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HIV/AIDS PREVENTION INTERVENTIONS IN UGANDA: A POLICY SIMULATION

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ABSTRACT

The HIV/AIDS epidemic continues to be a major health challenge in Uganda. The adult HIV/AIDS prevalence rate had increased to 7.3 percent by 2011 from 6.4 percent in 2005/6. Consequently, understanding the programmes that can curb down the spread of the disease is both an economic and a public health priority. Previously, HIV/AIDS control programmes in Uganda have relied on the ABC strategy (Abstinence, Being Faithfull and Condon use). However, as the epidemic matured in Uganda, public health authorities have adopted additional programmes to combat the spread of HIV such as male circumcision and counselling as well as testing. This policy simulation estimates the potential costs and impact of rolling out two HIV prevention methods - Safe Male Circumcision and Voluntary Counseling and Testing- on the HIV/AIDS epidemic. Using data from the recent Uganda Aids Indicator Survey 2011 as well as administrative cost data, we estimate the potential costs and impact of expanding the above two methods of HIV/AIDS control. Results from the policy simulation suggest that scaling-up safe male circumcision to reach 66% of the uncircumcised males aged 15-49 years would result in averting almost 121,278 new HIV infections through 2020, resulting in an average cost per HIV infection averted of $885 and net cost savings per infection averted of US$ 6,515. On the other hand, scaling up VCT to full coverage (100%) among adults (15-49 years) would result in averting 113,813 new infections through 2020, resulting in an average cost per HIV infection averted of $948 and net savings per infection averted of US$ 6,452.

1. INTRODUCTION AND CONTEXT OF THE STUDY

Despite significant breakthroughs in prevention, treatment and care, the HIV/AIDS remain a major health challenge in sub-Sahara Africa (SSA). The disease accounts for a large burden of disease in SSA, and understanding the programmes that can curb down the spread of the disease is both an economic and a public health priority on the continent. By the end of 2010, an estimated 34 million persons were infected with HIV globally, and at least 68 percent of the victims were in SSA—a region with only 12 percent of the global population (UNAIDS, 2011). Although Uganda initially registered a large reductions in HIV/AIDS prevalence rate from 18 percent during the 1990s, to approximately 6.4 percent by 2004/05, the scale of Uganda's predominantly heterosexually driven HIV epidemic remains immense—about 1.2 million Ugandan people are HIV infected (Uganda AIDS Commission, 2011). Recent evidence from the 2011 Uganda AIDS Indicator Survey revealed that the HIV/AIDS prevalence rate increased from 6.4 percent in 2004/5 to 7.3 percent by 2011 (MOH et al, 2012). This confirmed results from earlier assessments showing that the country's rate of new HIV infections is on the rise - approximately 130,000 new infections are registered annually-the fourth highest number of all the 53 countries in Africa- despite the huge amounts of resources earmarked for HIV/AIDS related expenditures (Government of Uganda, 2010 HSSP III).

Although Uganda has achieved some commendable results in combating the spread of HIV/AIDS, challenges remain. Table 1 shows the estimated trajectory of new infections in the past few years by demographic group and it is indicated that vulnerable groups such as infants account for a substantial proportion of new infections. The estimates in table suggest that the annual number of new HIV infections increased by 11.4 percent from 115,775 in 2007/08 to 128,980 in 2010/11, (UAC 2011a). Among adults, the annual number of new HIV infections rose by 16.4 percent during this period but there was a 6.2 percent decline in new infections among children less than fifteen years of age, most likely because of improvements in Prevention of Mother to Child Transmission (PMTCT) and HIV counseling and testing uptake registered during this period.

Table 1: Trends in HIV incidence 2007–2010 using mathematical modeling

Indicator	Population	Dec 2007	Dec 2008	Dec 2009	Dec 2010
People newly infected with HIV	Adults	87,727	91,967	97,163	102,157
	Women	49,566	51,948	54,873	57,685
	Children<15years	25,746	24,878	24,548	24,142
	Total	**115,775**	**119,258**	**124,261**	**128,980**

Source: *Ministry of Health Estimation and Projections Group, 2010, quoted in Aids National Strategic Plan, 2011/12-2014/15.*

Another challenge to combating the spread of HIV/AIDS is the relatively low rates of testing for HIV/AIDS despite the advent of HIV/AIDS control programmes more than 20 years ago. Only about half of Ugandans (56 percent) have ever tested for HIV. Thus, a substantial proportion of infected individuals have never been tested, and such individuals have an increased risk of spreading the disease. The recent surge in HIV infection rates in Uganda not only highlight internal inconsistencies on what the most appropriate method of HIV/AIDS control should be but also cast doubts on Uganda's ability to attain its Millennium Development Goal (MDG) target of reducing new HIV infections to zero by 2015. Furthermore, the current Health Sector Strategic Plan (HSSP) reports that the sero-prevalence among Ugandans has consistently remained above the national target of 5 percent (Government of Uganda, 2010 HSSP III).

Despite some of the above challenges, Uganda maintains ambitious targets regarding the control of the spread of HIV/AIDS. The current National HIV/AIDS Strategic Plan 2011/12-2014/15 targets to reduce the HIV incidence by 30 percent by 2015 (Uganda AIDS Commission, 2011a). The identified strategic objectives for HIV prevention include scaling up coverage, quality and utilization of proven biomedical behavioral HIV prevention interventions, scaling up of HIV counseling and testing coverage among other interventions. On the other hand, although Uganda has implemented various HIV prevention interventions for over twenty five years with new interventions evolving over time as scientific knowledge emerges, the existing interventions in the country have not yet attained universal coverage nor are they often adequately evaluated for effectiveness and impact This study, therefore, seeks to carry out a simulation exercise on two policy alternatives-safe male circumcision and Voluntary HIV testing (VCT)[1]- that the government can expand as a way of preventing further HIV/AIDS infections among adults aged 15-49 years. More specifically, for the two alternatives, this research examines: the relative effectiveness of each alternative; the cost-effectiveness of each policy; the fiscal impact of scaling-up; and the distributional benefits of the different policies.

The rest of the paper is organized as follows. In section 2 we provide literature on key studies related to the interventions being examined. Section 3 describes policy goals and alternatives as well as justification for their selection. In section 4, we detail the methodology and sources of data used in the simulation and the methodology, including an account of the costs and benefits of policy alternatives. Section 5 presents the key findings. Section 6 provides our main conclusions and policy recommendations.

1 In this paper, VCT/HCT includes interventions that comprise a minimum of pre- and post- test counseling associated with testing

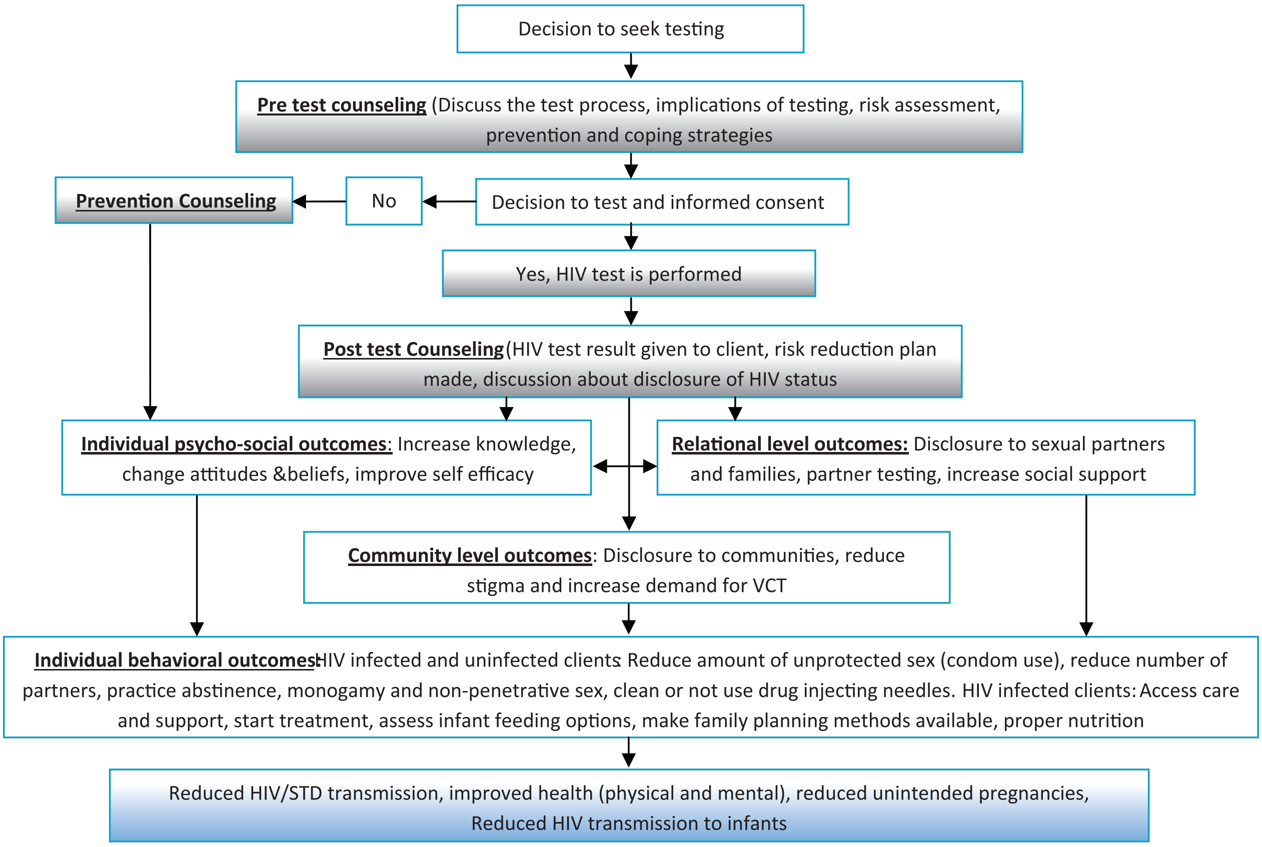
2. LITERATURE REVIEW

In the recent past, a number of studies have examined the efficacy of HIV/AIDS control programmes. Indeed, some studies have found compelling evidence that male circumcision reduces the risk of heterosexually acquired HIV infection in men by approximately 60 percent (WHO, 2012). Findings from a randomized trial of adult male circumcision in rural Uganda showed that the surgical interventions reduce the risk of acquisition of HIV in men by as much as 60 percent (Ronald *et al*., 2007). These findings are line with evidence from other African countries such as South Africa and Kenya which shows that male circumcision can greatly protect against HIV infection (Auvert *et al.,* 2005, Bailey *et al.,* 2007). Indeed, the WHO/ UNAIDS recommends the consideration of male circumcision as an effective intervention for HIV prevention in countries and regions with heterosexual epidemics, high HIV and low male circumcision prevalence where the intervention is likely to have the greatest public health impact (WHO, 2007); and Uganda fits the above profile. Furthermore, recent simulation models based on a 60 percent protective effect and 100 percent male circumcision coverage estimate that as many as 2 million new HIV infections and 300,000 HIV/AIDS related deaths could be averted over the next ten years in sub-Saharan Africa (Centers for Diseases Control and Prevention *et al.,* 2012).

Previous research also posits that male circumcision rates may partly explain the differences in the HIV/AIDS prevalence rates within SSA (Ferry *et al*., 2001). For instance, HIV/AIDS prevalence rates are much lower in West African countries, which have a large Muslim population that practice male circumcision—especially during infancy, than in East and Central Africa countries, which have much lower rates of male circumcision. Indeed since 2007, WHO and UNAIDS have recommended voluntary medical male circumcision as an additional important strategy for HIV prevention. Medical male circumcision offers excellent value for money as it saves costs by averting new HIV infections and reducing the number of people needing HIV treatment and care (WHO, 2007).

On the other hand, the current National HIV Prevention Strategy for Uganda identifies HIV counseling and Testing (HCT) service as an entry point for the population to access appropriate integrated packages of services depending on the test results. Glick (2007), notes that the majority of the adult population in SSA have never tested for HIV despite the outbreak of the disease more than 20 years ago. Thus, there is limited knowledge about HIV/AIDS status, which aggravates the spread of the disease. Indeed, the limited knowledge of individual sero-status is considered as one reason why the HIV virus spread at a fast pace in SSA. In Uganda, HIV testing coverage has increased tremendously in the recent past—increasing from 15 percent for women and 12 percent for men aged 15-49 years in 2004/5 to over 69 for women and 47 percent for men by 2011 (Kasirye, 2012); however, the current HIV policy is to have universal coverage by 2015. Figure 1 below adopted from Denison et al., 2007 articulates the intermediate and health outcomes that can arise out of VCT intervention.

Figure 1: VCT intervention components and outcomes



Source: Adopted without alterations from Denison et al., 2007

According to Denison *et al.,* (2007), combining personalized counseling with knowledge of one's HIV status, HCT/Voluntary Counseling and testing (VCT) is believed to motivate people to change their behaviors to prevent the transmission of the virus. According to the study, VCT recipients were significantly less likely to engage in unprotected sex when compared to behaviors before receiving VCT, or as compared to participants who had not received VCT. There is also evidence to show that Voluntary HIV-1 counseling most cost-effective for HIV-1-infected people and those who received VCT as a couple (Sweat *et al.,* 2000). Further evidence of the role of VCT in reducing HIV incidence is from a cohort study undertaken by Kumaranayake et al., 2007 in Malawi where VCT is believed to have reduced the HIV infections by 32 percent.

VCT has also been shown to be important for certain demographic groups—especially discordant couple.[2] In 2005, 57 percent of HIV infected individuals had HIV sero-discordant partners. Uninfected partners in this situation have higher risk of HIV infection, representing a high unmet need for HIV prevention (Gray *et al.,* 2001). With most discordant couples unaware of their sero-discordant status, and given the low condom use in marriage and long

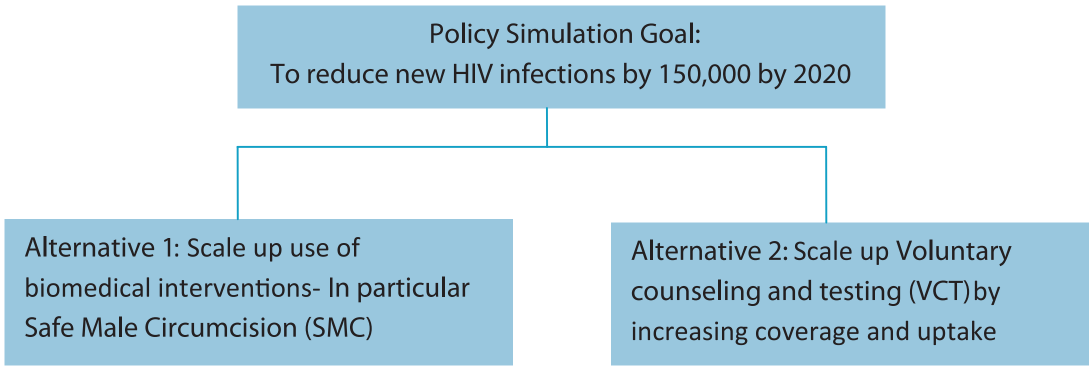
2 Sero-discordance is where only one of the two partners is infected with HIV/AIDS.

standing relationships, there is a compelling case for increasing knowledge of HIV sero-status of partners and tailored HIV prevention interventions for HIV sero-discordant partners (UAC, 2011a).

3. POLICY GOALS AND ALTERNATIVES

The policy alternatives undertaken in this study are aimed at reducing potential new HIV infections among adults by 150,000 by 2020. Though this is an ambitious goal, it reflects the urgency of the challenge and it is in line with the HIV prevention targets in the current National Aids Prevention Strategy, National Aids strategic Plan and the overriding National Development Plan and MDG 6 targets. Achieving this goal requires sustainability of HIV and AIDS programs through scaling up and intensifying HIV prevention interventions to avert the rising new infections. The alternative policies/interventions to be examined are Safe Male Circumcision (SMC) and Voluntary Counseling and Testing (VCT).

Figure 2: Specific goal and interventions for HIV prevention



Safe Male circumcision (SMC) -Alternative A

Uganda adopted SMC as part of the broader strategies for HIV prevention in the National Safe Male Circumcision Policy 2010, following results of the three randomized controlled trials in 2007 showing that medical male circumcision is effective in reducing HIV acquisition among men by approximately 60 percent. Based on these results, World Health Organization (WHO) and the Joint United Nations Programme on HIV/AIDS (UNAIDS) issued a set of recommendations for the use of MC as one of the HIV prevention strategies in countries with low male circumcision rates like Uganda, where only 26 percent of its men aged 15-49 years are circumcised and has a high HIV prevalence of 7.2 percent (WHO, 2007). The guidelines however highlight that SMC does not provide complete protection against HIV, it should be considered only as part of a comprehensive package to prevent HIV.

It is on this basis that we set out to examine the impact of this rather new prevention strategy– at least in Uganda—in reducing new HIV infection based on the evidence based 60 percent effectiveness rate. The Government of Uganda through the HIV prevention strategy sets out to a target to reach 80 percent of uncircumcised men by 2015. However based on a recent campaign in Kenya, we assume that the SMC roll out campaign will achieve a success rate of 82.3 percent attained in Kenya in 2008-2011 during the roll out of its Voluntary medical male circumcision program (CDC, 2012). As such we assume that only 66 percent of the uncircumcised men will be covered by 2020. The specific target population for this policy alternative is males aged 15-49 years of age.

Voluntary counseling and Testing – Alternative B

As alluded to earlier, a big percentage of the adult population in SSA has never been tested for HIV/AIDS since the outbreak of the disease more than 20 years ago. The fact that fewer than half of those living with HIV do not know it is a huge barrier to treatment scale up and realizing the benefits of treatment for prevention. Limited knowledge about HIV/AIDS status exacerbates the spread of the disease, as mentioned earlier (Glick, 2007). Indeed, many studies have found that VCT is effective as a strategy for facilitating behavioral change around both preventing HIV and early access to care and support (UNFPA, 2002).

It is imperative to design the VCT service package and delivery mechanism to best respond to the client's needs vulnerabilities and preferences. The following service delivery options have been shown to be effective for VCT: - Free-standing sites, VCT services integrated with other health services, VCT services provided within already established non-health locations and facilities, Mobile VCT services (UNFPA, 2002).The study proposes use of the different methods of delivery according to the target population and preferences. The target for this alternative is adults aged 15-49 years of age.

4. METHODOLOGY

This section gives a brief overview of how the policy simulation exercise will be undertaken. The data sources benefit measures, cost implications of the alternatives, funding scenarios and equity distribution.

4.1 Data sources

The data used in this policy simulation is from different data sources namely; the Uganda Aids Indicator Survey, the National HIV Aids documents (HIV prevention strategy 2011-15 and the National HIV/AIDS strategic Plan 2011/12-2014/15). Data on unit cost of interventions is based on previous studies undertaken in Uganda on SMC and VCT. In some cases, computations are based on average growth changes of the variables in question overtime.

4.2 Assumptions

a. Distribution of Uganda's population by sex and age remains constant during 2013-2020.
b. Assume that the male circumcision rate increases by 1% per year based on the changes observed during 2004/5 and 2011 (Sero-behavioural surveys).
c. Assume that the male circumcision campaign will achieve a success rate of 82.3% attained in Kenya in 2008-2011 during the roll out of its Voluntary medical male circumcision program (CDC, 2012).
d. We assume 100 % coverage of VCT
e. Assume that HIV prevalence rate remains constant i.e. 6.1 % for men aged 15-49 years and 7.3% women aged 15-49 years (Uganda AIDS Indicator Survey, 2011).
f. We assume an effectiveness rate of 32% for VCT in reducing new HIV infections as evidenced in a cost-effectiveness study of voluntary counselling and testing within the integrated HIV/TB/STI ProTEST intervention in Malawi, 2006.
g. We assume a discounted lifetime antiretroviral therapy cost of US$ 7,400 (Based on UNAIDS)
h. Zero inflation rate
i. Average cost of the two interventions remain constant over the 2013-2020 period

4.3 Analytical Approach

The relative effectiveness, benefits and costs of the policy alternatives are derived. Based on the cost and effectiveness estimates, a cost-effectiveness analysis is undertaken for both policies to determine the efficiency and sustainability of the two alternatives. Sensitivity analysis is undertaken to test for the robustness of the results subject to changes in key variables. The fiscal impact and equity distribution analysis is undertaken.

The study assumes two health benefits; new HIV infections averted due to either intervention and death averted due to increased coverage of either intervention plus economic benefits in terms of net cost savings per infection averted. We use the 60 percent effectiveness rate of SMC in reducing HIV infections as cited in literature above, while 32 percent effectiveness rate of VCT is used based on the cohort study undertaken in Malawi in 2006.

The costs used are based on previous studies undertaken in Uganda. The cost of SMC is based on a Safe Male Circumcision Project undertaken in Kayunga-Uganda in 2011. We shall adopt a consolidated cost per circumcision catering for an SMC service delivery team is comprised of 3 teams; a surgeon, a theatre nurse and a counselor. The cost used is US $35 per circumcision. The cost of VCT is based on a study on costs and effectiveness of four counseling and testing strategies in Uganda undertaken in 2009. The average cost of the four mechanisms of administering VCT is used and inflated to 2011 figures since the SMC cost is for 2011. The average cost used is $ 23.4 per client.

5. RESULTS AND DISCUSSION

This section presents and discusses the results from the policy simulation. In particular, we discuss the estimated probable impact (benefits), cost effectiveness, equity distribution fiscal impact of the two alternatives.

Coverage: The results of the simulation (appendix A) show that policy A will achieve 66% additional circumcision coverage of the males aged 15-49 years. In addition, it will lead to gross circumcision coverage of coverage of about 77 percent by 2020 (8 years). Similarly, policy B will achieve universal VCT coverage (100 percent) by the end of 2020. This difference in coverage largely depends on the relative effectiveness of the two programs and does not necessarily imply that policy B is better than policy A. It is thus necessary to go beyond this and consider associated probable impact and cost.

Benefits: As pointed out previously, two important health benefits – reduction in HIV incidence/ morbidity and mortality are used as benefits and an economic benefit in terms of net cost savings defined as the lifetime antiretroviral therapy costs multiplied by the annual number of infections averted, less the cumulative net costs of implementing the scaled-up SMC program. By the end of 2020, it is projected that an additional 3.3 million adult males will be covered by SMC (policy A) and an additional 4.8million adults would be covered by VCT (policy B).[3] With the prevailing HIV prevalence of 6.1 percent for males aged 15-49 years and 7.3 percent for all adults aged 15-49 years, it is estimated that policy A results into 26,861 new infections cases avoided (in the first year) while policy B results into 26,953 new infections avoided by 2013. After 8 years of the intervention (i.e. 2020), the new infections avoided increases to 121,278 and 113,813 cases respectively for policy A and B. The deaths averted are estimated at 6,064 and 5,691 cases for alternative A and B respectively. Policy A provides more benefits (details in Table 1 and 2 below); nonetheless, it is important to underscore the fact that both programs are effective in averting new HIV infections and can be implemented concurrently with VCT being an entry point to SMC. In line with UNAIDS recommendation that countries should use a mix of behavioral, biomedical and structural HIV prevention actions that suit their epidemic and the needs of those most at risk (UNAIDS, 2009), both interventions should be rolled out.

3 Note that the target population for policy A and B are different only males aged 15-49 years for circumcision and all 15-49 adults for VCT.

Table 2: Impact Analysis of Policy A

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of males aged 15-49 years	6,025,288	6,218,097	6,417,077	6,622,423	6,834,341	7,053,039	7,278,737	7,511,656
B. Projection males circumcised 15-49 years	1,566,575	1,678,886	1,796,781	1,920,503	2,050,302	2,186,442	2,329,196	2,478,847
C. Likely Incidence of HIV avoided (Prevalence (6.1%)*effectiveness of circumcision (60%)* A	57,337	61,447	65,762	70,290	75,041	80,024	85,249	90,726
D. Likely Mortality avoided from incidence(average of 5% per year)	2,867	3,072	3,288	3,515	3,752	4,001	4,262	4,536
E. Projected increment in circumcised adults after roll out of policy A	**733,904**	**1,307,520**	**1,711,126**	**2,128,324**	**2,559,221**	**2,803,647**	**3,055,104**	**3,313,602**
F. Total number of adults circumcised after policy A (E+B)	2,300,479	2,986,406	3,507,908	4,048,827	4,609,524	4,990,089	5,384,300	5,792,449
G. Likely total Incidence of HIV avoided (Prevalence (6.1%)*effectiveness of circumcision (60%) after policy A	84,198	109,302	128,389	148,187	168,709	182,637	197,065	212,004
H. Likely total Mortality avoided from incidence (average of 5% per year)	4,210	5,465	6,419	7,409	8,435	9,132	9,853	10,600
Impact of policy A								
I. Morbidity avoided due to A	***26,861***	***47,855***	***62,627***	***77,897***	***93,668***	***102,613***	***111,817***	***121,278***
J. Mortality avoided due to A	***1,343***	***2,393***	***3,131***	***3,895***	***4,683***	***5,131***	***5,591***	***6,064***

Table 3: Impact Analysis of Policy B

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of adults aged 15-49 years	13,292,705	13,718,071	14,157,050	14,610,075	15,077,598	15,560,081	16,058,003	16,571,859
B. Projection adults tested 15-49 years	7,523,671	8,038,790	8,579,172	9,145,907	9,740,128	10,363,014	11,015,790	11,699,733
C. Likely Incidence of HIV avoided (Prevalence (6.1%)*effectiveness of testing (43%)* A	175,753	187,786	200,409	213,648	227,529	242,080	257,329	273,306
D. Likely Mortality avoided from incidence (average of 5% per year)	8,788	9,389	10,020	10,682	11,376	12,104	12,866	13,665
E. Projected increment in tested adults after roll out of policy B	1,153,807	2,271,713	3,346,727	4,098,126	4,536,849	4,677,360	4,790,102	4,872,127
F. Total number of adults tested after policy B (E+B)	8,677,478	10,310,502	11,925,899	13,244,033	14,276,977	15,040,374	15,805,893	16,571,859
G. Likely total Incidence of HIV avoided (Prevalence (6.1%)*effectiveness of VCT(32%) after policy B	202,706	240,853	278,589	309,381	333,510	351,343	369,226	387,119
H. Likely total Mortality avoided from incidence (average of 5% per year)	10,135	12,043	13,929	15,469	16,676	17,567	18,461	19,356
Impact of policy B								
I. Morbidity avoided due to B	***26,953***	***53,067***	***78,180***	***95,732***	***105,981***	***109,263***	***111,897***	***113,813***
J. Mortality avoided due to B	***1,348***	***2,653***	***3,909***	***4,787***	***5,299***	***5,463***	***5,595***	***5,691***

Source: Authors calculations

Cost-Effectiveness Analysis

Tables 4 and 5 illustrate the total benefits (decrease in morbidity and mortality), the cost of each policy alternative and the net cost savings associated with the two interventions. The associated incremental costs of the policy alternatives are discounted at 3%.

Table 4: Cost Effectiveness of Policy A

Year	Estimated Incremental cost of Policy A (UGX)	Discounted Incremental cost of Policy A (UGX	HIV infections averted	Mortality avoided	Net cost savings for total infections averted
2013	66,785,283,255	66,785,283,255	26,861	1,343	450,018,320,082
2014	52,199,016,391	50,678,656,690	20,994	1,050	353,245,657,920
2015	36,728,194,695	34,619,846,069	14,772	739	249,578,576,719
2016	37,965,012,972	34,743,364,969	15,269	763	259,046,130,654
2017	39,211,635,667	34,839,030,418	15,771	789	268,610,907,646
2018	22,242,704,609	19,186,752,384	8,946	447	152,924,949,249
2019	22,882,632,790	19,163,844,713	9,203	460	157,919,586,779
2020	23,523,295,799	19,126,592,133	9,461	473	162,905,544,347
Total	**301,537,776,178**	**279,143,370,631**	**121,278**	**6,064**	**2,054,249,673,395**
		Cost per case averted	***2,301,682*** (US$ 885.26)		
		Net saving per infection averted	***16,938,354*** (US$ 6,515)		

Source: Authors' calculations

The results presented in Table 4 reveal that that by the end of 2020 the incremental benefits (decrease in morbidity and decrease in mortality) as a result of policy intervention A will amount to 121,278 and 6,064 respectively. Put simply, with roll out of SMC, about 121,278 new infections would have been avoided with 6,064 related deaths averted. The cost implication for these benefits is estimated at UGX 279 billion by the end of 2020. The discounted cost per adult HIV infection averted is the cumulative incremental costs incurred through implementing the scaled-up SMC program, divided by the cumulative number of adult HIV infections averted over the relevant time period. The cost per HIV infection averted is US$ 885 which simply means that it will cost the government US$ 885 for each HIV infection case avoided.

The discounted net cost savings in millions of dollars are displayed in Table 4—defined as the lifetime antiretroviral therapy costs multiplied by the annual number of infections averted, less the cumulative costs of implementing the scaled-up SMC program. Over the time period 2013 to 2020, the cumulative net cost savings will be almost US$ 790 million by 2020. Subsequently, the discounted net savings per adult HIV infection averted are also calculated by dividing the discounted net savings with the cumulative number of adult HIV infections averted. The net savings per infection averted of US$ 6,515 far outweigh the net cost per HIV infection averted.

Table 5: Cost Effectiveness of Policy B

Year	Estimated Incremental cost of Policy B (UGX)	Discounted Incremental cost of Policy B(UGX)	HIV infections averted	Mortality avoided	Net cost savings for infections averted
2013	70,197,604,116	70,197,604,116	26,953	1348	448,376,696,652
2014	68,013,391,107	66,032,418,550	26,114	1306	436,397,751,096
2015	65,403,846,609	61,649,398,255	25,112	1256	421,485,306,847
2016	45,715,149,514	41,835,837,784	17,553	878	295,884,467,494
2017	26,691,908,892	23,715,415,335	10,249	512	173,480,069,463
2018	8,548,698,214	7,374,182,174	3,282	164	55,774,702,849
2019	6,859,230,633	5,744,497,668	2,634	132	44,930,364,305
2020	4,990,357,248	4,057,617,117	1,916	96	32,808,357,303
Total	**296,420,186,333**	**280,606,971,000**	113,813	**5,691**	**1,909,137,716,008**
		Cost per case averted	***2,465,509*** (US$ 948)		
		Net saving per death averted	***16,774,338*** (US$ 6,452)		

Source: Authors calculations

The results presented in Table 5 reveal that that by the end of 2020 the incremental benefits (decrease in morbidity and decrease in mortality) as a result of policy intervention B will amount to 113,813 and 5,691 respectively. The cost implication for these benefits is UGX 280 Billion by the end of 2020. The cost per HIV infection averted is US$ 948 which simply means that it will cost the government US$ 948 for each HIV infection case avoided. The discounted net cost savings in millions of dollars are displayed in Table 5. Over the time period 2013 to 2020, the cumulative net cost savings will be almost US$ 734 million by 2020. The net savings per infection averted of US$ 6,452 far outweigh the net cost per HIV infection averted.

Sensitivity analysis

A sensitivity analysis is performed for some of the key parameters to explore the robustness of the findings. Some of the parameters include SMC effectiveness in the reduction in female-to male HIV transmission, which is initially assumed to be 60 percent; VCT effectiveness which is initially assumed to be 32 percent; the discount rate, which is initially assumed to be 3 percent; and the discounted lifetime cost of ART, which is assumed initially to be $7,400; unit costs for circumcision and VCT which are initially assumed at US$ 35 and US$ 23.4 respectively. The results of the sensitivity analysis are shown in Table 6 and 7. Each of the base values of the parameters in the sensitivity analysis are shown in bolded font.

Table 6: Sensitivity analysis of key parameters, Policy A

	Parameter values	Infections averted	Cost per infection averted	Net cost saving per infection averted
Effectiveness	30	60,639	1,770	5,630
	60	**121,278**	**885**	**6,515**
	75	151,597	708	6,692
Lifetime cost of ART	5000	121,278	885	4,115
	7400	**121,278**	**885**	**6,515**
	10000	121,278	885	9,115
Discount rate	**3**	**121,278**	**885**	**6,515**
	5	121,278	844	6,556
	9	121,278	773	6,627
Unit cost of policy A	25	121,278	632	6,768
	35	**121,278**	**885**	**6,515**
	45	121,278	1,138	6,262
	Minimum	60,639	632	4,115
	Base case	**121,278**	**885**	**6,515**
	Maximum	151,597	1,770	9,115

Source: Authors calculations

The results are as expected, and help to confirm the robustness of the model. If the effectiveness of male circumcision is reduced so that the transmission rate is relatively higher, the number of HIV infections averted decreases, the cost per infection averted increases, and the net saving per infection averted reduces. If instead the effectiveness of circumcision is higher, so that the transmission probability is reduced even further than the initial reduction of 60 percent, then the number of infections averted increases, cost per infection averted reduces.

Table 7: Sensitivity analysis of key parameters, Policy B

	Parameter values	Infections averted	Cost per infection averted	Net cost saving per infection averted
Effectiveness	15	**53,350**	2,023	5,377
	32	**113,813**	**948**	**6,452**
	45	**160,049**	674	6,726
Lifetime cost of ART	5000	113,813	948	4,052
	7400	**113,813**	**948**	**6,452**
	10000	113,813	948	9,052
Discount rate	**3**	113,813	**948**	**6,452**
	5	113,813	916	6,484
	9	113,813	859	6,541
Unit cost of policy B	15	113,813	608	6,792
	23.4	**113,813**	**948**	**6,452**
	30	113,813	1,216	6,187
	Minimum	53,350	608	4,052
	Base case	**113,813**	**948**	**6,452**
	Maximum	160,049	2,023	9,052

Source: Authors calculations

Just like for policy A, the results are as expected, and help to confirm the robustness of the model. If the effectiveness of VCT is reduced, the number of HIV infections averted decreases, the cost per infection averted increases, and the net saving per infection averted reduces. If instead the effectiveness of VCT is higher, then the number of infections averted increases, cost per infection averted reduces. If the discounted lifetime cost of ART increases (decreases), then the effect is to increase (decrease) the net savings per HIV infection averted.

Distributional Analysis

The study uses the latest Uganda Aids Indicator Survey data to profile the coverage rates of SMC and VCT of circumcision and among adults aged 15-49 according to their wealth index from the poorest to the richest. The practice of male circumcision is related to wealth. Men from the lowest wealth quintile are least likely to be circumcised, compared with those in the highest quintile. The current distribution shows that about 50 percent of the total circumcision coverage is amongst the richest two quintiles.

Figure 3: Distribution of benefits before and after policy A (%)

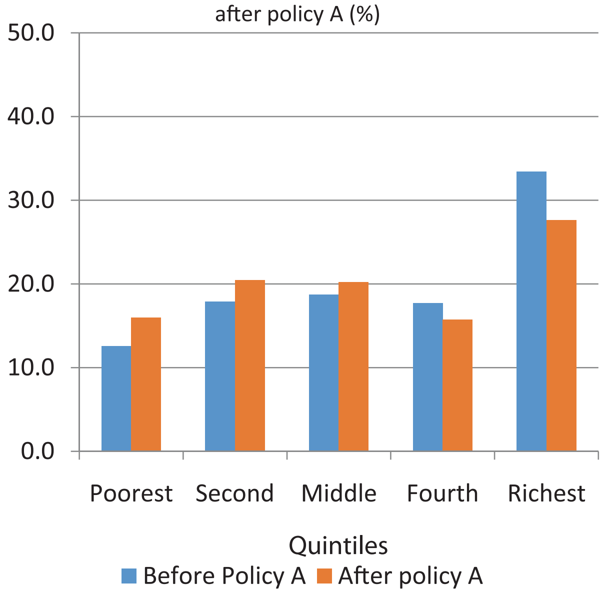
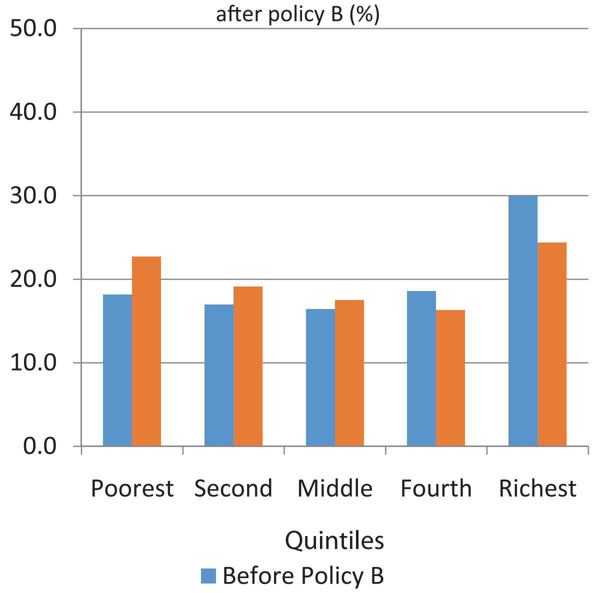


Figure 4: Distribution of benefits before and after policy B (%)



Furthermore, the current distribution of VCT is also slightly biased towards the rich with the richest two quintiles accounting for 48.5 percent of the VCT coverage compared to 35 percent for the poorest two quintiles. The study proposes a redistribution of the funding allocated to the two policy interventions so that is more pro poor. The study proposes that the poorest households get 100 percent of the subsidy, the second poorest get 90 percent, third richest get 85 percent while the last two quintiles get 70 percent and 65 percent respectively. The new percentage distribution of benefits ensures that the poorest three quintiles account for close to 57 percent of the benefits while the riches two quintiles account for 43 percent of the benefits for SMC. For VCT, the study ensures that close to 60 percent of the benefits accrue to the poorest three quintiles while 40 percent accrues to the richest two quintiles.

Fiscal impact of the two policy alternatives

Finally, the fiscal impact of the two interventions is analyzed to show how each of the alternatives would impact on the current spending patterns throughout the 7-year period (2013-2020). What is noticeable from figures 3 and 4 is that the spending as a percentage of GDP and government spending will gradually reduce over time. In absolute terms, to circumcise about 5.8 million males aged 15-49 by 2020 (77 percent gross coverage), an equivalent of UGX 527 Billion is required by 2020. In addition, 100 percent coverage of VCT among adults aged 15-49 years will require about UGX 1,008, Billion.

Figure 5: Fiscal impact of policy A

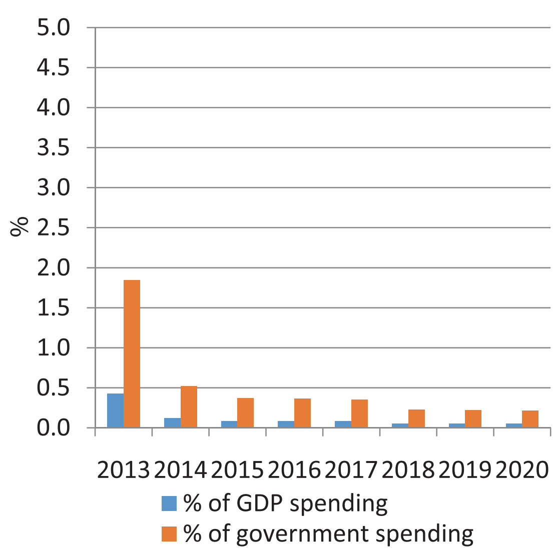
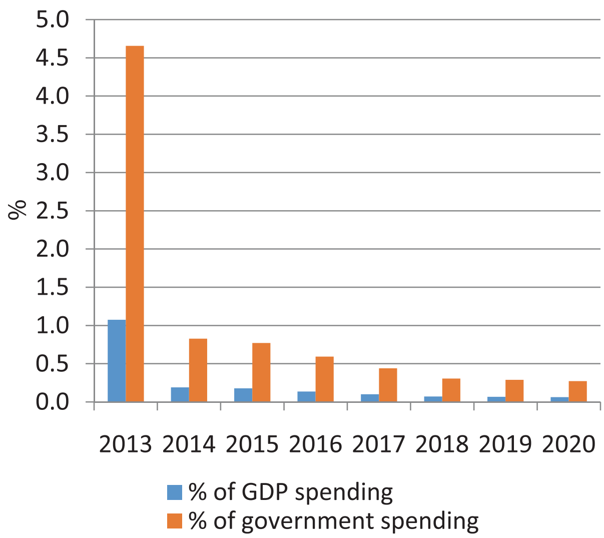


Figure 6: Fiscal impact of policy B



6. CONCLUSIONS AND RECOMMENDATIONS

Based on the results above, we believe that both policies /alternatives can be implemented to achieve the desired goal reducing new infections by 150,000 by 2020. For both polices, the values of the cost per HIV infection averted are much lower the net cost savings per infection averted, suggesting that both policies can be implemented.

Results from the policy simulation suggest that scaling up adult safe male circumcision to reach 66% of the uncircumcised males aged 15-49 would result in averting almost 121,278 new HIV infections through 2020, resulting in an average cost per HIV infection averted of $885 and net savings per infection averted of US$ 6,515.

Scaling up VCT to full coverage (100%) among adults would result in averting 113,813 new infections through 2020, resulting in an average cost per HIV infection averted of $948 and net savings per infection averted of US$ 6,452.

Based on these results, we recommend that both interventions be rolled out in order to curb the rising new HIV infections experienced in the recent past. In recognition of the UNAIDS recommendation that an HIV prevention approach based solely on one element doesn't work; that countries should use a mix of behavioral, biomedical and structural HIV prevention actions that suit their epidemic and the needs of those most at risk (UNAIDS, 2009). Better still, the two programs can be rolled out concurrently for example by having VCT as the entry point to SMC and this could substantially cut down the costs. As SMC is rolled out effective counseling about the need to continue using other HIV protection methods after circumcision is very important given that SMC only provides a 60 percent risk reduction against HIV infection.

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APPENDIX A: EFFECTIVENESS AND ESTIMATED COST OF POLICY A

Table 1: Effectiveness (Additional Circumsion Coverage) and Estimated Cost of Policy A

	2013	2014	2015	2016	2017	2018	2019	2020
Population of Ugandans aged 15-49 years	13,292,705	13,718,071	14,157,050	14,610,075	15,077,598	15,560,081	16,058,003	16,571,859
Population of males aged 15-49 years	6,025,288	6,218,097	6,417,077	6,622,423	6,834,341	7,053,039	7,278,737	7,511,656
Population of circumcised men aged 15-49 years	1,566,575	1,678,886	1,796,781	1,920,503	2,050,302	2,186,442	2,329,196	2,478,847
Gross coverage ratio (26%)	0.26	0.27	0.28	0.29	0.3	0.31	0.32	0.33
Projected number of uncircumcised males aged 15-49 years in Uganda	4,458,713	4,539,211	4,620,295	4,701,920	4,784,038	4,866,597	4,949,541	5,032,810
Policy simulation objective (ensure up to 80% coverage in the next 8 years)	**20%**	**35.0%**	**45.0%**	**55.0%**	**65%**	**70.0%**	**75.0%**	**80.0%**
Policy Alternatives (Effectiveness)								
A: Circumcision will achieve 82.3 % of coverage similar to Kenya	16%	29%	37%	45%	53%	58%	62%	66%
Projected increment in number of circumcised males covered(Policy A)	733,904	1,307,520	1,711,126	2,128,324	2,559,221	2,803,647	3,055,104	3,313,602
Total number of males covered in Uganda based on policy A	2,300,479	2,986,406	3,507,908	4,048,827	4,609,524	4,990,089	5,384,300	5,792,449
Gross coverage ratio	38	48	55	61	67	71	74	77
Number of new men circumcised each year	733,904	573,616	403,607	417,198	430,897	244,425	251,458	258,498
C	2,300,479	685,927	521,502	540,919	560,697	380,565	394,211	408,149
RESULTS (Financial Implications)								
Cost From Simulation								
Unit Cost of Programme A (UGX)	91000							
Cost per circumcision (US$ 35: Kayunga case study)	66,785,283,255	52,199,016,391	36,728,194,695	37,965,012,972	39,211,635,667	22,242,704,609	22,882,632,790	23,523,295,799
Exchange Rate (1US$: 2600 UGX)	2600							

APPENDIX B: EFFECTIVENESS AND ESTIMATED COST OF POLICY B

Table 1: Effectiveness (Increase in HIV/AIDS IEC Coverage) and Estimated Cost of Policy B

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of adults aged 15-49 years	13,292,705	13,718,071	14,157,050	14,610,075	15,077,598	15,560,081	16,058,003	16,571,859
Population of ever testing	7,523,671	8,038,790	8,579,172	9,145,907	9,740,128	10,363,014	11,015,790	11,699,733
Gross coverage ratio (Changes are guessed: 2% increment)	56.6	58.6	60.6	62.6	64.6	66.6	68.6	70.6
Projected number of adults not tested	5,769,034	5,679,282	5,577,878	5,464,168	5,337,470	5,197,067	5,042,213	4,872,127
Policy simulation objective (ensure up to 100% coverage in the next 8 yea	**20%**	**40.0%**	**60.0%**	**75.0%**	**85%**	**90.0%**	**95.0%**	**100.0%**
Policy Alternatives (Effectiveness)								
Assume 100% effectiveness	20%	40%	60%	75%	85%	90%	95%	100%
projected increment in number of adults tested (Policy B)	1,153,807	2,271,713	3,346,727	4,098,126	4,536,849	4,677,360	4,790,102	4,872,127
New adults tested per year	1,153,807	1,117,906	1,075,014	751,400	438,723	140,511	112,742	82,024
Total number of adults tested (Policy B)	8,677,478	10,310,502	11,925,899	13,244,033	14,276,977	15,040,374	15,805,893	16,571,859
Gross coverage ratio	65.28	75.16	84.24	90.65	94.69	96.66	98.43	100.00
RESULTS (Financial Implications)								
Cost From Simulation								
Cost ofTesting (US$ 23.4)	70,197,604,116.35	68,013,391,107.17	65,403,846,609.25	45,715,149,514.03	26,691,908,891.82	8,548,698,214.37	6,859,230,632.57	4,990,357,247.63

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