# Safe Love Campaign
# Cost-Effectiveness Analysis Protocol

## Overview

The goal of this analysis is to evaluate the cost-effectiveness of the Safe Love campaign in preventing the spread of HIV in Zambia. The campaign targeted four domains of behavior change: increasing condom use, decreasing multiple concurrent partnerships, and increasing voluntary male circumcision. The effectiveness of this campaign is being measured using an outcome evaluation survey. Respondents who recognize the campaign are considered "exposed" and respondents who did not are considered "controls." The overall effectiveness of the campaign is taken to be the difference in the reported behavior in the exposed survey population compared to the control population in each of four target domains.

Using a mathematical model of HIV spread, calibrated to Zambia's population and HIV epidemic rate, we will estimate the expected number of new HIV infections, life-years, and costs over a 10-year time horizon with the campaign (based on behavior reported by the exposed population) and without the campaign (based on behavior reported by the control population). We will use these estimates to evaluate the cost-effectiveness of the Safe Love campaign, measured in terms of the cost per HIV infection averted and cost per life-year saved.

## Methods

For this analysis, we will adapt a stochastic microsimulation model of HIV transmission and progression previously developed by Enns, et al., to evaluate the cost-effectiveness of reducing concurrency in four southern African countries, including Zambia [1]. The model simulates the spread of HIV through heterosexual contact in a population of 15-49 year-olds in one-month intervals. The model tracks sexual partnerships, entry into the population, HIV transmission and disease progression, deaths from HIV and other causes, life years experienced in the population, and HIV incidence and prevalence over time. Full details of the model are described in the published article and appendix [1]. We provide a brief description here, with a focus on features that will be modified or added for this analysis. Input parameter values that will added or changed for this analysis are summarized in Table 1 along with their data sources.

### Population Dynamics

Individuals in the model are characterized by a set of attributes (which may or may not change over time), such as gender, age, circumcision status (for men), HIV infection status, awareness of HIV status, and CD4 count. New individuals enter the model each month at age 15 and older; individuals age out of the model at age 50. Individuals face age-specific mortality risks (non-HIV-related), as well as additional mortality for those infected with HIV, depending on their CD4 count.

As in the analysis by Enns, et al., population demographics and rates of aging will be estimated from demographic data. Age-specific mortality rates will be taken from country-specific life tables. The prevalence of male circumcision will be taken from the Safe Love campaign outcome evaluation survey results.

## HIV Disease Progression

The model of HIV disease progression will be unchanged from that used in the analysis by Enns, et al. The model reflects stages of infection (acute, chronic), changes in CD4 counts (sharp drop during acute infection, slow declines during chronic), CD4 count-specific mortality and occurrence of AIDS-defining illnesses, the impact of antiretroviral therapy (recovery in CD4 count), and risks of treatment failure.

## Sexual Partnership Dynamics

The model by Enns, et al., simulates HIV transmission through heterosexual contact. Heterosexual partnerships are explicitly tracked in the model and they evolve over time, with old partnerships ending and new partnerships forming. Individuals can have up to four concurrent sexual partnerships. Partnership dissolution probabilities were estimated from average partnership durations, while partnership formations are calculated so as to balance the process of partnership dissolution as well as new individuals entering the population at age 15 years without partnerships, to maintain a stable partnership distribution in the population over time. The model has the capacity to include multiple types of partnerships with different durations and/or risk behaviors. In the original model, the authors made the distinction between "spousal" and "non-spousal" partnerships. In this analysis, we will model "regular" (spousal or cohabiting) and "casual" (neither spousal nor cohabiting) partnerships to be consistent with the language of the outcome evaluation survey.

We will estimate the partnership distribution (proportion of individuals reporting zero, one, two, or three concurrent partners) in the population by partnership type from the Safe Love campaign outcome evaluation survey. Depending on the behaviors reported by respondents to the outcome evaluation survey, we may restructure the model. For example, we may divide the population into those having multiple concurrent partnerships and those practicing serial monogamy. For those reporting no concurrent partnerships, rates of partner change would then be determined by the number of partners reported in the past six months.

## HIV Transmission

The model by Enns, et al., simulated heterosexual HIV transmission with varying transmission risk by stage of HIV infection (acute, chronic, and on treatment). It did not explicitly model condom use. To capture the potential impact of the Safe Love campaign on increasing condom use, and subsequent impact on HIV spread, we extend the model to include condom use, stratified by regular and casual partner, as an input parameter. We also explicitly include the protective effects of male circumcision against acquiring HIV. Levels of condom use, by partnership type, will be estimated from the Safe Love campaign outcome evaluation survey.

### Model Calibration

We will calibrate the model to match historic HIV prevalence trends in Zambia prior to the introduction of the Safe Love campaign in 2011. To do this, we will run the model for the base case scenario (no intervention), using historic prevalence data and survey responses among the control population in the Safe Love campaign outcome evaluation survey where appropriate. We will adjust uncertain parameters until the HIV prevalence projected by the model matches that observed in reality over the calibration period (2005-2010).

### Intervention Effects

To estimate the potential impact of the Safe Love campaign on HIV spread over the 10-year time horizon, we will simulate two scenarios: one where the intervention is not in place (Base Case) and the other where the Safe Love Campaign is in place (Intervention). The Base Case scenario will be parameterized using the levels of condom use, number of sexual partners, and prevalence of circumcision reported by the control population in the evaluation survey, while the intervention scenario will be simulated using the quantities reported by the exposed population in the outcome evaluation survey.

### Costs

In the base case scenario, we will account for the cost of HIV treatment (incurred each month an individual is receiving ART). The intervention scenario incurs additional costs, including a one-time setup cost at the beginning of the time horizon and then a per-person ongoing operational cost (incurred by every individual each month they are alive in the simulation in the intervention scenario).

## Outcomes and Cost-Effectiveness Results

For each scenario, the model outputs the expected number of infections, number of life-years accrued in the population, and the total healthcare (and intervention) costs over the 10-year time horizon. See Table 2 for a template of the results. We will calculate the expected number of infections averted and life-years saved by the Safe Love campaign taking the difference in outcomes between the Base Case and Intervention scenarios. As measures of cost-effectiveness, we will compute the cost per HIV infection averted and per life-year saved of the campaign. These quantities can be compared against standard cost-effectiveness thresholds (e.g., cost per life-year saved less than 3 x GDP [2-3]) or against the efficiency of other HIV prevention programs (e.g., $112 per HIV infection averted with community-based voluntary counseling and testing or $321-1665 per infection averted for the treatment of ulcerative STIs [4]).

**Table 1: Model parameters and sources.**

| Model Parameter | Source |
|---|---|
| **Population demographics** | |
| Prevalence of male circumcision | Outcome evaluation survey (Q806: “Are you circumcised?”) |
| **HIV progression, diagnosis, and treatment** | |
| % receiving ART of those eligible | Update using 2014 Zambia Country Report submitted to UNAIDS. |
| **Sexual behaviors** | |
| Partnership distribution (% with 0, 1, 2, or 3+ concurrent partners) | Calculated from outcome evaluation survey (Q405 onward: Number of concurrent sexual partners in the past 6 months) |
| Rates of partner acquisition and/or dissolution for serial partnerships | Calculated from outcome evaluation survey (Q405 onward: Number of non-concurrent sex partners in the past 6 months) |
| Rates of condom use with regular partners | Calculated from outcome evaluation survey (Q411: Used condoms consistently with regular partners in the last 6 months) |
| Rates of condom use with casual partners | Calculated from evaluation survey (Q411: Used condoms consistently with non-regular partners in the last 6 months) |
| **Costs** | |
| Safe Love campaign start-up costs (one-time) | Estimates from campaign administrators |
| Safe Love campaign maintenance costs (ongoing, per person) | “ “ |
| Cost of medical male circumcision in Zambia | “ “ |
| Cost of ART (per month) in Zambia | “ “ |

**Table 2: Template for model outcomes and cost-effectiveness results.**

| | Status Quo | Safe Love Campaign | Difference |
|---|---|---|---|
| New infections | | | |
| Life-years | | | |
| Healthcare costs | | | |
| Intervention costs | | | |

| | Safe Love Campaign |
|---|---|
| $ / infection averted | |
| $ / life-year saved | |

## References


1. Enns, E. A.; Brandeau, M. L.; Igeme, T. K.; Bendavid, E. Assessing Effectiveness and Cost-Effectiveness of Concurrency Reduction for HIV Prevention. *Int J STD AIDS.* **2011**, 22(10): 558–67.
2. Evans DB, Lim SS, Adam T, Edejer TT, WHO Choosing Interventions that are cost effective (CHOICE) Millennium Development Goals Team. *BMJ*. **2005**, 331(7530): 1457-61.
3. Shillcutt, M. S. D., Walker, D. G., Goodman, C. A., & Mills, A. J. Cost effectiveness in low- and middle-income countries. *Pharmacoeconomics*. **2009**, 27(11): 903-917
4. Galárraga, O., Colchero, M. A., Wamai, R. G., & Bertozzi, S. M. HIV prevention cost-effectiveness: a systematic review. *BMC Public Health*. **2009**, 9(Suppl 1), S5.