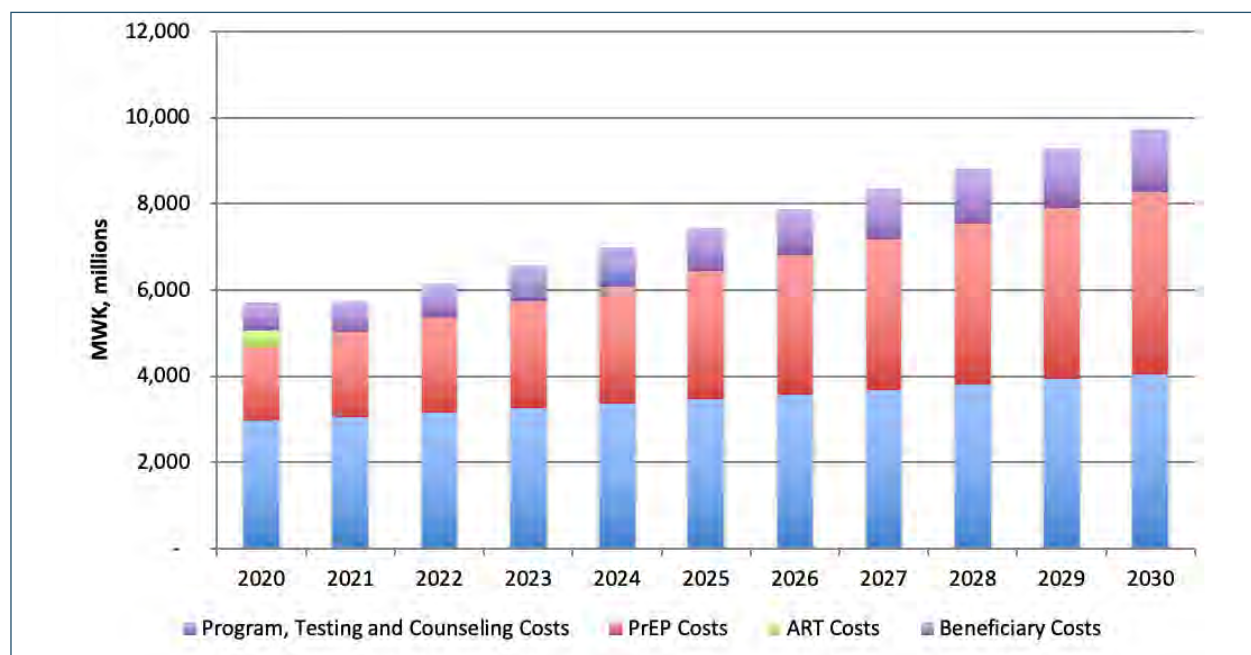
4.4 Cost-benefit analysis of Comprehensive Ambipolar Package

This intervention combines the previous two interventions – i.e. providing PrEP for HIV-negative FSWs and ART adherence counseling for HIV-positive FSWs. The assumptions used for this intervention are the same as for the individual interventions. However, here we account for both synergies and overlaps in costs and benefits associated with the combined approach. The benefits of the intervention are presented in Table 2. The PrEP component of the intervention leads to a reduction in new FSWs becoming infected, which is equal to the benefits from the PrEP intervention alone. Regarding male clients and partners, CAP demonstrates a larger benefit than either intervention alone – with avoided infections starting at 2,732 rising to 5,023 by 2030. In total, CAP avoids 63,206 infections to 2030. Note that this figure is less than the naïve addition of the impacts from the stand-alone intervention due to the fact that both PrEP and ART treatment are both preventative interventions, and there is some overlap of benefits when deploying both simultaneously. Estimated deaths avoided to 2040 are 13,341.

4.4.1 Costs of the intervention

The cost profile of the intervention is presented in Figure 7. Total costs are MWK 5.7 billion in 2020 rising to MWK 9,744 by 2030. Initially program, testing and counseling costs represent the greatest share, though by 2030 PrEP costs are the largest component, primarily due to the larger pool of FSWs who avoid infection. Extra ART is only required in the first year, after which there are ART savings (defined as benefits). The total undiscounted cost to 2030 is MWK 83 billion.

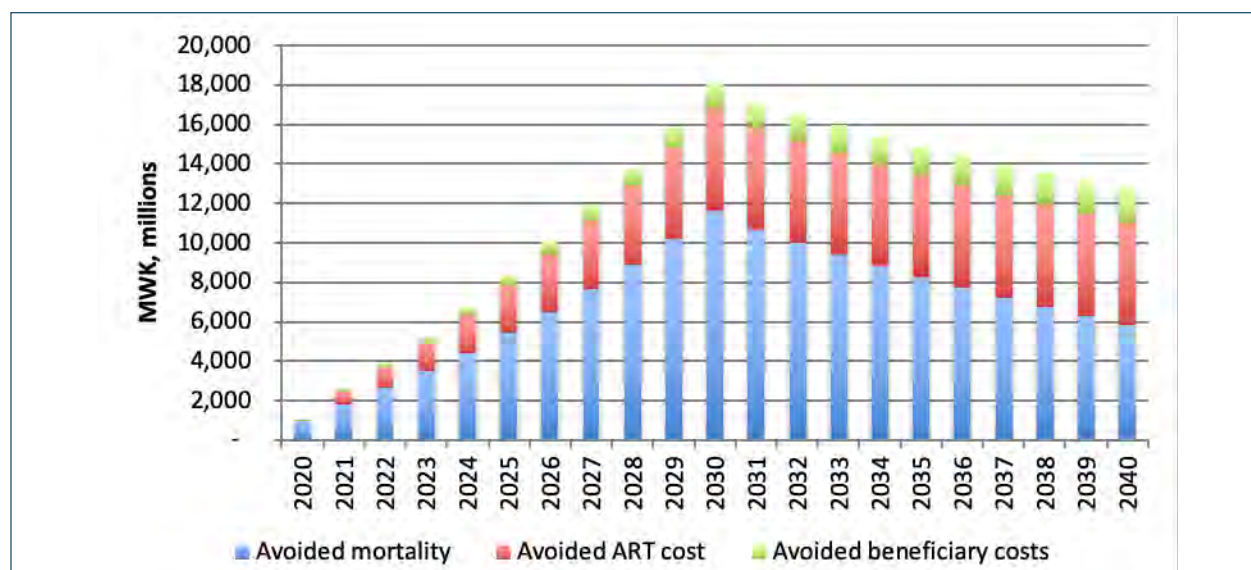
Figure 7: Cost profile of Comprehensive Ambipolar Program



4.4.2 Benefits of the intervention

The benefits of the intervention are presented in Figure 8 and are similar in characteristics (albeit with higher magnitude) as the other interventions. The total undiscounted benefits are MWK 245 billion to 2040.

Figure 8: Benefits of Comprehensive Ambipolar Program



4.4.3 Summary

Adopting an 8% discount rate, the total benefits of the intervention are estimated at MWK 137 billion, while costs are estimated at MWK 59 billion for a benefit-cost ratio of 2.3. Results at different discount rates are provided in Table 5.

Table 5: Summary of Costs and Benefits for Comprehensive Ambipolar Package

	Costs (MWK, millions)	Benefits (MWK, millions)	BCR
5%	68,199	215,074	3.2
8%	59,451	137,414	2.3
14%	46,701	71,414	1.5

5. Sensitivity Analyses

We conduct several analyses to assess the sensitivity of results to changes in key parameters. We vary the:

- unit cost of ART, with a high end of USD 450 (MWK 337,500) as per Kripe et al. (2017) and a low end of USD 100 (MWK 75,000)
- unit cost of PrEP with a high end of USD 300 (MWK 225,000) and a low end of USD 100 (MWK 75,000)
- unit program costs associated with the intervention, with a high end of USD 200 (MWK 150,000) and a low end of USD 50 (MWK 37,500)
- the assumed number of onward infections associated with FSW living with HIV and not taking ART, with a high end of 1.0 and a low end of 0.25

The results of this sensitivity analysis are presented below in Table 6. The results indicate that PrEP is likely the least cost-effective of all interventions, with only one scenario where the BCR is higher than one of the other two interventions. Additionally, there is substantial overlap in the BCR range of CAP (1.6 - 3.7) and ART counseling (1.1 - 4.6) suggesting that the two are indistinguishable in terms of cost-effectiveness within reasonable uncertainty bounds. However under all scenarios, the absolute impact in terms of avoided infections of CAP is higher than ART counseling as a stand-alone intervention.

Table 6: Benefit-cost ratios (8% discount rate) of the different interventions under changes to key assumptions

Scenario	CAP	ART Counseling	PrEP
Base case	2.3	2.2	1.7
ART costs = MWK 337,500	3.3	3.6	2.6
ART costs = MWK 75,000	2.1	1.9	1.5
PrEP costs = MWK 225,000	2.0	2.2	1.4
PrEP costs = MWK 75,000	2.8	2.2	2.1
Program costs = MWK 150,000	1.6	1.2	1.1
Program costs = MWK 75,000	3.0	3.9	2.2
Onward infections associated with each FSW living with HIV not taking ART = 1.0	3.7	4.6	2.4
Onward infections associated with each FSW living with HIV not taking ART = 0.25	1.6	1.1	1.4

6. Conclusion

This report analyses three interventions that provide HIV and AIDS services to FSWs in Malawi. The results suggest that providing a comprehensive package involving testing, counseling, PrEP and ART adherence in FSWs would avoid 63,206 infections to 2030, and has the largest pay-off with an estimated BCR of 2.3. Focusing on improving ART adherence in FSWs as a standalone intervention would avoid 35,278 infections to 2030 and has a similar BCR of 2.2 at an 8% discount rate. Providing PrEP alone would avoid 39,290 infections to 2030, and it has the lowest BCR of 1.7 at an 8% discount rate. These BCRs are based on calculations that suggest interactions with FSWs contribute around 15% of all new infections in individuals aged 15+ annually.

The BCRs reported from the interventions are relatively modest.

Table 7: Summary of Results

Intervention	Discount rate	Costs (MWK, millions)	Benefits (MWK, millions)	BCR
PrEP for HIV-negative female sex workers, 2020-2030	5%	61,973	143,620	2.3
	8%	53,843	91,133	1.7
	14%	42,018	46,105	1.1
ART adherence counseling for female sex workers, 2020-2030	5%	33,462	101,772	3.0
	8%	29,369	64,173	2.2
	14%	23,376	32,655	1.4
Combined ambipolar package of PrEP and ART adherence counseling 2020-2030	5%	68,199	215,074	3.2
	8%	59,451	137,414	2.3
	14%	46,701	71,414	1.5

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8. Appendices

Appendix 1: Intervention selection process

A thorough literature review of measures to prevent HIV transmission was undertaken to ascertain the extent to which Malawi had integrated the intervention in its strategic plan; based on previous Copenhagen Consensus research, whether the interventions were considered high social return on investment, and whether there were similar country examples, pilot/demonstration projects, and/or the results of randomized trials that could inform the selection and design of the interventions to be analyzed. We also interviewed several local experts, including:

Melchiade Ruberintwari, FHI360

Ceesay Nuha, UNAIDS-Malawi

Kondwani Chalulu, Malawi VMMC programme

The intervention selection process starts with a wide universe of potential interventions drawing from literature, stakeholder interviews and advisor input. From here, the prioritization of interventions takes in a number of considerations. Though there is no mechanical formula for selecting interventions, several important factors include:

1. Sector expert priority – An intervention is accorded higher priority if sector experts note that it is important. There are several avenues from which experts provide input into our process such as the Reference Group questionnaire, direct interview, inferences from the NPC research agenda, and via our academic advisory group.
2. High benefit-cost ratio or cost-effectiveness in similar previous research – The purpose of the Malawi Priorities project is ultimately to identify interventions of outsized benefits relative to costs. Input into this factor is determined from the economics literature, particularly previous research conducted by the Copenhagen Consensus Center. In the Center’s experience BCRs above 15 are among the highest across all interventions. Due consideration is given to contextual differences between previous research and the current situation in Malawi in determining the effect of this criterion.
3. Addresses a problem of sufficient size – some interventions could be considered highly effective but only address a small percentage of a given problem, limiting the overall net benefits of the approach. To avoid focusing on solutions that are too small, each intervention must have the potential to address a problem that is significant.
4. Significant gap in current coverage levels of intervention – all analysis conducted in Malawi Priorities focuses on marginal benefits and costs. Therefore if an intervention already has high coverage rates, then additional resources provided towards that intervention are unlikely to be effective, or will suffer from the ‘small-size’ problem.
5. Availability of crucial data or credible knowledge of impact – due to time and resource constraints, all analyses conducted by Malawi Priorities are based on secondary data. No primary research is conducted, such as field experiments or trials. Therefore, each intervention is constrained by the availability of data. In many cases, one key constraint is knowledge concerning the impact of a given intervention. It is typical to formally deal with uncertainty via sensitivity analyses. However, in some cases the uncertainty is so great that it precludes even researching the intervention at all.

The universe of potential HIV interventions draws heavily from a project Copenhagen Consensus conducted in 2011 called ReThink HIV, which analyzed multiple interventions. The process of screening and prioritizing interventions is summarized in Table A1.

Table A1: Intervention screening process

Intervention considered	Sector expert priority	High BCR or cost-effectiveness	Addresses a problem of sufficient size	Significant gap in current coverage levels	Availability of data	Overall
Testing and counseling on ART adherence for HIV-positive female sex workers	Yes, focus on FSWs noted by sector experts and NPC research agenda	Uncertain	Yes, it was widely considered before the research that FSWs contribute significantly to new infections	Yes, health services for FSWs are much lower than the general population, ART adherence is ~60% among FSWs	Yes	High
Testing and pre-exposure prophylaxis for HIV-negative female sex workers	Yes, focus on FSWs noted by sector experts and NPC research agenda	Uncertain	Yes, it was widely considered before the research that FSWs contribute significantly to new infections.	Yes, access to health services for FSWs is lower than the general population	Yes	High
Voluntary medical male circumcision	Yes, focus on promotion of circumcision at birth suggested by Academic Advisor and VMMC coordinator.	Yes, previous research indicates BCRs between 10 and 60, depending on HIV prevalence	Yes, VMMC is considered highly effective in preventing sexual transmission.	Yes, only 30% of males have been circumcised (traditional and medical).	Yes	High
Promotion and distribution of condoms	Not considered a priority by sector experts	Yes, previous research indicates condom (male and female) usage typically have a cost/DALY averted of between \$100 and \$300 (Stover et al., 2017).	Yes, only 27% of women and 30% of men reported using a condom during the last sexual intercourse (Malawi DHS 2015/16).	No, a recent review noted in 2015 a total of 71 million condoms were distributed against a target of 40 million	Yes	Medium
Interventions targeting adolescents	Young adults, especially, women, were considered a priority group by UNAIDS.	Previous CCC analyses indicate that BCRs tend to be below 5.	Yes, new infections appear to be concentrated among adolescents and young adults	Yes, sexual and reproductive health programs tend to focus on abstinence.	Yes	Medium
Conditional cash transfers	No	Widely considered effective in the literature, but costly	Yes, has effectively targeted adolescent girls in experiments	Not part of current HIV prevention policy	Yes	Medium

Intervention considered	Sector expert priority	High BCR or cost-effectiveness	Addresses a problem of sufficient size	Significant gap in current coverage levels	Availability of data	Overall
Self-testing kits	No	Unknown	Targeting marginalized populations and high-risk groups.	There are 15 drop-in clinics which service FSWs (LINKAGES/FHI360 demonstration project, but FSWs have concerns of confidentiality and are a migratory group.	There was a feasibility experiment for self-testing kits among FSWs. Confidentiality remains a factor to uptake.	Low
Universal testing and treatment	No	Previous CCC analyses indicate BCRs between 5 and 30.	Population-focused intervention	No, it is currently offered in various forms: client-initiated, community-based, mobile, home-based, and door-to-door. Malawi has achieved the WHO 90% target of identifying PLHIV	Yes	Low
Safe medical injections	No	Previous CCC analyses indicate BCRs between 1.6 - 19.8	Not considered a significant source of new infections		Yes	Low
Safe blood transfusions	No	Previous CCC analyses indicate BCRs between 146 - 882	Not considered a significant source of new infections	Blood transfusions are generally safe in Malawi with seroprevalence testing of blood now standard	Yes	Low
HIV and AIDS services for intravenous drug users	No	Previous CCC analyses indicate BCRs between 0.5 - 7.5	Not considered a significant source of new infections		Limited	Low
Prevention of Mother-to-Child transmission	No	Previous CCC analyses indicate that the BCR is high, ranging from 15 to as high as 150.	Mother-to-Child transmission are only an estimated 9% of new infections	None, Malawi has achieved 95% testing of pregnant women, and neonates	Yes	Low

The interventions considered for further research are noted below.

Interventions targeting FSWs: Testing and counseling on ART adherence for HIV-positive FSWs; Testing and pre-exposure prophylaxis for HIV-negative FSWs

The project team focused on FSWs since profession-driven infections were accorded particular focus in the NPC research agenda. Subsequent literature reviews and stakeholder discussions confirmed this particular group as a likely driver of new infections in the country. FSWs have a significantly higher prevalence of HIV, with a report from 2014 noting 63% prevalence (NSO, 2014). At the same time, adherence to ART was only reported at 62% (Malawi National Aids Commission, 2018) relative to almost 80% among the general population (DHS, 2015/16). Given the large number of sexual encounters occurring between FSWs and the broader population, with one report noting around 30 interactions per week per FSW (Project SOAR, 2019), it seemed worth investigating interventions targeting this sub-group. Stakeholder consultations indicated adherence counseling and pre-exposure prophylaxis were important interventions in this regard.

Voluntary medical male circumcision (VMMC)

According to the National AIDS Council, the National VMMC program was formally launched in 2006 and since then VMMC has been promoted as a core intervention for prevention. However, VMMC remains low at 11.5%, though including traditional circumcision places coverage at 30%. To date, the number of medically circumcised men numbers approximately 200,000. According to the DHS 2015/16, among men aged 15-49, approximately 28% have been circumcised, 18% by traditional practitioners or family friends, and 9% by a health professional.

The current national target is 80% VMMC prevalence among men aged 10-34 years. The determination of targets for each district was informed by the VMMC modelling of Kripke et al. (2017) that showed circumcising 60% of males aged 10-34 years would result in a huge impact of preventing 128,819 new HIV infections by 2050. The priority geographical areas thus include all districts in South Eastern and South Western Zones, as well as Ntcheu, Dedza and Lilongwe. According to the IASA WIC Population estimates for 2020, this age group corresponds to approximately 4.81 million men, 3.84 million to be medically circumcised.

There is an abundance of evidence that male circumcision significantly reduces the risk of HIV infection in men, around 60%. Furthermore, previous Copenhagen Consensus research has demonstrated that this intervention is likely to have a high benefit-cost ratio (Geldsetzer, Humair, Bloom and Barnighausen, 2015) so much so that an Eminent Panel of distinguished scholars including two Nobel Laureates put increased circumcision to avoid HIV infections as one of the top 19 targets for the Post-2015 development agenda (Lomborg, 2020). Lastly, despite the low uptake, conversations with local experts revealed that there are still ways to improve uptake. This intervention was therefore retained for further investigation.

Promotion and distribution of condoms

Previous research has indicated that condom promotion could be an effective intervention providing a triple benefit of reduced STIs, fertility and HIV infections (Stover et al. 2017). The analysis by Stover et al. (2017) demonstrates a cost per DALY avoided between \$115 and \$304 for a suite of 81 countries, far below the weighted average GDP per capita of ~\$7000. If the value of a DALY were equivalent to 1x GDP per capita, this would imply a BCR of 25-70, a very large return on investment. In Malawi, the promotion of the simplest of prevention measures, the use of condoms during sex, has gotten some traction. An independent review (2014/14) of the government's performance against planned activities cited that 2014/15 recorded the highest condom distribution ever for both public and socially marketed condoms, with a total of 71,008,826 condoms being distributed against a target of 40,240,000. The increase is attributed to a number of factors, among them being the establishment of district condom committees. Despite this, only 27% of women and 30% of men reported using a condom during the last sexual intercourse (Malawi DHS 2015/16). This intervention was not retained due to the already high coverage of the intervention and limited indications from sector experts concerning the importance of this intervention.

Targeting adolescents: abstinence, sexual and reproductive health education, and health services

The age of sexual initiation in Malawi is high, while knowledge of HIV and prevention measures are low. According to the DHS 2015/16, overall, the percentage of young people age 15-24 who have had sex by age 15 has decreased only slightly between 2000 and 2015-16 for both women (from 17% to 14%) and men (from 25% to 19%). The percentage of young people aged 18-24 who have had sex by age 18 has decreased only slightly from 2000 to 2015-16, from 64% to 59% among young women and from 58% to 53% among young men. 51% of women 15-19

years have never been tested (65.4 for men of same age), yet sexual activity has already begun for the majority. This percentage declines considerably with age. For 20-24 years, the percentage of girls never tested is 9.4%; 27.3% for men. Furthermore, comprehensive knowledge of HIV is low among adolescents, about 40%.

While new infections appear to be concentrated among adolescents and young adults, previous Copenhagen Consensus research informs that the benefit-cost ratios of such interventions are relatively low (less than 5), mainly because all adolescents must be targeted in order to capture the most vulnerable. That said, there is some overlap with adolescent girls and FSW, as the latter begin having transactional sex, at age 18 on average.

Conditional cash transfers

Randomized trials in Malawi have found that conditional and unconditional cash transfers for adolescent girls were associated with lower rates of marriage (Baird et al. 2010) and HIV (World Bank 2010a). Furthermore, Baird et al (2012) recruited 1,289 never-married women aged 13-22 years, who were randomly assigned to receive cash payments (intervention group) or nothing (control group), with conditions attached to school attendance. The primary outcomes were prevalence of HIV and herpes simplex virus 2 (HSV-2) at 18 months and were assessed by intention-to-treat analyses. Weighted HIV prevalence at the 18 month follow-up was 1.2% in the combined intervention group versus 3.0% control group. The results were similar for HSV-2. The researchers concluded that cash transfer programs can reduce HIV and HSV-2 infections in adolescent schoolgirls in low-income settings. There is no shortage of evidence on the effectiveness of conditional cash or asset transfers, but previous Copenhagen Consensus analysis informs that these programs are costly from a social investment perspective. Thus, the intervention was not retained.

Self-testing kits

Napierala (2019) conducted a rapid ethnographic assessment of the feasibility of self-testing kits for FSWs. Services were provided at three female sex workers' drop-in clinics operating out of primary care clinics. Outreach was mainly delivered through peer educators. The women's preference was for distribution of HIV self-testing kits through peers rather than general population clinics. There were several concerns by participants relating to discretion, confidentiality, and social stigmatization. The participants feared that male clients would become aware. There was also a concern logistically about how to securely store kits which led to the decision for weekly stocks to be delivered to peer distributors, because of the migratory nature of the profession. The women's diary reports noted 29 events of coercive testing and 28 forced disclosures between female sex workers and established intimate partners, family members, peers or peer distributors. Some female sex workers reported regretting testing. Some women experienced physical violence, mostly perpetrated by an established partner. This intervention was not retained, nor was it proposed by local experts.

Universal test and treat

Malawi has been implementing 'Test and Treat' since 2016. The goal of this policy is to identify as many people living with HIV (PLWHIV), as early as possible, and to get them enrolled in an ART program. It is currently offered in various forms: client-initiated, community-based, mobile, home-based, and door-to-door. Malawi has achieved the WHO 90% threshold associated with diagnosis of all people estimated to be living with HIV. However, it has been observed that there is a retardation in ART initiation among newly positive persons, as well as a drop-in adherence from those who have been taking ART for some time. Dovel et al. (2020) surveyed health care workers about these issues and discovered that 'feeling healthy', fear of disclosure, fear of disruption of life activities, and the social stigma attached to HIV and AIDS, makes it difficult to convince the PLWHIV to begin ART. The decline in ART adherence emerged as a pertinent point of interrogation, as such adherence drops to as low as 62% among FSW. This aspect of ART adherence was retained, as noted above.

Safe blood transfusions

The Malawi Blood Transfusion Service has made great progress. Mbaya et al (2019) found, in an analysis of the MBTS database from 2011-2015, that the mean sero-positive prevalence among blood donors was 1.9%.

Intravenous drug users

Illicit drug use appears to be negligible in Malawi, with the drugs of choice being alcohol (not illicit) and cannabis. Intravenous drug use seem negligible. Despite having high benefit-cost ratios in previous CCC work, these intervention areas do not feature as priorities in the Malawi Strategic Plan for HIV/AIDS 2015-2020: blood transfusions, men who have sex with men (MSM), and intravenous drug use (IDU) are not key drivers of HIV transmission. This is supported by the data, heterosexual sex and Mother to child transmission account for 88% and 9%, respectively. These (on blood transfusion, IDU, and MSM) intervention areas were thus not retained.

Prevention of mother-to-child transmission (PMTCT) programs

This is a success area for Malawi, which has passed the threshold of 95% of testing pregnant women, getting them started on antiretroviral therapy, and getting infants born to women living with HIV to be tested within two months of birth. Consequently, Malawi has driven down new HIV infections among children (ages 0-14). In 2018 there were 3,500 new paediatric infections, compared with 15,000 in 2010, 9% of new infections.

Below is a list of previous analyses relating to prevention of HIV transmission undertaken by the Copenhagen Consensus Center.

Intervention	Country/ Geographic region	Coverage	Benefit-cost ratio
VMMC	Sub-Saharan Africa	80% of HIV negative males	28
ART treatment as prevention	Haiti	80% general population	3.0
VMMC	Botswana		60.3
VMMC	Mozambique		11.9
Test and treat	Botswana		30.7
Test and treat	Mozambique		5.4
Mass information campaign	Botswana		11.1
Mass information campaign	Mozambique		1.9
PMTCT	Sub-Saharan Africa	90%	15 - 146
Safe medical injections	Sub-Saharan Africa	95%	1.6 - 19.8
Safe blood transfusions	Sub-Saharan Africa	100%	146 - 882
Intravenous drug users	Kenya, South Africa, Tanzania	60%	0.5 - 7.5

Appendix 2: Indicative Cost-benefit analysis of Voluntary Medical Male Circumcision (VMMC) versus Early infant Male Circumcision (EIMC)

There is consensus in the literature regarding the effectiveness of VMMC to lower the risk of HIV for men. Mills et al. (2008) identified three RCTs involving a total of 11,050 men in South Africa, Kenya, and Uganda, in which the pooled analysis indicates a RR of 0.44 (95% CI 0.33–0.60) in favour of circumcision, corresponding to a RR reduction of 56% (95% CI 40–67%). Kripke et al (2017) study the impact of scaling up VMMC to different target populations of Malawi. Over a fifteen-year period, circumcising males ages 10–29 would avert 75% of HIV infections, and circumcising males ages 10–34 would avert 88% of infections, compared to the current strategy of circumcising males ages 15–49. The Ministry of Health’s South West and South East health zones had the lowest cost per HIV infection averted. Furthermore, circumcising men in urban areas would be both cost-effective and cost-saving, with a VMMC cost per DALY saved of \$120 USD and with 15 years of VMMC implementation resulting in lifetime HIV treatment costs savings of \$331 million USD.

Uptake of the procedure is key to realizing the social benefit implied when men cannot transmit the HIV to their partners. The current national target is 80% VMMC prevalence among men aged 10–34 years. Since the launch of the VMMC programme in 2006, Malawi has achieved an uptake rate of 11.5% for VMMC. When traditional circumcision is included, 28% of the male population has been circumcised.

Ensor et al (2019), in a review of effective demand creation interventions, found that the greatest absolute impact on VMMC prevalence was seen with a complex intervention including VMMC promotion training for religious leaders ((compared to control: 23% (95% CI 22.8 to 23.8) absolute increase; OR 3.2 (1.4 to 7.3)). Financial incentives generally produced the largest relative effects with men up to seven-times more likely to undergo VMMC in the intervention arm compared to control (adjusted OR 7.1 (95% CI 2.4 to 20.8), 7.1% (3.7 to 10.5) absolute increase). Likewise Torres-Rueda et al (2018) demonstrate in Tanzania that is not only cost-effective but also cost-saving to invest in demand creation activities.

Curiously, Lau et al. (2015) found that countries with large proportions of circumcisions performed by medical professionals (i.e., Namibia, Rwanda, Swaziland, Tanzania and Zambia) show age at circumcision being performed before age ten. Because targeting is key to the success of this intervention, one of the alternative strategic points of demand uptake may be at birth. Antenatal care coverage has achieved 98% (AIDSinfo/UNAIDS), 51% realized four antenatal visits, and, according to the DHS, over 80% of women receive HIV testing and counseling as part of antenatal care. This is essentially the first contact a male has with the health system. Kondwani Chalulu, the chief surgeon of the Malawi VMMC programme, organized a modest demonstration project of 100 women who were approached at antenatal clinics, counselled by ‘mobilizers’ and accorded a 30 day window to have the circumcision done. The uptake rate was around 30% within the span of a few months. With financial incentives like transport support, he believes this could increase to 40%.

Waters et al. (2014) undertook a similar demonstration project in Lusaka, Zambia, in which mothers of new-born boys (median age was 1 day old) were approached and counselled on VMMC. Of the 1,249 eligible mothers approached, 1000 (80%) agreed to participate in a survey. Although 97% of surveyed mothers said they definitely or probably planned to have their newborn son circumcised, only 11% of participants brought their newborn sons for circumcision. Significant predictors of uptake in adjusted models included: Older maternal age (AOR 3.77, 95 % CI 1.48–9.63 for age 36 and above compared to mothers age 25 and below), having attended antenatal care at an NMC site (AOR 2.13, 95 % CI 1.32–3.44), older paternal age (AOR 4.36, 95 % CI 1.28–14.91 for age 26–35 compared to fathers age 25 and below), and the infant’s father being circumcised (AOR 2.21, 95 % CI 1.35–3.62). In an exit interview, 26% of women who declined to have their infant circumcised thought that he was too young. Interestingly, more than half the respondents (54 %) said they thought they would have the child circumcised in the future, at ages ranging from 4 months–14 years.

It was therefore decided to calculate the benefit-cost ratios of circumcising one male at various ages, in order to determine which age group would yield the highest social returns. The model used is an adaptation of Haacker et al. (2016), which entailed a cost-effectiveness analysis of circumcising a male at various ages in South Africa. In a subsequent consultation for the Copenhagen Consensus Center (details available upon request), Haacker undertook a cost-benefit analysis of circumcising one male with varying parameters (prevalence and ART adherence rates) to reflect demographic heterogeneity and epidemiological differences of HIV and AIDS across sub-Saharan Africa.

This model was further adapted as part of the Malawi Priorities project with the parameters noted below.

Table A2: Model parameters used

Parameter	Model parameters	Source
HIV prevalence, population aged 15-49	8.8%	Malawi DHS 2015/16
HIV prevalence, male, aged 15-49	6.4%	Malawi DHS 2015/16
HIV prevalence, female, aged 15-49	10.8%	Malawi DHS 2015/16
ART coverage	81%	Immutable parameter in Haacker (2016)
Viral suppression	90%	Immutable parameter in Haacker (2016)
ART cost, per person, per year, USD	\$451	Kripke et al. (2019)
Time untreated, HIV+	8	CCC assumption
Life expectancy, ART	25	CCC assumption
EIMC cost, USD	\$42	VMMC Program
VMMC cost, USD	\$200	VMMC Program

BCRs were estimated for male circumcision at age 0, 10, 15, 20 years of age and onward to 50 years of age with 10 years increments, except for 10 and 15 year olds where results are reported for 5 year increments.

The age cohorts range from birth to 50 years old.

Cohort label	Age	Projected population (2020) **, millions
0	0-9	3.23
10	10-14	1.321
15	15-19	1.09
20	20-29	1.752
30	30-39	1.157
40	40-49	0.738
50	50-54	0.212

**IIASA-WiC POP-SSP2, © SSP Public Database (Version 2.0), generated: 2020-04-21 17:03:37

With regards to demand uptake, the rates of 40%, 60% and 80% were considered.

Costs

Cost is the medical circumcision intervention cost. According to the Malawi VMMC programme, neonatal circumcision ranges from \$38 to \$45, while adult circumcision ranges from \$150 to \$250. The midpoints of both ranges were used for the analysis: \$42 for infants and \$200 for adolescents and adults. Generally, circumcision of infants is cheaper because it requires no sutures, fewer surgical personnel, and is undertaken with a clamp. Furthermore, three post-operative visits are required for adult circumcision: at 48 hours, 7 days and 28 days, while none are required for neonates.

By way of comparison, a study undertaken by Binagwaho et al. (2010) found that neonatal male circumcision was 25.4% (\$15) of the cost of those of adult males (\$59) at public hospitals; 51.7% (\$45 of \$87) at private hospitals. UNAIDS (2009), in a systematic review of cost effectiveness studies in South Africa, Kenya, Uganda, Eswatini, Zambia, and Lesotho, observed that neonatal circumcision costs approximately one third of that of adult males, \$30-\$60, depending on programme settings.

The cost of stimulating demand uptake has not been factored in. It was assumed, given that the highest BCR is associated with circumcision at birth, that beneficiary targets would be pregnant and/or recently birthed women. Therefore, the use of structures already in place to reach out to pregnant women for both antenatal care and ART would imply minimal additional costs for this campaign.

Table A3: Total costs by demand uptake, age cohort, USD million

	0-9	10-14	15-19	20-29	30-39	40-49	50-59
40%	54.2	105.7	61.9	98.1	68.4	44.2	12
60%	81.4	158.5	92.8	147.1	102.7	66.4	18
80%	108.5	211.4	123.8	196.2	136.9	88.5	24

Benefits

Benefits are averted premature deaths and averted HIV treatment cost associated with reduced HIV transmission. There are two benefit streams: direct beneficiaries are the circumcised males, and indirect beneficiaries are the averted transmissions to their female partners.

Averted premature death is valued using the VSLY approach based on GDP per capita in Malawi. Lifetime treatment cost per HIV positive is US\$2275 (based on the annualized patient cost of \$451 and a discount rate of 8%). It is further assumed that most people begin treatment after 8 years of infection and consequently have an average lifespan of 25 years.

Circumcising before sexual experimentation, age 20 and before, averts the most HIV infections.

Table A4: Infections averted per male circumcised

	0-9	10-14	15-19	20-29	30-39	40-49	50-59
Total	0.051	0.051	0.048	0.050	0.018	0.005	0.002
Direct	0.02	0.02	0.02	0.02	0.01	0.00	0.00
Indirect	0.03	0.03	0.03	0.03	0.00	0.00	0.00

Table 9: Infections averted by demand uptake, age cohort

	0-9	10-14	15-19	20-29	30-39	40-49	50-59
40%	66,371	26,709	14,771	24,349	6,173	1,109	124
60%	99,556	40,063	22,156	36,523	9,259	1,663	185
80%	132,741	53,417	29,541	48,697	12,346	2,218	247

The number of avoided infections per cohort is largely driven by the number of persons in each cohort, as avoided infections per VMMC are almost constant for ages up to 20.

Summary

This analysis sought to answer the question: What is the return on investment of circumcising an HIV negative male in the current year? The highest social benefit is associated with EIMC in the immediate term.

Table A5: Costs and benefits, per male circumcised (USD)

Age	0-9	10-14	15-19	20-29	30-39	40-49	50-59
Costs	42	200	200	200	200	200	200
DALY value	17	20	23	26	10	3	1
ART savings	30	45	60	79	31	9	4
Total benefits	47	65	83	106	41	12	5
BCR (8% discount rate)	1.12	0.32	0.41	0.53	0.20	0.06	0.03
Cost per HIV infection averted	818	3,957	4,192	4,029	11,096	39,930	97,112

The highest benefits are realized at younger ages, peaking at age 20, just before the age of increased sexual activity. However, the cost differential between EIMC and VMMC results in EIMC having the highest BCR, even as the benefits of being circumcised at birth are not realized until 20 years into the future.

There are studies that have assessed the return on investment for VMMC by age group over the long term; that is, as part of a long-term strategy to prevent HIV transmissions in future. Kripke et al. (2017b) in a study of Malawi, South Africa, Swaziland, Tanzania, and Uganda to assess the impact and cost of scaling up age-targeted VMMC coverage find that over a 15-year time frame, inclusion of males ages 10–14 only leads to a small increase in HIV infections averted, and results in a higher cost per HIV infection averted. However, over the long term (30+ years), circumcising males ages 10–14 delivers the greatest reduction in HIV incidence from VMMC compared with other age groups.

The analysis reveals that BCRs are very low in Malawi. This is mostly driven by an assumed ART coverage of 81%. The higher the number of people and adherent on ART, the higher the rate of viral suppression. Consequently, the value of additional preventative interventions such as VMMC is lower since fewer infections can be averted by this intervention. These were also the results echoed by Haacker et al. (2016): a scenario of HIV prevalence of 5% and ART coverage of 81% yielded BCRs between 1 and 3, whereas a scenario of HIV prevalence of 20% and only 50% ART coverage yielded BCRs between 20 and 45. An additional reason for the low BCRs is the low value ascribed for a DALY avoided, which are derived from GDP per capita. The projected GDP per capita in 2020 is MK187,158. At an exchange rate of 740, the value of a DALY is USD 253.

In a similar analysis on VMMC in sub-Saharan Africa, Behrman and Kohler (2012) also found that BCRs for VMMC are sensitive to certain factors: BCRs are substantially higher for lower discount rates, and high (25 percent) HIV prevalence compared with a medium (11 percent) HIV prevalence.

The policy implications are that male circumcision has its highest value for money in a high HIV prevalence, low ART coverage scenario. Furthermore, as ART coverage approaches universality of those HIV infected persons, the circumcision option having the highest value for money becomes EIMC. Finally, the timing of EIMC/VMMC activities will impact the benefits realized.

Appendix 3 – Approach to valuing mortality risk reductions

We value each death avoided using a value of statistical life year (VSL) of \$9.4m USD (2015 dollars) – representing approximately 160 times income as measured by income per capita PPP – transferred to Malawi using an income elasticity of 1.5.

To estimate these values, we take the GDP per capita figure in 2018 Int\$ for both Malawi and the USA, and estimate the VSL, in time t=0, 2018.

$$VSL_t = \left(\frac{GDP_{PC_{Malawi}}}{GDP_{PC_{USA}}} \right)^{0.5} * 160 * GDP_{PC_{Malawi}} \quad (\text{Eq. 1})$$

Following Cropper et al. (2019) we estimate each subsequent VSL in the time series according to the following formula:

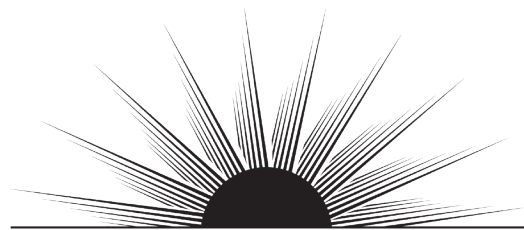
$$VSL_{t+1} = VSL_t * [(1 + g_t)]^e \quad (\text{Eq. 2})$$

Where g_t is the GDP per capita growth rate between period t and t+1 and $e=1.5$.

Robinson, Hammitt and O’Keeffe (2019) suggest that when the beneficiaries of health interventions are likely to be the very old or the very young, analysts should also include an approach that values each life year lost from an avoided death. This time series of value of statistical life year (VS LY) across years t is calculated by:

$$VS LY_t = \frac{VSL_t}{LE_t(\text{average adult age}_t)} \quad (\text{Eq. 3})$$

where the numerator, VSL is given by the equation 1, and the denominator LE (average adult age) is the life expectancy of the average adult age, where adult is defined as anyone aged 15 and above. Age profiles to estimate average age are sourced from Riahi et al. 2017 (SP2 medium term scenario) while the life table for Malawi is sourced from WHO (2019). The benefit of avoided mortality is VS LY * avoided years of life lost from each avoided death.



The Malawi Priorities Project



Cost-benefit analysis of expanding HIV prevention and treatment services to female sex workers in Malawi